BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-056895
Article Type:	Original research
Date Submitted by the Author:	07-Sep-2021
Complete List of Authors:	Ansar, Adnan; La Trobe University; Institute for Breathing and Sleep (IBAS) Lewis, Virginia; La Trobe University, Australian Institute for Primary Care and Aging McDonald, Christine; Austin Health, Respiratory and Sleep Medicine Liu, Chaojie; La Trobe University, Public Health Rahman, Aziz; Federation University Australia, School of Nursing and Healthcare Professions; La Trobe University, School of Nursing and Midwifery
Keywords:	Respiratory tract tumours < ONCOLOGY, PREVENTIVE MEDICINE, PRIMARY CARE, PUBLIC HEALTH, RESPIRATORY MEDICINE (see Thoracic Medicine)

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Title

Defining timeliness in care for patients with lung cancer – a scoping review

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Abstract

Objectives

Early diagnosis and reducing the time taken to achieve each step of lung cancer care is essential. This scoping review aimed to examine timepoints and intervals used to measure timeliness and to critically assess how they are defined by existing studies of the care seeking pathway for lung cancer.

Methods

This scoping review was guided by the methodological framework for scoping reviews by Arksey and O'Malley. MEDLINE, EMBASE, CINAHL and PsycINFO electronic databases were searched. After duplicate removal, all publications went through title and abstract screening followed by full text review and inclusion of articles in the review against the selection criteria. A narrative synthesis describes the timepoints, intervals and measurement guidelines used by the included articles.

Results

A total of 2113 articles were identified from the initial search. Finally, 68 articles were included for data charting process. Seven timepoints and 14 intervals were identified as the most common events researched by the articles. Seventeen lung cancer care guidelines were used to benchmark intervals in the articles; all were developed in Western countries. The British Thoracic Society guideline was the most frequently used guideline (20%). Western guidelines were used by the studies in Asian countries despite differences in the health system structure.

Conclusion

This review identified substantial variations in definitions of some of the intervals used to describe timeliness of care for lung cancer. The differences in healthcare delivery systems of Asian and Western countries, and between High Income Countries and Low - Middle Income Countries may suggest different sets of timepoints and intervals need to be developed.

Strengths and limitations of this study

- This scoping review documented the commonly studied timepoints in the lung cancer care pathway and the heterogeneity in naming the intervals in the disease care pathway for lung cancer across different studies.
- This scoping review documented the lung cancer care guidelines adopted by different research studies and described how the studies presented their findings if not compared with guidelines.
- This scoping review documented the lack of guidelines in Asian countries and possible limitations of using the Western guidelines.
- Only studies published in English were included in the review, which may miss potential literature in other languages.

Background

Lung cancer is the most common cancer, with an incidence of 2.1 million globally during 2018, and is the most frequent cause of deaths in both sexes in 14 regions of the world[1]. Incidence and mortality vary across countries due to differences in smoking prevalence and other risk factors, but overall survival rates are low globally (5-year survival of 10-20% in most countries) with most patients diagnosed at an advanced stage[1].

Timely diagnosis and access to effective treatment are important determinants of outcome in patients with cancer[2]. Higher cancer survival rates are evident in high performing health care systems. For example, lung cancer patients in Japan (33%), Israel (27%) and Korea (25%) have a much higher five-year survival rate than their counterparts in India, Thailand, Brazil and Bulgaria (all less than 10%)[3]. Early diagnosis can improve survival and reduce lung cancer mortality through timely initiation of treatment[4].

Numerous studies have been conducted to assess timeliness of initiation and completion of cancer treatment. However, the pathway to cancer diagnosis and treatment is complex[5]. The patient journey from onset of symptoms to initiation of treatment involves multiple stages, which vary significantly across different health systems[6], with different health systems having different "bottlenecks" in the patient journey.

The patient journey can be categorized into different care timepoints. Timeliness is the idea of reaching different timepoints of care in a way that supports the best patient outcomes. It usually starts from the date of onset of symptoms and ends at the date of initiation of treatment. Depending on the outcome of interest of a research or intervention, intervals are defined by calculating the time between two agreed timepoints. In some countries, clinical guidelines have been developed to establish a maximal length requirement for the intervals between different timepoints to ensure optimal patient care outcomes. These have enabled measurement of

delay. However, studies describing time intervals often mislabeled these intervals as 'delays' despite a lack of benchmarking, creating confusion among readers. There are also marked variations in the definitions of these delays, and in how the data were obtained, measured and presented[7]. This ambiguity leads readers to make assumptions about the interpretation of the terms and findings. Moreover, due to differences in health systems, studies are seldom comparable across countries[6]. Referral pathways vary between countries. For example, in some developing countries, all the diagnostic tests required in order to diagnose a cancer are completed before a patient is referred to a specialist, thus contribute to variation in the definition and length of the diagnostic segment in the care pathway between such developing countries and the developed country which was the source of the guidance .

Existing guidelines for lung cancer care vary in the benchmarks or cutoff values used to describe acceptable limits of time for each step in the disease care pathway. As a result, definitions and measures of "timeliness of care" vary across countries. Furthermore, the majority of guidelines were developed in Western countries, considering country-specific resources and healthcare mechanisms, and associated with effective referral systems governed by policies[8]. It is unlikely that guidelines developed for Western health systems can be fully effective in poorly resourced health systems [8 9], which require different definitions, measurements and guidelines for timely care compatible with their available resources and the strength of their health systems [10].

Several models were proposed in an attempt to improve consistency in the definition, classification and measurement of timeliness of care, but the models are not devoid of limitations. These include the Andersen model of total patient delay[11], the model of pathways to treatment[12] and the Aarhus statement[6]. Andersen's model can capture the decisional and behavioral processes that occur before the initiation of treatment but is limited in its capacity to address the complex and dynamic journey into and through the healthcare system[12]. The

subsequently proposed 'Model of pathways to treatment' is a descriptive framework which can encompass the psychological theories with a focus on patient factors in the appraisal and help-seeking intervals. The most recent and widely accepted framework, 'The Aarhus Statement,'[13] proposes a universal framework to incorporate the issue of lack of consensus in definitions and methods across studies conducted on timeliness of cancer care. It defines four important timepoints that links different interval durations with patient outcomes to determine targets and guidelines (date of first symptom, date of first presentation to a general practitioner (GP), date of referral, and date of diagnosis). It also provides guidance on how to design research with greater precision and transparency. All these models provide an overarching framework that can be adapted to different system contexts. This scoping review aimed to examine timepoints and intervals used to measure timeliness and to critically assess and compare how they are defined by existing studies of the care seeking pathway for lung cancer.

Methods

This scoping review followed the methodological framework for scoping reviews by Arksey and O'Malley[14] which was further enhanced by Levac et al[15] and the Joanna Briggs Institute[16]. Stages of the scoping review framework included (1) Identifying the research question, (2) Identifying relevant studies, (3) Study selection, (4) Charting the data, and (5) Collating, summarising, and reporting the results. The University of York Centre for Reviews and Dissemination guidance for undertaking reviews in health care[17] and the PRISMA-ScR checklist[18] were followed to ensure the comprehensiveness of the review. This scoping review categorised available definitions and terminologies relating to timeliness in the disease care pathway, without an intention of achieving consensus.

Identifying the research question

To address the aim of assessing definitions describing timeliness of seeking and receiving care in patients with lung cancer in published articles, the following research questions were posed:

1. What are the timepoints and intervals commonly identified in the care pathway for lung cancer in the existing literature?
2. How is timeliness of seeking and receiving care for lung cancer described in the existing literature?
3. Are there differences in definitions and terminologies used in Western and Asian countries?

Identifying relevant studies

The study population of included literature was patients with diagnosed lung cancer, irrespective of histological type and disease stage. Studies were identified through the keywords that were used to describe timeliness of seeking care, timepoints in seeking care and intervals between timepoints in the disease care pathway. Studies were excluded if timeliness of care or timepoints and intervals in the care pathway were ambiguous, were not specific for lung cancer, if the primary focus of the article was not timeliness of care, if the articles were not published in English, or if studies were published only as abstracts. This scoping review included all studies, irrespective of study methodology, quality, and publication type to gain a better understanding of how researchers have operationalized and measured timeliness of seeking and receiving care for lung cancer in various study settings in the last twenty years.

The text contained in the titles and abstracts of the papers from the initial search and the keywords used to describe those articles were used to formulate the search strategies specific to the selected databases. MEDLINE, EMBASE, PsycINFO and CINAHL were searched for published articles. An academic health sciences librarian was consulted on selecting the

appropriate keywords and the most appropriate MeSH terms and filters to maximize inclusion of articles within the search, and how to modify them for selected bibliographic databases. Reference lists were screened for relevant articles. Search results were imported into EndNote (version X9) to organize search results specific to each database and later used to generate the reference list for the review. References were imported to Covidence, which was used for documenting the process including duplicate identification and removal, title and abstract screening, and full-text review for included articles. Detailed keywords mapping and database specific search strategies were published in the protocol of this scoping review[19].

Study selection

Selection of publications involved two stages. First, title and abstract were screened against the inclusion criteria, and second, the potentially relevant papers went through full-text review. To increase the reliability of the decision process all selected papers were independently assessed by at least two researchers. Due to the exploratory nature of this scoping review, a detailed methodological quality assessment was not required[20]. One author (AA) performed a search of the electronic database for literature. Two authors (AA and MAR) independently reviewed and screened the abstracts of the searched articles for inclusion. The other two authors (VL and CMcD) reviewed the disagreements and resolved by discussion with all the authors.

Data charting, collating and summarising

A data extraction chart was used to capture the data from selected articles (supplementary file 1), which was recorded on Microsoft Excel 365. Data were extracted by AA independently and examined by authors (VL, CL, CMcD and MAR).

Initially a coding tree was constructed which had three levels: timepoints as the first level, time intervals (with starting and ending timepoint) as the second level, and timeliness (with a definition or benchmarking) as the third level. The initial coding tree was further expanded and

divided when new categories emerged from data. An exhaustive list of timepoints related to seeking or receiving care on the patient care journey was extracted through comparing and merging similar terminologies. The sequence of the timepoints was determined as follows, i) patient recalled onset of symptoms, ii) first contact with a healthcare provider, iii) diagnosis, iv) referral to a specialist, v) first visit to a specialist/hospital admission, vi) patient informed about diagnosis, vii) pre-initiation of treatment, and viii) initiation of treatment. Afterwards, we summarized and charted the type of intervals examined in the included studies. Intervals in the lung cancer patient care pathway considered the duration between one timepoint and another timepoint. Relevant definitions or measurements in relation to the three level coding themes (timepoints, intervals, and timeliness) were also extracted with or without further verification from the cited guidelines. The data on definition of interval or delay were extracted when an article explicitly mentioned the guiding principle (cancer care guideline or self-definition) which included researcher/study constructed definitions as well. Comparisons between Asian and Western countries were based on the similarities or differences in using timepoints, intervals and measurement of timelines for intervals.

Ethics approval

Ethical approval is not needed as this scoping review reviewed already published articles. The results produced from this review will be submitted to a scientific peer-reviewed journal for publication and will be presented at scientific meetings.

Results

A total of 2113 articles were identified from the initial search. After duplicates removal, 1546 articles were screened for eligibility and 269 articles were selected for full text review. Two hundred and one articles were excluded because they were not relevant, only published as abstract, or not related to lung cancer. Finally, 68 articles were included for the data charting

process (figure 1). Characteristics of the included articles are given in table 1 (review articles were excluded).

Figure 1: PRISMA flow chart

Table 1: Characteristics of included articles

N=68	Characteristics of included articles	N (%)
Year of publication	2001-2010	25 (37)
	2011-2018	43 (63)
Study setting	UK	14 (20.6)
	USA	13 (19.1)
	Australia	7 (10.2)
	Canada	8 (12)
	India	3 (4.4)
	Turkey	3 (4.4)
	Denmark, Netherland, Norway, Spain (two from each)	8 (11.8)
	Italy, Sweden, France, New Zealand, Finland, Poland, Scotland, mainland China, Taiwan, Nepal (one from each)	10 (14.7)
Study design	Cohort	9 (13.2)
	Cross sectional	41 (60.83)
	Case control	3 (4.4)
	Systematic Review	1 (1.5)
	Scoping Review	1 (1.5)
	Other study designs	13 (19.1)
Sample size	Range	12 - 171208
	All studies total	280591

Timepoints

Based on the selected articles, timepoints were classified and the sequence was determined into eight categories (Table 2). Commonly mentioned timepoints included onset of symptom(s), first contact with healthcare provider, diagnosis/first suspicious investigation result, referral/receipt of referral by a specialist (at secondary care), first visit to a specialist/hospital admission, patient informed of lung cancer diagnosis and initiation of treatment.

Table 2: Timepoints in the lung cancer care pathway

Timepoints	Articles	Definition of timepoint
Patient recalled onset of symptoms	Baughan et al. 2009 UK[21]	Date patient first noticed symptoms
	Corner et al. 2005 UK[22]	The date, week, or month when a symptom or health change was recalled, and actions taken as a result by the patient were recorded as well as a description of the health change or symptom
	Dobson et al. 2017 UK[23]	The date of symptom onset was defined as the first symptom reported
	Melling et al. 2002 UK[24]	First symptom reported by the patients to their GPs
	Neal et al. 2015 UK[25]	Onset of first symptom
	Özlü et al. 2004 Turkey[26]	Onset of symptoms

Timepoints	Articles	Definition of timepoint
	Yang et al. 2015 Mainland China[27]	First symptom
	Yilmaz et al. 2008 Turkey[28]	Date of initial symptoms
	Smith et al. 2009 Scotland[29]	The date participant defined first symptom
	Salomaa et al. 2005 Finland[30]	The dates of onset of symptoms
First contact with healthcare provider	Baughan et al. 2009 UK[21]	Date patient of first presentation with a GP
	Corner et al. 2005 UK[22]	Timing of first visit to the GP
	Dobson et al. 2017 UK[23]	Date on which person consulted a GP about their symptoms.
	Largey et al. 2015 Australia[31]	Dates of first presentation as the time point the clinician started investigation or referral for possible investigation
	Melling et al. 2002 UK[24]	Presentation of the first cancer symptom to the GP
	Neal et al. 2015 UK[25]	First presentation (Face-to-face consultations, nurse consultations, telephone consultations) to primary care
	Helsper et al. 2017 Netherlands[32]	first contact (physical or telephone) with the GP for suspected cancer-related signs or symptoms
	Özlü et al. 2004 Turkey[26]	First presentation to a physician;
	Rankin et al. 2017 Australia[33]	First consultation with primary healthcare provider
	Vidaver et al. 2016 USA[34]	First visit to primary healthcare provider
	Yang et al. 2015 Mainland China[27]	First contact with local doctor
	Yilmaz et al. 2008 Turkey[28]	Date of first doctor visit
	Salomaa et al. 2005 Finland[30]	First visit to a doctor, who was in general, a GP
	Smith et al. 2009 Scotland[29]	Date of presentation to a medical practitioner
Diagnosis/ First suspicious investigation result	Corner et al. 2005 UK[22]	Date of diagnosis (the investigation procedure was not specified)
	Malalasekera et al. 2018 Australia[35]	First suspicious investigation report (the investigation procedure was not specified)
	Melling et al. 2002 UK[24]	Date of Diagnosis (bronchoscopy, mediastionsocopy, CT scan, bone scan, plural cytology)
	Neal et al. 2015 UK[25]	Date of diagnosis (CT/PET scan, a tissue diagnosis)
	Grunfeld et al. 2009 Canada[36]	Date of confirmed diagnosis (date of the pathology or radiology report)
	Helsper et al. 2017 Netherlands[32]	Date of the histological confirmation of the primary tumor
	Rankin et al. 2017 Australia[33]	Time of the formal cancer diagnosis being made
	Vidaver et al. 2016 USA[34]	First imaging result with a lung abnormality
	Singh et al 2010 USA[37]	Earliest date that a diagnostic clue could have been recognized by a care provider
	Largey et al. 2015 Australia[31]	Date of histological diagnosis
	Li et al. 2013 Canada[38]	Date of diagnosis
	Maiga et al. 2017 USA[39]	Date of pathology diagnosis
	Özlü et al. 2004 Turkey[26]	Date of histopathological diagnosis
	Yang et al. 2015 Mainland China[40]	Date of diagnosis (CT scan and biopsy)
	Yilmaz et al. 2008 Turkey[28]	Date of diagnosis
	Schultz et al. 2009 USA[41]	Date when a pathologic diagnosis of lung cancer was confirmed
Referral to a specialist/ receipt of referral by a specialist or thoracic department	Baughan et al. 2009 UK[21]	Date of decision to refer by primary care
	Largey et al. 2015 Australia[31]	Date of referral by primary healthcare provider
	Malalasekera et al. 2018 Australia[35]	Date of first referral to secondary care
	Melling et al. 2002 UK[24]	Date of referral to secondary care
	Neal et al. 2015 UK[25]	Date of GP referral to specialist or admission to hospital
	Grunfeld et al. 2009 Canada[36]	Referral for diagnostic assessment was received by the consultant
	Helsper et al. 2017 Netherlands[32]	The timepoint when the responsibility for the patient was transferred from a GP to secondary care
	Vidaver et al. 2016 USA[34]	Date of referral to a specialist
	Yang et al. 2015 Mainland China[40]	Date of referral to hospital from primary physician
	Salomaa et al. 2005 Finland[30]	The date of the writing of the referral requesting consultation from a specialist
	Stokstad et al. 2017 Norway[42]	A referral letter for suspected lung cancer was received by the Department of Thoracic Medicine

Timepoints	Articles	Definition of timepoint
First visit to a specialist/ Hospital admission	Alexander et al. 2016 Australia[43]	Date of first medical oncology or hematology review for patients with an urgent presentation
	Baughan et al. 2009 UK[21]	Date patient first seen by specialist
	Largey et al. 2015 Australia[31]	First specialist visit
	Malalasekera et al. 2018 Australia[35]	First specialist visit
	Vidaver et al. 2016 USA[34]	First visit to a specialist
	Yilmaz et al. 2008 Turkey[28]	Date of admission to pneumology department
	Salomaa et al. 2005 Finland[30]	The first appointment with the specialist
Patient informed of the cancer diagnosis	Baughan et al. 2009 UK[21]	Date patient told the diagnosis
	Grunfeld et al. 2009 Canada[36]	Date patient informed of diagnosis
	Vidaver et al. 2016 USA[34]	Date patient informed of the biopsy result
Pre-initiation of treatment	Maiga et al. 2017 USA[39]	• Date of lung nodule identification on computed tomography (CT) imaging according to the medical record • Date when a lung nodule originally less than 10 mm in size was documented as having new growth on CT imaging.
Initiation of treatment	Li et al. 2013 Canada[38]	Date of first treatment, surgery and adjuvant treatment
	Alexander et al. 2016 Australia[43]	Time to chemotherapy should be measured from the date that chemotherapy treatment was decided. For adjuvant chemotherapy, time to chemotherapy should be measured from the date of surgery.
	Evans et al. 2016 Australia[44]	Date of initial definitive management
	Malalasekera et al. 2018 Australia[35]	Treatment start date
	Melling et al. 2002 UK[24]	Date treatment started (surgery, radical radiotherapy with chemotherapy).
	Grunfeld et al. 2009 Canada[36]	Date of initiation of neoadjuvant chemotherapy, surgery if no preoperative treatment was required, chemotherapy, radiotherapy, or a decision not to treat.
	Helsper et al. 2017 Netherlands[32]	Date of start of therapy as registered in the Network of Cancer Registries
	Iachina et al. 2017 Denmark[45]	First day of treatment is defined as the date of initiation of surgical, oncological, or radiological treatment, whichever comes first
	Özlü et al. 2004 Turkey[26]	Start of treatment
	Rankin et al. 2017 Australia[33]	Start of treatment
	Shugarman et al. 2009 USA[46]	First date recorded for treatment (surgery, radiation, or chemotherapy)
	Vidaver et al. 2016 USA[34]	First treatment date
	Yang et al. 2015 Mainland China[40]	Initiation of treatment date
	Yilmaz et al. 2008 Turkey[28]	Date of thoracotomy
	Stokstad et al. 2017 Norway[42]	The time for treatment decision as the date when such a decision was documented in the Electronic Medical Record
	Maiga et al. 2017 USA[39]	Time of resection.

Intervals

Fifteen different intervals, from onset of symptom to initiation of treatment, were identified in this scoping review (Table 3): (1) onset of symptoms to first contact with healthcare provider, (2) first contact with general healthcare provider to first contact with specialist healthcare provider, (3) first contact with secondary/tertiary healthcare provider to diagnosis, (4) first contact with healthcare provider to diagnosis, (5) diagnosis to contact with secondary/tertiary healthcare

provider, (6) onset of symptoms to contact with secondary/tertiary healthcare provider, (7) contact with secondary/tertiary healthcare provider to initiation of treatment, (8) onset of symptom(s) to referral to a specialist/ receipt of referral by a specialist or thoracic department, (9) referral to a specialist/ receipt of referral by a specialist or thoracic department to diagnosis, (10) onset of symptom to diagnosis, (11) referral to a specialist/ receipt of referral by a specialist or thoracic department to treatment, (12) first contact with healthcare provider to treatment, (13) diagnosis to initiation of treatment, (14) onset of symptom to Initiation of treatment, and (15) post initiation of treatment intervals. Intervals were not measured as completion of treatment or death.

Some articles used different terminologies to label the same intervals; and similarly, the same terminology was used to label different intervals in different articles.

1. Onset of symptoms to first contact with healthcare provider interval: patient delay[30 40 47-50] and patient's application interval[28 51].
2. Duration from first contact with healthcare provider to first contact with specialist at secondary care or next level: GP delay[30 47-49], GP interval[52], primary care interval[32], referral delay[30 47 49], and referral interval[28 51].
3. First contact with secondary or tertiary healthcare provider to diagnosis interval: specialist interval[52], specialist's delay (second doctor's delay)[30 48 49], diagnosis delay[53] and diagnosis interval[51].
4. First contact with healthcare provider to diagnosis: diagnostic interval[32 33 35 52] and delay in diagnosis[54].
5. Diagnosis to contact with secondary/tertiary healthcare provider: referral interval in one study[55].
6. Interval between onset of symptom to contact with secondary/tertiary healthcare provider: patient delay[56].

7. Interval between contact with secondary/tertiary healthcare provider and initiation of treatment: hospital delay[49 53] and treatment interval[55].
8. Referral to a specialist or receipt of referral by a specialist or thoracic department to diagnosis: referral interval[32].
9. Interval between onset of symptom to diagnosis: total diagnostic delay[52] and time to diagnosis[57].
10. Referral to a specialist/receipt of referral by a specialist or thoracic department to treatment interval: time to treatment (hospital delay)[58] and delay in secondary healthcare[40].
11. Interval between first contact with healthcare provider to treatment: healthcare interval[32], system delay[40] and doctor's interval[28 51].
12. Diagnosis to initiation of treatment: therapeutic delay[47], treatment delay[40 53], treatment interval[32 35], system interval[59], pretreatment interval[33], diagnosis-to-treatment delay[60] and diagnosis-to-treatment interval[39].
13. Onset of symptom(s) to initiation of treatment: global delay[61], total delay[49], and symptom to treatment delay[60].

Table 3: Intervals in the lung cancer care pathway

Intervals	Articles	Study setting
Onset of symptoms	Baughan et al. 2009 [21]	UK
To	Brocken et al. 2012 [47]	Netherlands
First contact with healthcare provider	Corner et al. 2005 [22]	UK
	Ellis & Vandermeer 2011 [61]	Canada
	Ezer et al. 2017 [62]	Canada
	Helsper et al. 2017 [32]	Netherlands
	Koyi et al. 2002 [48]	Sweden
	Neal et al. 2015 [25]	UK
	Özlü et al. 2004 [26]	Turkey
	Rolke et al. 2007 [49]	Norway
	Thapa et al. 2014 [50]	Nepal
	Verma et al. 2018 [63]	Australia
	Yang et al. 2015 [40]	Mainland China
	Yilmaz et al. 2008 [28]	Turkey
	Salomaa et al. 2005 [30]	Finland
	Sawicki et al. 2013 [64]	Poland
	Sulu et al. 2011 [51]	Turkey
	Smith et al. 2009 [29]	Scotland
First contact with general healthcare provider	Brocken et al. 2012 [47]	Netherlands
To	Baughan et al. 2009 [21]	UK

Intervals	Articles	Study setting
First contact with specialist healthcare provider	Barrett & Hamilton 2008 [65]	UK
	Devbhandari et al. 2007 [66]	UK
	Ellis & Vandermeer 2011 [61]	Canada
	Emery et al. 2013 [52]	Australia
	Forrest et al. 2014 [67]	UK
	Hueto Pérez De Heredia et al. 2012 [68]	Spain
	Koyi et al. 2002 [48]	Sweden
	Helsper et al. 2017 [32]	Netherlands
	Rolke et al. 2007 [49]	Norway
	Sood et al. 2009 [69]	New Zealand
	Melling et al. 2002 [24]	UK
	Verma et al. 2018 [63]	Australia
	Thapa et al. 2014 [50]	Nepal
	Vidaver et al. 2016 [34]	USA
	Yilmaz et al. 2008 [28]	Turkey
	Salomaa et al. 2005 [30]	Finland
	Sulu et al. 2011 [51]	Turkey
	Girolamo et al. 2018 [70]	UK
	Grunfeld et al. 2009 [36]	Canada
	Olsson et al. 2009 [71]	USA
First contact with secondary/tertiary healthcare provider To Diagnosis	Ellis & Vandermeer 2011 [61]	Canada
	Emery et al. 2013 [52]	Australia
	Koyi et al. 2002 [48]	Sweden
	Gozalez et al. 2014 [53]	Spain
	Salomaa et al. 2005 [30]	Finland
	Sulu et al. 2011 [51]	Turkey
	Özlü et al. 2004 [26]	Turkey
	Rolke et al. 2007 [49]	Norway
First contact with healthcare provider To Diagnosis	Barrett & Hamilton 2008 [65]	UK
	Corner et al. 2005 [22]	UK
	Devbhandari et al. 2007 [66]	UK
	Emery et al. 2013 [52]	Australia
	Ezer et al. 2017 [62]	Canada
	Forrest et al. 2014 [67]	UK
	Neal et al. 2015 [25]	UK
	Hsieh et al. 2012 [54]	Taiwan
	Helsper et al. 2017 [32]	Netherlands
	Özlü et al. 2004 [26]	Turkey
	Rankin et al. 2017 [33]	Australia
	Vidaver et al. 2016 [34]	USA
Diagnosis To Contact with secondary/tertiary healthcare provider	Kanarek et al. 2014 [55]	USA
	Wai et al. 2012 [72]	Canada
	Winget et al. 2007 [73]	Canada
	Zullig et al. 2014 [74]	USA
Onset of symptoms To Contact with secondary/tertiary healthcare provider	Ampil et al. 2014 [56]	USA
	Bjerager et al. 2006 [75]	Denmark
	Thapa et al. 2014 [50]	Nepal
Contact with secondary/tertiary healthcare provider To Initiation of treatment	Ellis & Vandermeer 2011 [61]	Canada
	Ampil et al. 2014 [56]	USA
	Devbhandari et al. 2008 [76]	UK
	Girolamo et al. 2018 [70]	UK
	Hueto Pérez De Heredia et al. 2012 [68]	Spain
	Hubert et al. 2018 [77]	Canada
	Kanarek et al. 2014 [55]	USA
	Verma et al. 2018 [63]	Australia
	Gozalez et al. 2014 [53]	Spain
	Rolke et al. 2007 [49]	Norway
	Olsson et al. 2009 [71]	USA
	Wai et al. 2012 [72]	Canada
	Winget et al. 2007 [73]	Canada
	Vidaver et al. 2016 [34]	USA

Intervals	Articles	Study setting
Onset of symptoms To Referral to specialist/ receipt of referral by a specialist or thoracic department	Buccheri & Ferrigno 2004 [78]	Italy
	Gozalez et al. 2014 [53]	Spain
	Lee et al. 2002 [79]	UK
Referral to a specialist/ receipt of referral by a specialist or thoracic department To Diagnosis	Barrett & Hamilton 2008 [65]	UK
	Grunfeld et al. 2009 [36]	Canada
	Helsper et al. 2017 [32]	Netherlands
	Evans et al. 2016 [44]	Australia
	Largey et al. 2016 [80]	Australia
	Sood et al. 2009 [69]	New Zealand
	Smith et al. 2009 [29]	Scotland
Onset of symptoms To Diagnosis	Corner et al. 2005 [22]	UK
	Emery et al. 2013 [52]	Australia
	Koyi et al. 2002 [48]	Sweden
	Lee et al. 2002 [79]	UK
	Wai et al. 2012 [72]	Canada
	Walter et al. 2015 [57]	UK
	Sachdeva et al. 2014 [81]	India
	Chandra et al 2009 [60]	India
	Dubey et al 2016 [82]	India
Referral to a specialist/ receipt of referral by a specialist or thoracic department To Treatment	Devbhandari et al. 2007 [66]	UK
	Ampil et al. 2014 [56]	USA
	Forrest et al. 2014 [67]	UK
	Bozcuk & Martin 2001 [58]	UK
	Evans et al. 2016 [44]	Australia
	Largey et al. 2016 [80]	Australia
	Grunfeld et al. 2009 [36]	Canada
	Iachina et al. 2017 [45]	Denmark
	Olsson et al. 2009 [71]	USA
	Smith et al. 2009 [29]	Scotland
	Sood et al. 2009 [69]	New Zealand
	Yang et al. 2015 [40]	Mainland China
First contact with healthcare provider To Treatment	Ezer et al. 2017 [62]	Canada
	Helsper et al. 2017 [32]	Netherlands
	Özlü et al. 2004 [26]	Turkey
	Vidaver et al. 2016 [34]	USA
	Yang et al. 2015 [40]	Mainland China
	Yilmaz et al. 2008 [28]	Turkey
	Melling et al. 2002 [24]	UK
	Sawicki et al. 2013 [64]	Poland
	Sulu et al. 2011 [51]	Turkey
Diagnosis To Initiation of treatment	Borrayo et al. 2016 [83]	USA
	Brocken et al. 2012 [47]	Netherlands
	Gozalez et al. 2014 [53]	Spain
	Grunfeld et al. 2009 [36]	Canada
	Evans et al. 2016 [44]	Australia
	Forrest et al. 2014 [67]	UK
	Kanarek et al. 2014 [55]	USA
	Kim et al. 2016 [59]	Canada
	Helsper et al. 2017 [32]	Netherlands
	Iachina et al. 2017 [45]	Denmark
	Largey et al. 2016 [80]	Australia
	Li et al. 2013 [38]	Canada
	Maiga et al. 2017 [39]	USA
	Malalasekera et al. 2018 [35]	Australia
	Olsson et al. 2009 [71]	USA
	Ost et al. 2013 [84]	USA
	Özlü et al. 2004 [26]	Turkey
	Rankin et al. 2017 [33]	Australia
	Vidaver et al. 2016 [34]	USA
	Winget et al. 2007 [73]	Canada

Intervals	Articles	Study setting
	Yang et al. 2015 [40]	Mainland China
	Yilmaz et al. 2008 [28]	Turkey
	Yorio et al. 2009 [85]	USA
	Zullig et al. 2014 [74]	USA
	Salomaa et al. 2005 [30]	Finland
	Schultz et al. 2009 [41]	USA
	Sulu et al. 2011 [51]	Turkey
	Chandra et al 2009 [60]	India
Onset of symptoms To Initiation of treatment	Ellis & Vandermeer 2011 [61]	Canada
	Koyi et al. 2002 [48]	Sweden
	Olsson et al. 2009 [71]	USA
	Özlü et al. 2004 [26]	Turkey
	Rolke et al. 2007 [49]	Norway
	Verma et al. 2018 [63]	Australia
	Yilmaz et al. 2008 [28]	Turkey
	Salomaa et al. 2005 [30]	Finland
	Sawicki et al. 2013 [64]	Poland
	Sulu et al. 2011 [51]	Turkey
	Chandra et al 2009 [60]	India
Post initiation of treatment intervals	Grunfeld et al. 2009 [36]	Canada
	Kim et al. 2016 [59]	Canada
	Lee et al. 2002 [79]	UK
	Li et al. 2013 [38]	Canada
	Hubert et al. 2018 [77]	Canada
	Hueto Pérez De Heredia et al. 2012 [68]	Spain
	Ju et al. 2017 [86]	USA
	Ost et al. 2013 [84]	USA
	Özlü et al. 2004 [26]	Turkey
	Rolke et al. 2007 [49]	Norway
	Smith et al. 2009 [29]	Scotland
	Vidaver et al. 2016 [34]	USA
	Wai et al. 2012 [72]	Canada
	Wilcock et al. 2016 [87]	UK
	Yilmaz et al. 2008 [28]	Turkey
	Yorio et al. 2009 [85]	USA
	Zullig et al 2014 [74]	USA
	Kudjawu et al. 2016 [88]	France
	Sood et al. 2009 [69]	New Zealand

Table 4 presents the time intervals commonly studied in the included articles. The most frequently studied interval was “diagnosis to initiation of treatment”, followed by “first contact with HP to specialist” and “symptom onset to first contact”. Both “diagnosis to specialist” and “specialist to diagnosis” paths were studied. Very few studies have researched onset of symptom to referral and specialist consultation. The timepoint “patient informed of diagnosis” and intervals involving this timepoint was rarely studied.

Table 4: Time intervals commonly studied – Dark blue>10 (most commonly), Light blue>7 (commonly), Lighter blue>3 (occasionally), White = none

Starting point	Ending point: First contact with HCP	Referral	Specialist consultation	Diagnosis	Patient informed of diagnosis	Initiation of Treatment
Onset of symptom	18	3	3	9	-	11
First contact with HCP	X	-	22	12	-	9
Referral		X	-	7	-	12
Specialist consultation			X	7	-	14
Diagnosis			4	X	3	28
Patient informed of Diagnosis					X	3

Timeliness measures

The review identified 30 articles which conceptualized delay in the care pathway by adapting benchmarks from established guidelines to set cutoff values. The benchmarks were guided by British Thoracic Society (BTS) recommendations on organizing the care of patients with lung cancer [89], National Institute for Clinical Excellence (NICE) guideline[90 91], United Kingdom National Cancer Plan (UKNCP)[92], United Kingdom National Health Service (UKNHS) guideline[93 94], United Kingdom Department of Health guideline[95], RAND Corporation guideline[96], Canadian Strategy for Cancer Control (CSCC)[97], Canadian guidelines[98], Standing Medical Advisory Committee (SMAC)[99], Cancer Council Australia and Cancer Australia[100], Danish Lung Cancer Group and Registry[101], Swedish Lung Cancer Group[102], and Scottish Executive Health Department (SEHD)[103 104], Institute of Medicine (IOM)[105], Dutch Association of Physicians for Pulmonary Disease and Tuberculosis[106], Joint Council for Clinical Radiology[107], American College of Chest Physicians (ACCP)[108], and Norwegian National Guidelines[109].

Six articles referenced cutoff values from other articles to compare timeliness[37 46 48 55 60 80] and one article proposed a benchmark cutoff value based on their findings[34]. Fifteen articles used single guidelines while the other half used more than one guideline to conceptualize timeliness measures. Out of 30 articles, UKNHS were used seven times[35 43 44 67 68 70 80], BTS was adopted

by 14 articles[26 28 35 37 41 47 49 51 60 66 68 69 79 84]; NICE guideline by four articles[21 62 66 69], RAND corporation guideline by four articles[35 41 84 110] and Canadian guidelines by four articles[28 36 51 60], SEHD guidelines by three articles[21 24 35], Danish Lung Cancer Group guidelines by three articles[35 45 80], UKNCP guidelines by two articles[66 76], SMAC guideline by two articles[24 35], Norwegian National Guidelines by two articles[42 49], and Swedish Lung Cancer Group guidelines by two articles[35 51] (Table 5).

Table 5: Measures of timeliness based on guidelines

Interval	Cutoff value	Guidelines	Naming of interval
Onset of symptoms to first doctor visit[28 51]	30 days	BTS	Patient's Application interval [28 51]
First clinical presentation to first suspicious investigation[35 80]	28 days	DLCG	
First abnormal investigation (CXR) to confirmation of diagnosis/specialist visit[41]	14 days 56 days	BTS RAND	
GP to Specialist[24 28 35-37 42 49 51 60 68 69 84]	1 day for urgent referrals, 10 days for standard referrals 80% within 3–5 days 7 days 14 days	IOM ACCP, DLCG, DAPPDT BTS, NICE, NNG UKNHS, Australian, UKDoH, SIGN, SMAC, CSCC, SLCG	Referral delay[49] or Referral Interval[28 51]
Primary care to initiation of treatment [28 35 42 51 62 66 67 76]	14 days 42 days 62 days 98 days 28 days for treatment decision, 35 days for systemic therapy 42 days for surgery or radiotherapy	DLCG SLCG, CSCC UKNHS, UKNCP, BTS, Joint Council for Clinical Radiology RAND Norwegian National Guidelines	System interval[35] or Doctor's interval [28 51]
Referral to secondary care to Diagnosis[28 36 45 51 60 84]	28 days 14 days	UKDoH, CSCC, DLCG BTS	Diagnosis Interval[28 51]
First referral to secondary care to treatment start [21 35 44 68-70 80]	42 days 49 days 62 days 42 days in ≥85% patients	Australian NOLCP UKNHS, SEHD, NICE, BTS DLCG	Secondary care interval [35]
First clinical presentation to Diagnosis [35 84]	28 days 60 days	CSCC RAND	Diagnostic interval[35]

Interval	Cutoff value	Guidelines	Naming of interval
First investigation to treatment[45]	14 days	DLCG	
Diagnostic investigation to patient informed of diagnosis [49]	7 days	BTS	Informed diagnostic delay [49]
Diagnosis to Treatment start [28 35 41 45-47 51 55 67 80 84 110]	14 days	Australian, DLCG	Treatment interval [28 35 51 55 67] or Therapeutic delay[47]
	14 days in ≥80% patients, 35 days if mediastinoscopy	SLCG, DAPPDT	
	14 days until surgery	CSCC	
	21 days	DLCG, DAPPDT	
	28 days	NOLCP	
	31 days	UKNHS	
	42 days for NSCLC/14 days for SCLC	RAND	
	42 days	DLCG, *Other study	
First clinical presentation to treatment start[24 34 35]	56 days for surgery	SMAC, UKDoH, SIGN,	Total interval [35]
	52 days	Cutoff value proposed by authors	
Decision to treatment to initiation of treatment [43 66 70 76]	21 days	UKNHS	
	31 days (28 days for surgery & radiotherapy, 7 days for chemotherapy)	UKNCP, BTS, Joint Council for Clinical Radiology	
Surgery to chemotherapy (Adjuvant chemotherapy)[43]	48 days	UKNHS	
Referral receipt to specialist consultation[21 43]	14 days	UKNHS, SEHD, NICE	
Oncology referral to radiotherapy/ chemotherapy[69]	14 days	BTS, NICE	
Specialist consultation to surgery[41 68 69 79]	56 days	BTS, NICE	
Surgeon consultation/Surgical waiting list to surgery [60 69 79]	28 days	BTS, NICE	
	14 days	CSCC, *Other study	
Onset of symptoms to treatment[28 51]	72 days	BTS, Canadian guidelines	Total interval [28 51]
Primary care referral to first diagnostic evaluation of symptom[37]	7 days	BTS	Type I missed opportunity (No evaluation or work-up was initiated within 7 days of appearance of a predefined clinical clue) [37]
Primary care referral to completion of evaluation at referral center[37]	30 days	BTS, *Other article	Type II missed opportunity (Failure to complete within 30 days a diagnostic procedure or consultation or the follow-up action requested in response to a predefined clue)[37]

*Cutoff value adapted from other studies. IOM: Institute of Medicine, CSCC: Canadian Strategy for Cancer Control, NHMRC: National Health and Medical Research Council, ACCP: American College of Chest Physicians, BTS: British Thoracic Society, UKDoH: United Kingdom Department of Health, UKNHS: United Kingdom National Health Service, NICE: National Institute for Health and Care

Excellence, UKNCP: United Kingdom National Cancer Plan, SLCG: Swedish Lung Cancer Group, RAND: Research and Development USA, NOLCP: National Optimal Lung Cancer Pathway, SEHD: Scottish Executive Health Department, DLCG: Danish Lung Cancer Group, SMAC: Standing Medical Advisory Committee, DAPPDT: Dutch Association of Physicians for Pulmonary Disease and Tuberculosis, NNG: Norwegian National Guidelines.

Differences between Asian and Western countries

There were nine studies from five Asian countries/territories included in the scoping review. There were no differences in the terminology for labelling time points and intervals in the lung cancer care pathway between studies from Asian and Western countries. Studies from Asian countries/territories adapted timeline for intervals from Western guidelines in many instances. One study from India [60] and several Turkish [26 28 51] studies measured timeliness by adapting guidelines from the BTS and Canada. The reporting of timeliness was not described as being guided by any specific guideline in studies from mainland China [40], Nepal [50], Taiwan [54] and two other studies from India [81 82].

Discussion

Timepoints

The first event in any health-seeking behaviour relates to the first health changes or the onset of symptom(s).It is difficult to capture the exact timepoint of onset of symptom(s) except by asking respondents directly. It may also be difficult to establish a link between onset of symptoms and health-seeking behaviour relating to the diagnosis of lung cancer as similar symptoms are shared by other respiratory diseases. Included studies obtained data from a variety of sources including cancer registries, longitudinal surveillance data, insurance claims data, and hospital records. Not all the studies included the time point ‘onset of symptoms’ because of the differences in the interval of interest or objective of the study. The relevance and importance of the first time point to understanding the overall patient care pathway is likely to vary across countries with different health systems and resources. In contrast, clinical processes post

diagnosis are highly standardized. As a result, research about timeliness in healthcare is focused primarily on the timepoints prior to diagnosis.

After onset of symptom(s) the next timepoint in the care seeking pathway is first contact with any healthcare provider. The studies included in this review reported only contact with formal healthcare providers. This may have been because of the difficulty involved in capturing reliable information on seeking healthcare from informal healthcare providers in the absence of any specific record management system and because of the potential for recall bias associated with self-report. Nonetheless, informal healthcare providers (including provision of over-the-counter medicines from unregulated pharmacies, village doctors and traditional or herbal remedies) are predominant in developing countries where, sometimes, informal healthcare is the only available healthcare option accessible[111].

Depending on the healthcare system, the next timepoint in the lung cancer care pathway after first contact with any healthcare provider is diagnosis or referral to the next level of healthcare for evaluation of the disease. Some of the studies included a timepoint reflecting hospital admission or first specialist visit date. Inclusion of referral time and hospital admission time or first specialist consultation time helped to measure the time elapsed from date of referral to consultation with a specialist or hospital admission. The date when a patient was informed of his/her diagnosis was mentioned by three studies. The last timepoint in the disease care pathway is the date of initiation of any oncological treatment.

Intervals

The terms ‘delay’ and ‘interval’ were both used in studies to describe timeliness. The term ‘delay’ conveys a negative connotation, despite most articles using the term in the absence of benchmarking. It is more appropriate to describe as ‘time interval’ rather than ‘delay’ as it is weighs down the value which might be inaccurate as many patients seek help promptly.

Therefore, several articles suggested using the term 'time interval' as a neutral alternative to 'delay'[11 12 112]. Researchers argued that the term 'time interval' should not be replaced by 'delay' unless the results were compared with others or against benchmarks.

Patients do not necessarily move through timepoints in sequential order. In some systems, patients may bypass certain timepoints. Most included studies were conducted in countries with a 'gate keeper' system consisting of GPs as the first point of contact for healthcare, except for the studies from Asian countries. Diagnosis occurred after the GPs referral of a patient with suspicious preliminary investigation to the next level of healthcare or the specialist. However, this pathway is not common to all healthcare systems, as confirmatory investigation requisition can be initiated before the referral to a specialist. For instance, a request for a CT and fine needle aspiration cytology can be initiated by a primary care physician and hence, a patient can be diagnosed with lung cancer by a GP before referral to secondary healthcare.

Studies have segmented the lung cancer care pathway into different intervals depending on the objectives of those studies and sources of data. However, there were marked differences in how the intervals were named and this heterogeneity in typologies can be misleading as the same name is used for different intervals. For instance, the 'patient's application interval' and 'the time between onset of symptoms to first contact with primary health care provider' were descriptions of the same interval in two studies[28 51] while 'patient delay' was used both for the interval 'onset of symptom to primary healthcare provider'[30 40 47-50] and 'onset of symptom to secondary healthcare provider'[56]. 'Patient delay' may not be entirely related to patient factors as lack of health resources can influence the time lapse from onset of symptom to contact with a healthcare provider.

Similarly, the interval 'first contact with a primary healthcare provider to secondary healthcare provider' was labelled as 'referral delay'[30 47 49] in some studies [55] and 'diagnosis to secondary/tertiary healthcare provider' and 'referral or receipt of referral by a specialist to

diagnosis'[32]in others. There were also differences in defining diagnostic intervals or delay, including 'from first contact with the secondary healthcare provider to diagnosis'[51 53], 'from first contact with primary healthcare provider to diagnosis'[32 33 35 52 54], and 'from onset of symptom to diagnosis'[52 57]. The interval between 'first contact with primary healthcare provider' and 'treatment initiation' was labelled as 'system delay'[40] and 'system interval' and was also described as the 'diagnosis to initiation of treatment' interval[59]. 'Treatment delay' was used for the intervals 'diagnosis to initiation of treatment'[40], and 'onset of symptoms to initiation of treatment'[60]. Use of different terminology for the same intervals and use of the same terminology to label different intervals is confusing and can lead to difficulties in interpretating results. Standardised typology would be helpful in order to streamline consistency and enable comparability across studies.

Timeliness benchmarks

British Thoracic Society (BTS) guidelines were those most frequently cited in the included studies (20%). Studies guided by the BTS guidelines adapted the definition of intervals and measurement of timeliness depending on the interval of interest. Common timeliness measures adapted from BTS included the length of time that should elapse from initial GP referral of suspected lung cancer to evaluation/respiratory assessment (≤1 week), primary care referral to receiving diagnostic tests (bronchoscopy/histology/cytology) (≤2 weeks), presentation of symptom to diagnosis (≤8 weeks), diagnosis to initiation of treatment (≤6 weeks), GP referral to specialist consultation (≤1 week), GP referral and initiation of any type of treatment (≤62 days), specialist consultation and surgery (thoracotomy) (≤8 weeks), surgical waiting list and thoracotomy (4 weeks), referral to surgeons to surgery (≤4 weeks), oncology referral to commencement of radiotherapy or chemotherapy (≤2 weeks), decision-to-treat to initiation of treatment (31 days). Although there are some differences in the recommended timeframes for each interval between the guidelines, there are no major variations. There were similarities in

timeliness measures between the BTS guidelines and most of the European guidelines, with some differences compared to the North American guidelines.

More than half of the included studies (38) did not quantify upper limits for intervals based on existing guidelines. Studies which did not compare their results to any guideline generally compared their results with other timeliness of lung cancer treatment related studies and among the subgroups of patients within the study. Studies also have used different time intervals with different time points, as a result they were not always comparable between studies. The comparison and interpretation of the results were difficult and created confusion when the studies were not from similar context and health system strength.

Asian and Western country differences

There were no differences between Asian and Western countries in the way they defined timeliness of care. Among 68 studies included in this review, nine studies were from Asian countries and/or territories[26 28 40 50 51 54 60 81 82]. Four of nine Asian studies used Western lung cancer guidelines to measure timeliness[26 28 51 60] and the other five studies did not use a guideline. It remains unclear how effective and relevant Western guidelines are for Asian countries, especially those with low and middle income. The lack of qualified providers, low availability of surgery and radiotherapy services, and poor access and affordability of up-to-date treatments remains as a prevailing concern for lung cancer care in LMICs compared to HICs [8 9]. Moreover, universal health care and health insurance mechanisms are still in the development phase in many Asian countries and LMICs. Western guidelines were developed in a context where such health system factors contribute to the effectiveness of guidelines. Using a guideline meant for highly resourced health systems in a resource-constrained country may not accurately reflect expectations and goals for timeliness of lung cancer care; culturally sensitive and resource-sensitive guidelines are required[8]. As most of the existing guidelines do not account for diversity in health resources, economic disparities or healthcare infrastructure, their

applicability could be limited[113 114]. The articles included from Asian countries/territories did not discuss the compatibility of Western guidelines in terms of relevance and appropriateness of recommended time limits for intervals in the disease care pathway in their context. Although the use of Western guidelines for LMICs with different health systems may not be appropriate, there is currently no guideline for lung cancer which dictates standard time limits that considers the limitations of weaker health systems. The Asian Oncology Summit 2009 proposed a resource-stratified management guideline for lung cancer (Non-Small Cell Lung Cancer) treatment; however, it does not provide benchmark for intervals in the care pathway, which need to be developed by respective countries adapting this guideline[10]. Informal healthcare is a unique feature of the diverse healthcare system in Asian countries and LMICs, whereas Western guidelines do not have to consider the inclusion of informal healthcare in the care pathway for lung cancer. Considering inclusion of a timepoint related to informal healthcare seeking and a measure of the number of times patients sought care from informal healthcare could be useful for Asian countries and LMIC settings.

This scoping review is not devoid of limitations. Only studies published in English were included in the review, which may miss potential literature in other languages. Other potential limitations are limiting databases included in the search and inclusion of articles published in last 20 years.

Conclusion

Although this review identified similarities in most of the timepoints and intervals studies included, there were substantial variations in defining some of the intervals. This lack of consistency creates a challenge for researchers who are trying to undertake research about timeliness of care for lung cancer. As timeliness of health seeking studies are mostly carried out in Western countries and guidelines are not suited to weaker healthcare delivery systems, there is a need to revisit the existing definitions to conduct timeliness of care related studies and a

unified set of definitions need to be set which can accommodate different structures and characteristics of health systems. The differences in healthcare delivery systems of Asian and Western countries, and between High Income Countries and Low - Middle Income Countries may suggest different sets of timepoints and intervals be developed that reflect resources and feasibility.

Patient and public involvement

Patients and the public were not involved in the design or planning of the study.

Ethics and dissemination of review findings

This study does not require ethical approval since the scoping review methodology aims at synthesizing information from secondary data sources (publications). Dissemination of findings at relevant national and international conferences will be planned to ensure the findings from the review are brought to the appropriate stakeholders. Results will provide key information to health professionals on operational definitions of the timeliness of seeking care and to policy makers in planning, funding and delivering evidence based and effective interventions to reduce delay in seeking care and develop health systems appropriate guidelines for lung cancer care.

Acknowledgements

The authors would like to acknowledge Lauren Zarb and Bijaya Pokharel for their collaboration and helping out with article screening for this review. We would like to thank the La Trobe University library for giving the access to the database for search.

Contributors

AA conceived the study, developed the protocol and search strategy, conducted the data charting, interpretation and manuscript development. MAR and VL contributed to screening the

articles, CL, CMcD, MAR and VL contributed to analysis, interpretation and critical feedback in manuscript finalization. All authors provided critical comments and input to revisions to the paper and approved the final manuscript for submission.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interest

None declared.

Provenance and peer review

None declared. Not commissioned, externally peer reviewed.

Figure 1: PRISMA flow chart

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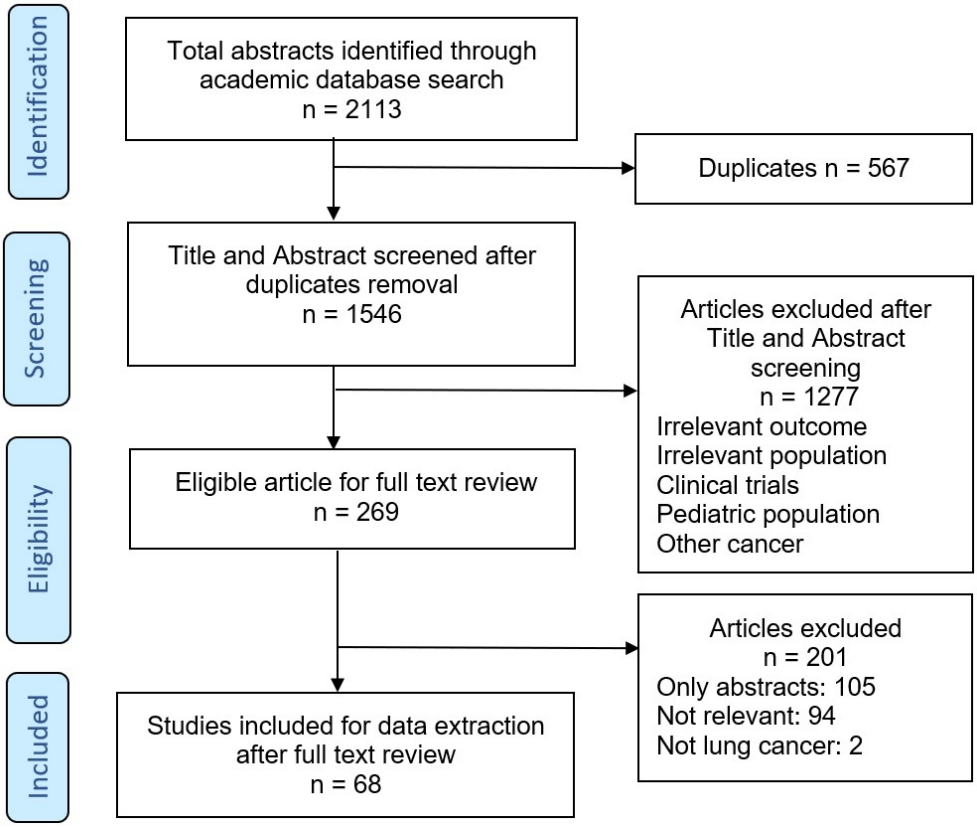

Figure1 PRISMA flow chart

213x179mm (120 x 120 DPI)

Table 1: Timeliness definition and timepoints identified

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
1	Alexander et al 2016 Australia	Position paper	Recommendations for the timely triage, review and treatment of cancer patients receiving systemic chemotherapy for six priority cancer groups (breast cancer, colorectal cancer, lung cancer (non-small-cell and small cell), ovarian cancer, lymphoma and myeloma)						The first medical oncology or haematology review for patients with an urgent presentation (Category 1) should occur immediately, within no longer than 48 h of referral receipt. Patients with suspected cancer, not classed as Category 1 or 2 (Category 3), should be seen in a medical oncology or haematology clinic within 14 days of referral receipt as recommended by existing local and international guidelines.			When chemotherapy is the first anti-cancer treatment for a patient, time to chemotherapy should be measured from the date that chemotherapy treatment was decided and the patient was prepared to receive chemotherapy (ready for care) to the date when chemotherapy was first administered (chemotherapy start date). However, in the setting of adjuvant chemotherapy, time to chemotherapy should be measured from the date of surgery.	
2	Ampil et al 2014 USA	Cross sectional	Evaluating the types of delay in the management of people with SVCO-L Ca and the impact of palliative thoracic radiotherapy (PTR) delay on patient outcomes.										
3	Barrett & Hamilton 2008 UK	Nested retrospective case-control study	Aimed at identifying and quantifying clinical features of lung cancer										
4	Baughan et al 2009 UK	Cross sectional	The aim of this study is to gain a better understanding of how quickly patients with cancer initially present to their GP, and how they are then referred to secondary care for further investigation and treatment.		Date patient first noticed symptoms	Date patient first reported symptoms to primary care		Date of decision to refer	Date patient first seen by specialist		Date patient told the diagnosis		
5	Bjerager et al 2006 Denmark	Population based observational case series	To explore diagnostic delay in primary health care among patients with lung cancer.	Delay in general practice: the time from the patient's presentation of the first symptoms or signs that could be related to the lung cancer until referral to hospital. Delay in general practice was subdivided into: doctor delay: time elapsed without investigation of cancer-related symptoms and signs. System delay: time elapsed due to waiting times related to investigation of cancer-related symptoms and administration.									
6	Borrayo et al 2016 USA	Mixed Method	To better understand the institution- and the patient-level determinants associated with the timely initiation of cancer treatment among underserved Hispanic patients diagnosed with lung and head and neck cancers.										
7	Bozcuk & Martin 2001 UK	Retrospective medical record review	to analyse survival in relation both to time to treatment (hospital delay) and other known prognosticators, in a cohort of NSCLC patients presenting in 1 year in a UK Hospital with thoracic surgery and clinical oncology departments.										

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8	Brocken et al 2012 Netherlands	Retrospective medical record review	To compare various delays in a rapid outpatient diagnostic program (RODP) for suspected lung cancer patients with those described in literature and with guideline recommendations, to investigate the effects of referral route and symptoms on delays, and to establish whether delays were related to disease stage and outcome.	Timeliness of lung cancer care starts with timely recognition of symptoms by patients themselves, which is often inadequate or delayed									
9	Buccheri & Ferrigno 2004 Italy	Retrospective medical record review	1) provide a more recent profile of the clinical manifestations of lung cancer; 2) evaluate possible time-related changes in the occurrence of symptoms; and 3) explore the possible relationship between symptoms and time to specialist referral.										
10	Bullard et al 2017 USA	Retrospective medical record review	To evaluate the impact that the initiation of timely treatment has on patient survival among a cohort of privately insured patients with NSCLC in South Carolina	Analysis of treatment timeliness was informed by the Andersen and Cacioppo model of delays in seeking cancer care.16 Delay in seeking cancer care is defined as the number of days from the identification of the first symptom to visiting a physician, being diagnosed as having a condition, or beginning a regimen for treating the condition. The model interprets delay as an aggregate of underlying decision-making processes imposed by the patient. Treatment delay is the time between receiving medical attention and when care or treatment is initiated.Timely care was defined according to the RAND Corporation as a maximal time limit of 6 weeks (≤42 days) from diagnosis to treatment.									
11	Corner et al 2004 UK	Exploratory study	To explore the pathway to diagnosis among a group of patients recently diagnosed with lung cancer.		Symptoms were recalled as having started between 4 months and more than 2 years	timing of their visits to the GP	Date of diagnosis						
12	Devbhandari et al 2007 UK	Prospective Cohort	To compare our waiting times with national recommendations										
13	Devbhandari et al 2008 UK	Prospective Cohort	To ascertain the causes of delays in treatment to all patients presenting to our centre with a working diagnosis of lung cancer										
14	Dobson et al 2017 UK	Qualitative study	to explore the patient intervals of people with symptoms of lung or colorectal cancer, considering how symptom appraisal and help-seeking experiences were influenced by the wider context of people's lives, such as family and work.		The date of symptom onset was defined as the first symptom reported	The end of the patient interval was defined as the date on which they consulted about their symptoms.							
15	Ellis & Vandermeer 2011 Canada	Cross sectional	Our objective was to establish the time delays in each phase to help inform strategies to reduce overall diagnostic delays.										

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
16	Emery et al 2013 Australia	Mixed methods study	The overall objective of this study was to identify the major subcomponents of the diagnostic interval for rural cancer patients in WA to inform the design of an intervention aimed at reducing time to diagnosis.										
17	Evans et al 2016 Australia	Retrospective cohort study	To assess factors associated with second-line delays in the management of patients diagnosed with lung cancer										
18	Ezer et al 2017 Canada	Cross sectional	The aim of the study was to assess the impact of this model of care (Rapid Investigation Clinic) on timeliness of lung cancer diagnosis , staging and treatment.										
19	Forrest et al 2014 UK	Population-based, data-linkage study	To investigate the factors (socioeconomic position (SEP), age, sex, histology, co-morbidity, year of diagnosis, stage and performance status (PS)) that may influence the likelihood of post-primary care referral, diagnosis and treatment within target times.										
20	Kanarek et al 2014 USA	Retrospective cohort	Evaluated the hypothesis that delay to first surgery and other time-related factors reduce survival after treatment (surgery). Then assessed the hypothesis that age, race, gender, place of residence, tumor characteristics, and morbidity confound the relationship between these factors and survival.										
21	Kim et al 2016 Canada	Retrospective medical record review	The aim of this study was to quantify the time intervals that NSCLC patients in Alberta with stage IeIII disease spend waiting for diagnosis (diagnostic interval), treatment (treatment interval) and their sum (system interval) and to determine which factors are associated with delays.										
22	Koyi et al 2001 Sweden	Cross sectional	The aim of the present study was to prospectively investigate a material of lung cancer patients in order to measure the delays, both by the patient and by the doctors.										
23	Kudjawu et al 2016 France	Retrospective medical record review	To describe time delays in each phase of lung cancer treatment after bronchoscopy.										
24	Largey et al 2015 Australia	Pilot study.	The audit was conducted as part of routine cancer quality improvement activities at Southern Metropolitan Integrative Cancer Services.			Dates of first presentation as the time point the clinician started investigation or referral for possible investigation		Referral	First specialist appointment	Diagnosis		Referral.	

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
25	Largey et al 2016 Australia	Retrospective medical record audit	(1) examine the current interval times for lung cancer patients from the point of initial referral to the start of first treatment at three large public principal referral hospitals in Victoria; (2) assess the effects difference treatment type (surgery, radiotherapy and chemotherapy) and health service had on interval times across the selected components of the lung cancer pathway; and (3) compare interval times and identify the proportion of patients who met the established target measures.										
26	Lee et,al. 2002 UK	Retrospective medical record audit	assessed the delays in their care against BTS guidelines.										
27	Li et al 2012 Canada	Retrospective medical record review	The purpose of this study was to assess the value in measuring specific time intervals across cancer sites to identify potentially important variation in the timeliness of cancer care that may inform needed changes and/or improvements incoordination of care.							dates of diagnosis			first treatment, surgery and adjuvant treatment.
28	Maiga et al 2017 USA	Retrospective cohort study	Investigation of the reasons for delays in treatment and the impact these delays have on tumor-stage progression.										
29	Malalasekera et al 2018 Australia	Scoping review	1) synthesise health system related waiting times to milestones of lung cancer care using standardised definitions; 2) benchmark measures of performance against relevant guidelines for timeframes; 3) supplement quantitative findings with barriers to timely care described in the literature; and 4) explore the impact of facilitators such as fast-track referral systems on waiting times.			First clinical presentation	First suspicious investigation	First referral to secondary care	First specialist visit	Diagnosis			Treatment start
30	Melling et al 2002 UK	Cross sectional	The purpose of this study was to find out what proportion of patients are referred as lung cancer guidelines assume, whether different referral pathways result in different management and what proportion of patients are seen within recommended time intervals between referral and treatment.	Definitive treatment was defined as surgery (pneumonectomy or lobectomy), radical radiotherapy (radiotherapy directed at treating lung cancer itself) and chemotherapy. Palliative treatment recorded was palliative radiotherapy (for symptom control only), palliative surgery or best supportive care.	Symptom	Presentation	Diagnosis	referral					treatment
31	Neal et al 2015 UK	Mixed method	aims to provide a detailed analysis of the diagnostic process of lung cancer from a primary-care perspective.		Onset of first symptom	face-to-face consultations, nurse consultations, telephone consultations, out of hours, home visits before initial referral or investigation request First presentation to primary care	Date of diagnosis CXR requested CXR report received Diagnosis	Referal or admission					

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32	Girolamo et,al. 2018 England	Retrospective medical record review	To assess the association between meeting waiting time targets, as currently available to the policymakers, and individual patients' cancer survival, and measure the time to different types of treatments.	Maximum two-week wait (TWW) between an urgent referral for a suspicion of cancer from a general practitioner (GP) to being seen by a specialist, a maximum 62 days from the referral to the start of the first treatment, and a maximum 31 days from the decision taken to treat a patient to the start of the first treatment, irrespective of the route to diagnosis the patient went through .									
33	Gozalez et,al. 2014, Spain	Retrospective medical record audit	To analyse the delays in the diagnosis and treatment of LC and the factors associated with the timeliness of care and their possible relationship with the survival of these patients										
34	Grunfeld et al 2009 Canada	Cross sectional	To prospectively measure peri-diagnostic and surgical time intervals for patients with suspected colorectal, lung, or prostate cancer				date of the pathology or radiology report	the date the referral for diagnostic assessment was received by the consultant		date of first relevant investigation initiated by consultant, whichever came first; relevant investigations included biopsy, bronchoscopy, chest X-ray, colonoscopy, sigmoidoscopy, CT scan, MRI, PSA, pulmonary function test, transrectal ultrasound, and other	date patient informed of diagnosis		date of initiation of first treatment (first treatment was definedas neoadjuvant chemotherapy, surgery if no preoperativetreatment was required, chemotherapy, radiotherapy, or a decisionfor no treatment
35	Helsper et al. 2017 Netherlands	Retrospective medical record review	To chart the diagnostic pathway for the five most common cancers in the Netherlands			The date of the first cancer-related GP consultation was defined as the first contact (physical or telephone) with the GP for suspected cancer-related signs or symptoms		The date of referral was defined as the moment when the responsibility for the patient was transferred from a GP to secondary care			the date of diagnosis was the date of the histological confirmation of the primary tumour.		The date of treatment initiation denotes the date of start of therapy as registered in the NCR
36	Hsieh et al 2012 Taiwan	Retrospective medical record review	To understand the delay in the diagnosis of lung cancer under the healthcare system in Taiwan, and to identify the factors associated with it										
37	Hubert et al 2018 Canada	Retrospective medical record review	To measure the timeliness of care with a standardized Rapid diagnostic assessment programs (DAP) in patients with early-stage non-small cell lung cancer (NSCLC) and to evaluate the impact of an ERP (enhanced recovery protocols) in these patients.										

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38	Heredia et al 2012 Spain	Cross sectional	To analyze the results obtained in a lung cancer (LC) screening program since its inception five years ago regarding correct referrals, diagnostic and therapeutic delay times and days of hospitalization. To compare the diagnostic–therapeutic delays and hospital stays with those obtained in patients evaluated with the standard system										
39	Iachina et al 2017 Denmark	Retrospective cohort study	To investigate the significance of primary investigation and treatment at two or more hospitals on the delay in Danish patients with Non-Small Cell Lung Cancer (NSCLC).	** Time from referral (time of diagnosis) to end of primary investigation = 28 days **Time from referral (time of diagnosis) to first day of treatment = 42 days End of primary investigation is defined as the date of decision on treatment. Referral is defined as the date where the investigating department receives the referral.									First day of treatment is defined as the date of initiation of surgical, oncological, or radiological treatment, whichever comes first
40	Ju et al 2017 USA	Computer process modelling	To evaluate delays in care delivery, in order to identify potential 'bottlenecks' in waiting time, the reduction of whichcould produce greater care efficiency.										
41	Olsson et al 2009 USA	Systematic review	To summarise all recently published studies that described the timeliness of care in patients with lung cancer, identified factors that were associated with more or less timely care, or examined the association between the timeliness of care and lung cancer outcomes, including stage distribution and survival. In addition, we aimed to identify studies that evaluated interventions to improve the timeliness of care for patients with lung cancer.										
42	Ost et al 2013 USA	Guideline/review	This guideline is intended to provide an evidence-based approach to the initial evaluation of patients with known or suspected lung cancer. It also includes an assessment of the impact of timeliness of care and multidisciplinary teams on outcome.										
43	Özlü et al 2004 Turkey	Retrospective medical record review	To determine the delay between the onset and the diagnosis and treatment of patients with lung cancer in two cancer centres in the Eastern Black Sea Region of Turkey.		onset of symptoms	first presentation to a physician				histopathological diagnosis			start of treatment
44	Rankin et al 2017 Australia	Qualitative study	To describe the lung cancer diagnostic pathway, focusing on the perspective of patients and general practitioners about diagnostic and pretreatment intervals			first consultation with HCP	diagnosis						start of treatment

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45	Rolke et al 2006 Norway	Cross sectional	to evaluate the delays in the diagnostic pathways for primary lung cancer in Southern Norway, and to compare results with recommendations from the British Thoracic Society (BTS) and the Swedish Lung Cancer Group (SLCG).	Patients referred by general practitioners, who have obvious clinical evidence of lung cancer, should be seen within 1 week of referral receipt in a respiratory physician's clinic, i.e. Referral delay. The results of bronchoscopy or any other similar diagnostic test, including the histological or cytological result, should be available and communicated to the patient within 2 weeks of a decision to do it, i.e. Informed diagnostic delay. Suspected lung cancer should wait no more than 1 week before they are investigated by a specialist, i.e. Referral delay. Diagnosed lung cancer should wait no more than 3 weeks since first specialist investigation to a treatment decision is made and no more than 10 days from a treatment decision was made until start of treatment, summarised as Hospital delay.									
46	Thapa et al 2014 Nepal	Cross sectional, prospective observational study.	To identify the steps through which the patients passed before he/she finally arrived to specialist care at Manmohan Cardiothoracic Vascular and Transplant Center (MCVTC) and also determine the time lost in each step.										
47	Verma et al 2018 Australia	Cross sectional	to identify any differences in time delays in lung cancer referral pathways between rural and urban patients and explore patients' perceived barriers to timely lung cancer diagnosis and management.										
48	Vidaver et al 2017 USA	Mixed method	This study explored when and why delays occur in lung cancer care and compared timeliness between two states with divergent disease incidence.	The RAND Corporation suggested that the diagnosis of lung cancer should be established within 2 months of abnormal radiography, and treatment should begin within 6 weeks of diagnosis. British Thoracic Society recommended that patients with suspected lung cancer be seen by a respiratory specialist within 7 days of referral; a specialist visit should occur within 2 weeks of an abnormal radiograph, and surgery should be within 8 weeks of a visit to a respiratory specialist.		A—first visit to health care provider with symptoms	B— first imaging result with a lung abnormality	C— referral to a specialist	D— first visit to a specialist	E— first diagnostic test F— last diagnostic test	G— patient informed of the biopsy result	H— first referral to treatment	I— first treatment
49	Wai et al 2012 Canada	A case-control study	The primary goal of this study is to investigate if delays in care may decrease the curability of patients with stage III NSCLC. The secondary goal is to describe the patterns of staging and diagnostic evaluation for palliatively and radically treated patients with stage III NSCLC in British Columbia.										

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50	Walter et al 2015 UK	Prospective cohort study	To investigate the symptoms and other clinical and sociodemographic factors associated with lung cancer diagnosis, time to diagnosis and stage at diagnosis.	The total diagnostic interval (TDI), or 'time to diagnosis', defined as the time from the first symptom/s to the date of diagnosis.									
51	Wilcock et al 2016 UK	Mixed-methods	to identify areas where there may be potential to improve the care provided so as to inform the need for further focused research.										
52	Winget et al 2007 Canada	Stakeholders workshop	1) identify a set of criteria and variables needed to create comparable measures of important time-to-cancer-care intervals that could be applied across provinces and 2) use the measures to compare time-to-care across participating provinces for lung cancer patients diagnosed in 2004.										
53	Yang et al 2015 China	Case control	In this study, we determined the total time from the first symptoms to the initial treatment for lung cancer patients at the Department of Respiratory Disease of Zhongshan Hospital (Fudan University, Shanghai, China), a tertiary health care medical center	In China, a diagnosis delay for lung cancer has been defined as more than 1 month between the first symptom or radiological change and the clinical diagnosis or suspicion for lung cancer.	First symptom	First contact with local doctor		Referral to hospital		Diagnosis/ referral to treatment			Initiation of treatment
54	Yilmaz et al 2009 Turkey	Cross sectional	The aims of this study were to investigate the delays in patients with lung cancer from the first symptom to thoracotomy and to examine whether the delays affect the stage of lung cancer at the time of thoracotomy.	The application interval that exceeded 30 days was considered indicative of a patient's delay. The interval that exceeded 14 days was considered indicative of a referral delay. The diagnosis interval that exceeded 14 days was considered as indicative of a delayed diagnosis. The interval that exceeded 14 days was considered as indicative of a delayed treatment. The interval that exceeding 6 weeks was considered as indicative of a doctor's delay. If exceeding 72 days it was considered indicative of a total delay	date of initial symptoms	date of first doctor visit			date of admission to pneumology department of our hospital	date of diagnosis			date of thoracotomy
55	Yorio et al 2009 USA	Cross sectional	to examine the predictors and impact of the timing of lung cancer care in this context, we examined diagnostic and treatment intervals at a large American medical center providing care to a diverse patient population within two different hospital systems.	Date of tissue diagnosis was defined as the date of final pathology report. Date of treatment was defined as the date of surgery, initial date of chemotherapy, or initial date of radiation therapy, whichever occurred first.									
56	Zullig et al 2013 USA	Cross sectional	Aim 3: Examine patient-level factors associated with (a) receipt of timely lung cancer care and (b) subsequent health outcomes										
57	Sachdeva et al 2017 India	Cross sectional	To determine time delay from the onset of initial symptoms to diagnosis of primary lung cancer.										

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
58	Salomaa et al 2001 Finland	Retrospective medical record review	To measure delays of diagnosis and to assess the causes for those delays in patients with lung cancer. To evaluate whether the lengths of the delays were acceptable according to the British recommendations, and To examine the relations between delays and survival			the first symptoms until the first visit to a doctor, who was in general, a GP		the date the consultation request for a specialist was written	the first appointment with the specialist				
59	Sawicki et al 2013 Poland	Cross sectional	To compare the differences in the periods of time and reasons for delay in diagnosisand initiation of treatment of lung cancer among patients who are inhabitants of the rural and urban regions of LublinVoivodeship, and who were consulted in Thoracic Surgery Department										
60	Schultz et al 2009 USA	Cross sectional	To evaluate timeliness of lung cancer care and identify institutional characteristics associated with timely care within the Veterans Affairs (VA) health care system	**British Thoracic Society guidelines)** *Specialist visit within 2 wk of abnormal CXR *Surgery within 8 wk of specialist visit **RAND guidelines** *****Diagnosis within 8 wk of abnormal CXR *Treatment within 6 wk of diagnosis							Time to diagnosis is the time from the first suspicious chest x-ray or CT scan to the date when a pathologic diagnosis of lung cancer was confirmed		
61	Shugarman et al 2009 USA	Cohort study	To evaluate the relationship of sex and race with the receipt of timely and clinically appropriate NSCLC treatment for each stage of diagnosis	Timely treatment as a 6-week timeframe from the date diagnosis to receipt of treatment (surgery, chemotherapy or radiation therapy)									
62	Singh et al 2010 USA	Cohort study	To evaluate characteristics and predictors of missed opportunities for earlier diagnosis of lung cancer in a health care system with an advanced integrated EHR		the first appearance of a diagnostic clue as the earliest date that the clue could have been recognized by the care providers, regardless of when the patient first started experiencing symptoms								
63	Smith et al 2009 Scotland	Cross sectional	To determine what factors are associated with the time people take to consult with symptoms of lung cancer, with a focus on those from rural and socially deprived areas		the date participant defined first symptom	date of presentation to a medical practitioner							
64	Sood et al 2009 NZ	Retrospective medical record review	To determine the patient characteristics, referral patterns and delays in assessment and treatment of patients with primary lung cancer in South Auckland, New Zealand and compare with international standards										

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65	Stokstad et al 2017 Norway	Retrospective medical record review	To quantify the proportion of patients who started treatment within the recommended timeframes; and to assess the proportion of non-complex patients for which there were no good reasons for delays.	For suspected lung cancer, the first hospital appointment should be offered within seven calendar days of receiving a referral letter; a treatment decision should be made within 28 calendar days; systemic therapy should start within 35 calendar days, and surgery or radiotherapy within 42 calendar days. According to Norwegian recommendations, start of treatment within 42 days (surgery or radiotherapy) or 35 days (systemic therapy) was considered “timely treatment”				start time as the date when a referral letter for suspected lung cancer was received by the Department of Thoracic Medicine – or the date when the decision was made to start diagnostic workup in patients with a known single pulmonary nodule (SPN)					the time for treatment decision as the date when such a decision was documented in the EMR
66	Sulu et al 2011 Turkey	Cross sectional	To investigate patterns of delays among patients with non-small-cell lung cancer and to identify reasons for the delays.	**An application interval that exceeded 30 days was considered indicative of a patient’s delay. **The referral interval that exceeded 14 days was considered indicative of a referral delay. **A diagnosis interval that exceeded 14 days was considered as indicative of a delayed diagnosis. **A treatment interval that exceeded 14 days was considered as indicative of a delayed treatment **Doctor's interval that exceeded 6 weeks was considered as indicative of a doctor’s delay. ** Total interval exceeded 72 days was considered indicative of a total delay									
67	Chandra et al 2009 India	Retrospective review	To determine the average time period required at various steps for diagnosing lung cancer from the onset of symptoms at a tertiary referral centre in Northern India										
68	Dubey et al 2015 India	Cross sectional	The aim was also to study the time duration for confirming the diagnosis, the relative yield of the investigations in diagnosis of lung cancer and the lung cancer stage in which patients are presenting.										

Table 2: Intervals identified

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
1	Alexander et al 2016 Australia																								
2	Ampil et al 2014 USA								Patient delay was inferred from the duration of presenting symptoms until hospital admission		In-hospital delay was defined as the interval from the date of hospitalization to the date of referral for therapy		Professional delay was defined as the interval from the date of referral to first treatment												
3	Barrett & Hamilton 2008 UK						First symptom presented to primary care to diagnosis							Interval between first presentation to primary care with a symptom of lung cancer and referral		Interval from referral to diagnosis	The intervals between first symptom presentation and diagnosis								
4	Baughan et al 2009 UK	time from patient first noticing symptoms to first presentation with a GP																Time from first presentation to time of referral							
5	Bjerager et al 2006 Denmark																		First symptom until referral to secondary care						
6	Borrayo et al 2016 USA																					Diagnosis to treatmentinitiation			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
7	Bozcuk & Martin 2001 UK												Time to treatment (*measure of hospital delay*): time from receipt of referral letter from GP /referring physician to first treatment. *Referral time (measure of referral delay):* time from receipt of GP /referring physician referral letter to first appointment on Norfolk & Norwich Hospital. It actually is a component of time to treatment.												
8	Brocken et al 2012 Netherlands	Patient delay as the time from first symptom until the first visit to a GP	GP delay as the time between first GP visit and referral to a chest physician		referral delay as the time between referral (written or by phone) and first rapid outpatient diagnostic program (RODP) day	Diagnostic delay as the time between first RODP day and date of final (accurate) diagnosis																Therapeutic delay as the time between diagnosis and start of treatment.			
9	Buccheri & Ferrigno 2004 Italy														Referral delay was defined as the time interval between the occurrence of the first symptom of alarm (as reported by the patients and confirmed by their relatives) and the date of the first specialist referral made to the study group) (normally made to the									

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															study group).										
10	Bullard et al 2017 USA																								
11	Corner et al 2004 UK	Time between first change in health status and onset of symptom that prompted patient to visit GP or other service Time between onset of symptom prompting patient to visit GP and date of visit to GP or other service					Visit to GP or other service and date of diagnosis										Time between first recalled change in health status and date of diagnosis								
12	Devbhandari et al 2007 UK		Urgent GP referral to date first seen in outpatient clinics was calculated by subtracting the date of urgent referral from the date first seen in chest outpatient clinics													Intervals for investigations such as bronchoscopy were calculated by subtracting the date of urgent GP referral from the date of investigation			GP referral to date of first definitive treatment was calculated by subtracting the date of urgent GP referral from the date of commencement of the first definitive treatment.					
13	Devbhandari et al 2008 UK																					The intervals from out-patient to decision-to-treat	Decision-to-treat to treatment	
14	Dobson et al 2017 UK																							

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
15	Ellis & Vandermeer 2011 Canada	T1: time from initial symptoms to first presentation to a family doctor or emergency department	T3: time from initial presentation to the first appointment with a specialist, either directly to the JCC or to a respirologist or thoracic surgeon		T5. Time from JCC referral to initial consultation	T4: time between the initial appointment with the specialist and the last date of additional diagnostic testing	T2: time from initial presentation to the last date of diagnostic testing ordered by the family physician			T6: time from initial contact with a medical or radiation oncologist to the starting date of treatment, defined as chemotherapy, radiation therapy, or the decision not to pursue treatment															T7: Overall time from onset of symptoms to commencement of defiitive therapy was also calculated as a global delay
16	Emery et al 2013 Australia		Fist presentation in general practice to referral (GP interval)	From date of referral to fist attendance at specialist (specialist access interval)		Time from fist attendance at the specialist to date of diagnosis (specialist interval)	The diagnostic interval is the time from fist presentation until cancer diagnosis										Total diagnostic interval was defied as the time from fist symptom to diagnosis.								
17	Evans et al 2016 Australia															Referral to diagnosis				Referral to initial definitive management		Diagnosis to initial definitive management				
18	Ezer et al 2017 Canada	time interval (in days) between first contact with a local physician for suspected lung cancer (T0)					time interval (in days) between first contact with a local physician to date of tissue diagnosis														Time interval (in days) between first contact with a local physician to date of first treatment				
19	Forrest et al 2014 UK		GP referral date to first hospital appointment date			First hospital appointment date to diagnosis date	GP referral date to diagnosis date														GP referral date to first treatment date	Diagnosis date to first treatment date			
20	Kanarek et al 2014 USA							Time from diagnosis to first contact at SKCCC was defined as the referral interval.					Time from first contact at SKCCC to first surgery is defined as the treatment interval									Diagnosis to first surgery interval			

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21	Kim et al 2016 Canada											**Diagnostic imaging interval:** From Date of the chest X-ray which preceded the last computed tomography scan prior to the first diagnostic biopsy attempt to Date of the last computed tomography scan prior to the first diagnostic biopsy attempt**Diagnostic biopsy interval:** From Date of the last computed tomography scan priorto the first diagnostic biopsy attempt to Date of the diagnostic biopsy procedure whichprovided pathological diagnosis											**System interval:** From Date of the chest X-ray which preceded the last computed tomography scan prior to the first diagnostic biopsy attempt to First day of treatment**Treatment interval:** From Date of diagnostic biopsy procedure which provided pathological diagnosis to First day of treatment			
22	Koyi et al 2001 Sweden	the patient's delay is the time from the first symptom(s) until the date he /she visits the doctor, in general the GP	GP delay, from the time a visit was arranged with the GP until the patient was referred to the specialist			specialist's delay (Second doctor's delay) is the time from when the lung specialist received the referral papers until the diagnosis was made.											Time symptom-diagnosis							Time symptom-treatment
23	Kudjawu et al 2016 France																								
24	Largey et al 2015 Australia																								
25	Largey et al 2016 Australia															Referral to-diagnosis				Referral-to-treatment		Diagnosis-to-treatment			
26	Lee et,al. 2002 UK																Onset of symptoms and their first chest radiograph	Onset of symptoms and referral to a surgeon by a chest physician							
27	Li et al 2012 Canada																					Time from diagnosis to first treatment			

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28	Maiga et al 2017 USA																					The interval between T2 and T3 is the diagnosis-totreatment interval for patients with a tissue diagnosis before resection.			
29	Malalasekera et al 2018 Australia		Primary care interval				Diagnostic interval													Secondary care interval		Treatment interval			
30	Melling et al 2002 UK			Referral by GP to first seen by specialist				1 week of a CXR request to first hospital visit													First visit to any treatment				
31	Neal et al 2015 UK	'Patient interval' (time from symptom onset to presentation)					Date of request of first GP-initiated chest X-ray and date report received																		
32	Girolamo et,al. 2018 England			urgent referral for a suspicion of cancer from a general practitioner (GP) to being seen by a specialist																			The decision taken to treat a patient to the start of the first treatment		
33	Gozalez et,al. 2014, Spain	from the first symptom to the first specialist consultation (specialist delay)				from the first specialist consultation until confirmation of the diagnosis (diagnosis delay)														From the first specialist consultation until the start of treatment (hospital delay)	From the confirmation of the diagnosis up to the start of the first treatment (treatment delay)				

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34	Grunfeld et al 2009 Canada			Date of referral to date of first diagnostic consultation											Date of referral to date of confirmed diagnosis				Date of referral to date of initation of first treatment (first tx was defined as neoadjuvant chemotherapy, surgery if no preoperative treatment was required, chemotherapy, radiotherapy, or a decision for no tx							**Date the referral for diagnostic assessment was received by the consultant ('date of referral') to date patient informed of diagnosis ** Date of first diagnostic consultation to date patient informed of diagnosis **Date of referral to date of surgery or decision for no surgery ** Date of confirmed diagnosis to date of surgery or decision for no surgery **Date of referral to date of surgery**Date of surgery to date of first oncology consultation or decision for no consultation
35	Helsper et al. 2017 Netherlands		the time between the first cancer symptom related contact with the general practitioner (GP) and its corresponding referral to secondary care (Primary care interval (ICP)				the time from the first presentation to the GP to diagnosis (diagnostic interval (ID)								The time from referral to histological diagnosis (refferal interval (IR)					The time from the first presentation to the GP to initial treatment (health care interval (IHC)	The time from diagnosis to initiation of the treatment (Treatmnet interval (IT)				
36	Hsieh et al 2012 Taiwan																								Delay in diagnosis' has been defined as the period from a patient's initial medical visit to any hospital to his/her confirmed diagnosis of lung cancer

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
37	Hubert et al 2018 Canada																								**The first one was the interval between the moment that the green file was opened until all lung cancer staging and clinical tests were performed, and patient was referred for surgery after discussion with the respirologist . **The second interval was the time between the referral to the thoracic surgery department the consult with the surgeon ** The last interval was from the surgical consult to the date of surgery
38	Heredia et al 2012 Spain																								
39	Iachina et al 2017 Denmark																						Time from end of primary investigation to first dayof treatment = 14 days		
40	Ju et al 2017 USA																								
41	Olsson et al 2009 USA			from referral to first respiratory specialist visit																GP referral to initial treatment		from diagnosis to treatment		specialist consultation to surgery	symptom onset to initial treatment
42	Ost et al 2013 USA																					Diagnosis to treatment			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
43	Özlü et al 2004 Turkey	From first symptom to presentation				admission and tissue diagnosis	From presentation to tissue diagnosis														From presentation to first treatment	From diagnosis to treatment			From symptoms to treatment
44	Rankin et al 2017 Australia						The diagnostic interval is defined as “the time between first appointment with a health-care provider (HCP) and the formal cancer diagnosis being made.”															The pretreatment interval is defined as “the time between formal cancer diagnosis and initiation of treatment”			
45	Rolke et al 2006 Norway	Patient delay: Time from first symptom to first personal contact with doctor	GP delay: Time from first contact with general practitioner (GP) to date on written referral.	Referral delay: Time from dated referral receipt to first contact with pulmonary consultant.		Specialist delay: Time from first contact with pulmonary consultant to dated diagnostic histology/cytology																		Hospital delay: Time from first contact with pulmonary consultant to start of treatment.	Total delay: Time from first symptom to start of treatment.
46	Thapa et al 2014 Nepal	D1=Time from onset of symptoms to fist contact with a doctor (T1-T2) or patient delay						D 2=Time from fist contact with doctor to referral to MCVTC (T2-T3) or doctor delay																	
47	Verma et al 2018 Australia	T2: Time between first symptoms to first GP consultation	T3: Time between GP and specialist consultation							T4: Time between specialist consultation and commencement of treatment.															T1: Time from first symptoms to commencement of treatment.
48	Vidaver et al 2017 USA		Initial presentation-specialist referral	Specialist referral-specialist consultation			Initial presentation-confirmed diagnosis			Specialist consultation-treatment											Initial presentation-treatment	Abnormal radiograph-treatment Confirmed diagnosis-treatment		Treatment consultation-treatment	

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
49	Wai et al 2012 Canada							Diagnosis to cancer centre referral Diagnosis to radiation oncology consult									First symptom to diagnosis							Radiation oncology consult to start of radiation treatment	
50	Walter et al 2015 UK																'time to diagnosis', defined as the time from the first symptom/ sto the date of diagnosis								
51	Wilcock et al 2016 UK																							time from lung cancer MDT treatment recommendation to commencement of an 'active' oncological treatment	
52	Winget et al 2007 Canada																					1) diagnosis to first treatment in a cancer facility (that is, radiation or chemotherapy)		3) first consult with an oncologist to first treatment in a cancer facility.	
53	Yang et al 2015 China	Patient delay: First symptom to first contact with a local doctor	Delay in primary care: first contact with a local doctor to referral to hospital													Diagnostic delay in secondary healthcare: referral to hospital to diagnosis				Delay in secondary health care: referral to hospital to initiation of treatment	System delay: First contact with a local doctor to initiation of treatment	Treatment delay: Diagnosis to initiation of treatment			
54	Yilmaz et al 2009 Turkey	patient's application interval was defined as the time passed between the onset of symptoms and the first doctor visit.	The referral interval was defined as the time from the first doctor visit to admission to one of the pneumology departments of our hospital for the further investigation																		Doctor's interval was defined as the time from the first doctor visit to thoracotomy	The treatment interval was the time passed from the diagnosis to thoracotomy			The total interval was the time between the onset of symptoms and thoracotomy
55	Yorio et al 2009 USA																					diagnosis to treatment.			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
56	Zullig et al 2013 USA							Days from diagnosis to referral to palliative care or hospice														Days from diagnosis to initiation of treatment			
57	Sachdeva et al 2017 India																Delay in diagnosis from the onset of initial symptoms to histological confirmation								
58	Salomaa et al 2001 Finland		Patient's delay is the time from the first symptoms until the first visit to a doctor, who was in general, a GP	GP delay, which is the time from the date the patient visited the first doctor until the date the consultation request for a specialist was written	The referral delay is the time between the writing of the referral and the first appointment with the specialist		The specialist's delay is the time from the first appointment until the diagnosis was made															The treatment delay is the time from the diagnosis until the treatment began			symptom-to-treatment delay
59	Sawicki et al 2013 Poland	Time from the first signs of the disease to the first medical examination																			the time from the first visit to a doctor to the start of treatment, or disqualification from the causative treatment				
60	Schultz et al 2009 USA	Time to treatment was the time from the first suspicious radiograph to the date on which any treatment was first initiated ** In patients who refused treatment, we used the date of refusal as the endpoint for time to treatment																							
61	Shugarman et al 2009 USA	first date recorded for treatment																							
62	Singh et al 2010 USA																								

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
63	Smith et al 2009 Scotland	The number of days from date of first symptom defined by the participant until date of presentation of symptoms to a medical practitioner																							
64	Sood et al 2009 NZ																								
65	Stokstad et al 2017 Norway																								
66	Sulu et al 2011 Turkey		Patient's application interval was defined as the time elapsed from the onset of symptoms to the first doctor's visit		The referral interval was defined as the time from the first doctor's visit to admission to our hospital for the further investigation.		The diagnosis interval was regarded as the time elapsed from admission to our hospital to the pathological diagnosis.														Doctor's interval was defined as the time elapsed the first doctor's visit to treatment	The treatment interval was the time elapsed from the diagnosis to treatment			The total interval was the time elapsed from the onset of symptoms to treatment
67	Chandra et al 2009 India																symptom-to-diagnosis delay, between the onset of symptoms to confirmed diagnosis					diagnosis-to-treatment delay, between diagnosis and treatment started			symptom-to-treatment delay, between onset of symptoms and treatment
68	Dubey et al 2015 India																The onset of symptoms to the confirmation of diagnosis								

Table 3: Other uncommon timepoint and intervals

#	Author, pub date and country	Other time point or Intervals
1	Alexander et al 2016 Australia	**NSCLC:** Where systemic chemotherapy is the first anti-cancer treatment modality, in either definitive or palliative treatment settings, chemotherapy should commence within 3 weeks of the ready for care date (level III, grade C †). Adjuvant chemotherapy should commence as soon as the patient is medically fit following surgery and within 8 weeks of the date of surgery (level III, grade C †). **SCLC:** Patients with severe or life-threatening symptoms should be regarded as a medical emergency and chemotherapy initiated immediately, within no longer than 48 h ‡ of the ready for care date – hospitalisation may be required (good practice point †). All other patients should commence chemotherapy within 2 weeks of the ready for care date (good practice point †)
12	Devbhandari et al 2007 UK	GP referral to chest outpatient GP referral to decision to treat GP referral to treatment Oncology referral to chemotherapy Waiting on surgical waiting list Oncology referral to radiotherapy
23	Kudjawu et al 2016 France	1) from bronchoscopy to: (a) first neo-adjuvant chemotherapy, (b) first combined neo-adjuvant radiotherapy chemotherapy, (c) surgery, (d) first chemotherapy (in patients who underwent chemotherapy only), (e) first radiotherapy (in patients who underwent radiotherapy only), (f) first treatment (irrespective of treatment type);2) from last neo-adjuvant chemotherapy to surgery; 3) from last combined neo-adjuvant radiotherapy-chemotherapyto surgery; 4) from surgery to: a) first chemotherapy, and b) first radiotherapy.1- Patients with surgical pathwayTime from bronchoscopy to surgery, Time from bronchoscopy to first neo-adjuvant chemotherapy, Time from bronchoscopy to first neo-adjuvant radiotherapy (combined to chemotherapy), Time from surgery to first chemotherapy, Time from last neo-adjuvant chemotherapy to surgery 2- Patients with non-surgical pathwayTime from bronchoscopy to first chemotherapy, Time from bronchoscopy to first radiotherapy 3- Treatment combinationTime from bronchoscopy to first treatment, Time from bronchoscopy to surgery as first treatment, Time from bronchoscopy to surgery as only treatment, Time from bronchoscopy to first chemotherapy as only treatment, Time from bronchoscopy to first radiotherapy as only treatment, Surgery followed by chemotherapy, Time from bronchoscopy to surgery, Time from surgery to first chemotherapy, Surgery followed by radiotherapy, Time from bronchoscopy to surgery, Time from surgery to first radiotherapy Chemotherapy followed by surgery and chemotherapy, Time from bronchoscopy to first neo-adjuvant chemotherapy, Time from last neo-adjuvant chemotherapy to surgery, Time from surgery to first chemotherapy, Time from bronchoscopy to surgery Chemotherapy followed by surgery, Time from bronchoscopy to first neo-adjuvant chemotherapy, Time from last neo-adjuvant chemotherapy to surgery, Time from bronchoscopy to surgery, Surgery followed by chemotherapy and radiotherapyTime from bronchoscopy to surgery, Time from surgery to first chemotherapy, Time from surgery to first radiotherapy
26	Lee et,al. 2002 UK	interval between referral by a respiratory physician and surgical out-patient attendance between referral by a respiratory physician and the surgical procedure time from surgical out-patient attendance to the surgical procedure
27	Li et al 2012 Canada	Time from surgery to post-surgical treatment. Time from surgery to consultation with an oncologist.
28	Maiga et al 2017 USA	**Timepoints:**Time zero (T0) is the date of lung nodule identification on computed tomography (CT) imaging according to the medical record; T1 is the date when a lung nodule originally less than 10 mm in size was documented as having new growth on CT imaging. T2 is the date of pathology diagnosis. T3 is time of resection and final pathology diagnosis.**Intervals:**Date of lung nodule identification on CT (T0) or date when a lung nodule originally less than 10 mm (T1) to time of resection and final pathology diagnosis (T3) is the time-totreatment interval.
29	Malalasekera et al 2018 Australia	Doctor interval: First clinical presentation to First suspicious investigation System interval: First suspicious investigation to Treatment start
38	Heredia et al 2012 Spain	**Interval in days between the 1st evaluation and staging **Interval in days between the first evaluation and the start of treatment **Interval in days between the referral date and staging **Interval in days between the staging date of the tumor and the start of treatment **Therapeutic delays in days since the first evaluation : Interval until surgical treatment, Interval until the start date of oncologic treatment, Interval until the start date of palliative treatment
39	Iachina et al 2017 Denmark	** Time from referral (time of diagnosis) to end of primary investigation = 28 days **Time from referral (time of diagnosis) to first day of treatment = 42 days **End of primary investigation is defined as the date of decision on treatment. Referral is defined as the date where the investigating department receives the referral.
40	Ju et al 2017 USA	1. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) tp diagnostic biopsy (Step 2), 2. diagnostic biopsy (Step 2) to radiologic staging (Step 3), 3. radiologic staging (Step 3) to invasive staging (Step 4), 4. invasive staging (Step 4) to surgery (Step 5). 5. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) to radiologic staging (Step 3) 6. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) to invasive staging (Step 4) 7. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) to surgery (Step 5)
41	Olsson et al 2009 USA	Waiting list for surgery Decision-to-treat to treatment other than surgery
42	Ost et al 2013 USA	Suspicion to treatment
45	Rolke et al 2006 Norway	Informed diagnostic delay: Time from decision of doing a diagnostic procedure to informing patient of diagnosis.
46	Thapa et al 2014 Nepal	T1=Time since the onset of symptoms to assessment at hospital (MCVTC) T2=Time since fist contact with a doctor to assessment at Hospital T 3=Time since referral to MCVTC with suspicion of Lung Cancer
48	Vidaver et al 2017 USA	First diagnostic test-last test
49	Wai et al 2012 Canada	Driving times to the nearest cancer center at the time of diagnosis First symptom to first abnormal test First abnormal test to diagnosis
51	Wilcock et al 2016 UK	From emergency admission to diagnosis From emergency admission to discussion at the lung cancer MDT
52	Winget et al 2007 Canada	2) diagnosis to first consult with an oncologist
54	Yilmaz et al 2009 Turkey	The diagnosis interval was regarded as the time passed between the admission to our hospital and the pathological diagnosis was made.
55	Yorio et al 2009 USA	Survival time was defined as the interval between the date of treatment and the date of death or censoring. The intervals included in this analysis were image to diagnosis. Image to treatment
56	Zullig et al 2013 USA	Days from diagnosis to death
62	Singh et al 2010 USA	Two types of missed opportunities that could result in diagnostic delays: (1) type I missed opportunities, defined as episodes of care in which there was failure to recognize a predefined clinical clue (ie, no required action or work-up was initiated within 7 days of clue appearance); appropriate decisions to watch and wait were not considered missed opportunities; and (2) type II missed opportunities, defined as episodes of care in which there was failure to complete within 30 days a diagnostic procedure, consultation, or other requested follow-up action in response to a predefined clue.
63	Smith et al 2009 Scotland	Two definitions of first symptom were used—participant-defined and health professional defined—using a checklist of symptoms compiled from CancerResearch UK lung cancer symptoms and SIGN guidelines. **the number of days from date of earliest symptom from the symptom checklist until date of presentation of symptoms to a medical practitioner

#	Author, pub date and country	Other time point or Intervals
64	Sood et al 2009 NZ	** postal delay (time taken to receive the referral at the outpatient clinic from the referrer) **grading delay (time taken to grade the referral) **clinic delay (interval between date of receiving referral and to date of patient assessment) **interval from initial chest physician assessment to bronchoscopy **interval from initial respiratory assessment to CT chest **interval from initial CT chest to CT-guided fine needle aspiration (CT FNA) ** First respiratory assessment to final diagnosis **Date referral received to diagnosis achieved **Date of GP referral to first respiratory assessment **First respiratory assessment to surgery **Date referred to surgeons to surgery **Date of oncology referral to commencement of radiotherapy **Date of oncology referral to commencement of chemotherapy
65	Stokstad et al 2017 Norway	Timepoint: Start of treatment as date of surgery, first fraction of radiotherapy, first day of intra-venous chemotherapy, or date of prescription of oral cancer therapy. Time to start of treatment was defined as the number of calendar days from start time until start of treatment ** time to treatment decision: start time to the date when such a decision was documented in the EMR

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Page 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Page 4-6
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Page 7
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Page 8
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Page 7
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Page 7
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Page 8
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Page 8
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Page 8-9
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Page 8-9
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Page 8-9
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Page 10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Page 10-12, 14-17, 19-20
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	-
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Page 9-10
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Page 9-21
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Page 21-26
Limitations	20	Discuss the limitations of the scoping review process.	Page 26
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Page 26-27
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	Page 28

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

BMJ Open

Defining timeliness in care for patients with lung cancer – a scoping review

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-056895.R1
Article Type:	Original research
Date Submitted by the Author:	08-Feb-2022
Complete List of Authors:	Ansar, Adnan; La Trobe University; Institute for Breathing and Sleep (IBAS) Lewis, Virginia; La Trobe University, Australian Institute for Primary Care and Aging McDonald, Christine; Austin Health, Respiratory and Sleep Medicine Liu, Chaojie; La Trobe University, Public Health Rahman, Aziz; Federation University Australia, School of Nursing and Healthcare Professions; La Trobe University, School of Nursing and Midwifery
Primary Subject Heading:	Public health
Secondary Subject Heading:	Health services research
Keywords:	Respiratory tract tumours < ONCOLOGY, PREVENTIVE MEDICINE, PRIMARY CARE, PUBLIC HEALTH, RESPIRATORY MEDICINE (see Thoracic Medicine)

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Title

Defining timeliness in care for patients with lung cancer – a scoping review

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Abstract

Objectives

Early diagnosis and reducing the time taken to achieve each step of lung cancer care is essential. This scoping review aimed to examine timepoints and intervals used to measure timeliness and to critically assess how they are defined by existing studies of the care seeking pathway for lung cancer.

Methods

This scoping review was guided by the methodological framework for scoping reviews by Arksey and O'Malley. MEDLINE, EMBASE, CINAHL, and PsycINFO electronic databases were searched for articles published between 1999 and 2019. After duplicate removal, all publications went through title and abstract screening followed by full text review and inclusion of articles in the review against the selection criteria. A narrative synthesis describes the timepoints, intervals, and measurement guidelines used by the included articles.

Results

A total of 2113 articles were identified from the initial search. Finally, 68 articles were included for data charting process. Eight timepoints and 14 intervals were identified as the most common events researched by the articles. Eighteen different lung cancer care guidelines were used to benchmark intervals in the included articles; all were developed in Western countries. The British Thoracic Society guideline was the most frequently used guideline (20%). Western guidelines were used by the studies in Asian countries despite differences in the health system structure.

Conclusion

This review identified substantial variations in definitions of some of the intervals used to describe timeliness of care for lung cancer. The differences in healthcare delivery systems of Asian and

Western countries, and between High Income Countries and Low - Middle Income Countries may suggest different sets of timepoints and intervals need to be developed.

Strengths and limitations of this study

- This scoping review documented the commonly studied timepoints in the lung cancer care pathway and the heterogeneity in naming the intervals and, guidelines adopted in the disease care pathway for lung cancer across different studies.
- Arksey and O'Malley's five-stage scoping review framework and PRISMA-ScR checklist was followed for this scoping review.
- This study was informed by a previously published protocol which dictated a transparent and rigorous search strategy for four databases.
- Quality of studies was not assessed.
- Only studies published in English were included in the review, which may miss potential literature in other languages.

Background

Lung cancer is the most common cancer, with an incidence of 2.1 million globally during 2018, and is the most frequent cause of deaths in both sexes in 14 regions of the world[1]. Incidence and mortality vary across countries due to differences in smoking prevalence and other risk factors, but overall survival rates are low globally (5-year survival of 10-20% in most countries) with most patients diagnosed at an advanced stage [1].

Timely diagnosis and access to effective treatment are important determinants of outcome in patients with cancer [2]. Higher cancer survival rates are evident in high performing health care systems. For example, lung cancer patients in Japan (33%), Israel (27%) and Korea (25%) have a much higher five-year survival rate than their counterparts in India, Thailand, Brazil and Bulgaria (all less than 10%) [3]. Early diagnosis can improve survival and reduce lung cancer mortality through timely initiation of treatment[4].

Numerous studies have been conducted to assess timeliness of initiation and completion of cancer treatment. However, the pathway to cancer diagnosis and treatment is complex[5]. The patient journey from onset of symptoms to initiation of treatment involves multiple stages, which vary significantly across different health systems[6], with different health systems having different "bottlenecks" in the patient journey.

The patient journey can be categorised into different care timepoints. Timepoints are the landmarks or events that take place in a patient journey to healthcare, for example, onset of symptom(s), contact with a healthcare provider, referral, diagnosis, initiation of treatment, and so on. Depending on the outcome of interest of a research or intervention, intervals are defined by calculating the time between two agreed timepoints. Timeliness can be defined as reaching different timepoints of care in a way that supports the best patient outcomes. It usually starts from the date of onset of symptoms and ends at the date of initiation of treatment. Guidelines can be defined as a set of agreed recommendation that aim to streamline the process in each step of the

disease care pathway to set routine or standard clinical practice. In some countries, clinical guidelines have been developed to establish a maximal length requirement for the intervals between different timepoints to ensure optimal patient care outcomes. These have enabled measurement of delay. However, studies describing time intervals often mislabeled these intervals as 'delays' despite a lack of benchmarking, creating confusion among readers. There are also marked variations in the definitions of these intervals across studies, and in how the data were obtained, measured and presented[7]. This ambiguity leads readers to make assumptions about the interpretation of the terms and findings. Moreover, due to differences in health systems, studies are seldom comparable across countries[6]. Referral pathways vary between countries. For example, in some developing countries, all the diagnostic tests required to diagnose a cancer are completed before a patient is referred to a specialist, thus contributing to variation in the definition and length of the diagnostic segment in the care pathway between such developing countries and the developed country which was the source of the guidance.

Existing guidelines for lung cancer care vary in the benchmarks or cutoff values used to describe acceptable limits of time for each step in the disease care pathway. As a result, definitions and measures of "timeliness of care" vary across countries. Furthermore, the majority of guidelines were developed in Western countries, considering country-specific resources and healthcare mechanisms, and associated with effective referral systems governed by policies[8]. It is unlikely that guidelines developed for Western health systems can be fully effective in poorly resourced health systems [8 9], which require different definitions, measurements and guidelines for timely care compatible with their available resources and the strength of their health systems [10].

Several models were proposed in an attempt to improve consistency in the definition, classification and measurement of timeliness of care, but the models are not devoid of limitations. These include the Andersen model of total patient delay[11], the model of pathways to treatment[12] and the Aarhus statement[6]. Andersen's model can capture the decisional and behavioral

processes that occur before the initiation of treatment, but is limited in its capacity to address the complex and dynamic journey into and through the healthcare system[12]. The subsequently proposed 'Model of pathways to treatment' is a descriptive framework which can encompass the psychological theories with a focus on patient factors in the appraisal and help-seeking intervals. The most recent and widely accepted framework, 'The Aarhus Statement,'[13] proposes a universal framework to incorporate the issue of lack of consensus in definitions and methods across studies conducted on timeliness of cancer care. It defines four important timepoints that links different interval durations with patient outcomes to determine targets and guidelines (date of first symptom, date of first presentation to a general practitioner (GP), date of referral, and date of diagnosis). It also provides guidance on how to design research with greater precision and transparency. All these models provide an overarching framework that can be adapted to different system contexts. This scoping review aimed to examine timepoints and intervals used to measure timeliness and to critically assess and compare how they are defined by existing studies of the care seeking pathway for lung cancer.

Methods

This scoping review followed the methodological framework for scoping reviews by Arksey and O'Malley[14] which was further enhanced by Levac et al[15] and the Joanna Briggs Institute[16]. Stages of the scoping review framework included (1) Identifying the research question, (2) Identifying relevant studies, (3) Study selection, (4) Charting the data, and (5) Collating, summarising, and reporting the results. The University of York Centre for Reviews and Dissemination guidance for undertaking reviews in health care[17] and the PRISMA-ScR checklist[18] were followed to ensure the comprehensiveness of the review. This scoping review categorised available definitions and terminologies relating to timeliness in the disease care pathway, without an intention of achieving consensus.

Identifying the research question

To address the aim of assessing definitions describing timeliness of seeking and receiving care in patients with lung cancer in published articles, the following research questions were posed:

1. What are the timepoints and intervals commonly identified in the care pathway for lung cancer in the existing literature?
2. How is timeliness of seeking and receiving care for lung cancer described and related to Guidelines in the existing literature?
3. Are there differences in definitions, measurements and benchmarking of timeliness used in Western and Asian countries?

Identifying relevant studies

The study population of included literature was patients with diagnosed lung cancer, irrespective of histological type and disease stage. Studies were identified through the keywords that were used to describe timeliness of seeking care, timepoints in seeking care and intervals between timepoints in the disease care pathway. Studies were excluded if timeliness of care or timepoints and intervals in the care pathway were ambiguous, were not specific for lung cancer, if the primary focus of the article was not timeliness of care, if the articles were not published in English, or if studies were published only as abstracts. This scoping review included all studies, irrespective of study methodology, quality, and publication type to gain a better understanding of how researchers have operationalized and measured timeliness of seeking and receiving care for lung cancer in various study settings between May 1999 and May 2019.

The text contained in the titles and abstracts of the papers from the initial search and the keywords used to describe those articles were used to formulate the search strategies specific to the selected databases. MEDLINE, EMBASE, PsycINFO and CINAHL were searched for published articles. An academic health sciences librarian was consulted on selecting the appropriate

keywords and the most appropriate MeSH terms and filters to maximize inclusion of articles within the search, and how to modify them for selected bibliographic databases (full search strategy in supplementary file 1). Reference lists were screened for relevant articles. Search results were imported into EndNote (version X9) to organize search results specific to each database and later used to generate the reference list for the review. References were imported to Covidence, which was used for documenting the process including duplicate identification and removal, title and abstract screening, and full-text review for included articles. Detailed keywords mapping and database specific search strategies were published in the protocol of this scoping review[19].

Study selection

Selection of publications involved two stages. First, title and abstract were screened against the inclusion criteria, and second, the potentially relevant papers went through full-text review. To increase the reliability of the decision process all selected papers were independently assessed by at least two researchers. Due to the exploratory nature of this scoping review, a detailed methodological quality assessment was not required[20]. One author (AA) performed a search of the electronic database for literature. Two authors (AA and MAR) independently reviewed and screened the abstracts of the searched articles for inclusion. The other two authors (VL and CMcD) reviewed the disagreements and resolved by discussion with all the authors.

Data charting, collating and summarising

A data extraction chart was used to capture the data from selected articles (supplementary file 2), which was recorded on Microsoft Excel 365. Data were extracted by AA independently and examined by authors (VL, CL, CMcD and MAR).

Initially a coding tree was constructed which had three levels: timepoints as the first level, time intervals (with starting and ending timepoint) as the second level, and timeliness (with a definition or benchmarking) as the third level. The initial coding tree was further expanded and divided when

new categories emerged from data. An exhaustive list of timepoints related to seeking or receiving care on the patient care journey was extracted through comparing and merging similar terminologies. The sequence of the timepoints was determined as follows, i) patient recalled onset of symptoms, ii) first contact with a healthcare provider, iii) diagnosis, iv) referral to a specialist, v) first visit to a specialist/hospital admission, vi) patient informed about diagnosis, vii) pre-initiation of treatment, and viii) initiation of treatment. Afterwards, we summarized and charted the type of intervals examined in the included studies. Intervals in the lung cancer patient care pathway considered the duration between one timepoint and another timepoint. Relevant definitions or measurements in relation to the three level coding themes (timepoints, intervals, and timeliness) were also extracted with or without further verification from the cited guidelines. The data on definition of interval or delay were extracted when an article explicitly mentioned the guiding principle (cancer care guideline or self-definition) which included researcher/study constructed definitions as well. Comparisons between Asian and Western countries were based on the similarities or differences in using timepoints, intervals and measurement of timelines for intervals.

Ethics approval

Ethical approval is not needed as this scoping review reviewed already published articles.

Results

A total of 2113 articles were identified from the initial search. After duplicates removal, 1546 articles were screened for eligibility and 269 articles were selected for full text review. Two hundred and one articles were excluded because they were not relevant, only published as abstract, or not related to lung cancer. Finally, 68 articles were included for the data charting process (figure 1). Characteristics of the included articles are given in table 1 (review articles were excluded).

Figure 1: PRISMA flow chart

Table 1: Characteristics of included articles

N=68	Characteristics of included articles	N (%)
Year of publication	2001-2010	25 (37)
	2011-2018	43 (63)
Study setting*	**North America** (USA, Canada)	21 (30.88)
	UK (England, Scotland, Wales and Northern Ireland)	15 (22.06)
	Europe (Denmark, Netherlands, Norway, Spain, Italy, Sweden, France, Poland, Finland)	13 (19.12)
	Asia (Turkey, India, Mainland China, Taiwan, Nepal)	9 (13.24)
	Australia and New Zealand	8 (11.76)
Study design	Cross sectional	41 (60.83)
	Other study designs	13 (19.1)
	Cohort	9 (13.2)
	Case control	3 (4.4)
	Systematic Review	1 (1.5)
	Scoping Review	1 (1.5)
Sample size	Range	12 - 171208
	All studies total	280591

*review papers not counted in study settings and sample size

Timepoints

Based on the selected articles, timepoints were classified and the sequence was determined into eight categories (Table 2). Commonly mentioned timepoints included onset of symptom(s), first contact with healthcare provider, diagnosis/first suspicious investigation result, referral/receipt of referral by a specialist (at secondary care), first visit to a specialist/hospital admission, patient informed of lung cancer diagnosis and initiation of treatment.

Table 2: Timepoints in the lung cancer care pathway

Timepoints	Articles	Definition of timepoint	Settings
Onset of symptoms	Baughan et al. 2009 UK[21]	Date patient first noticed symptoms	**UK**
	Corner et al. 2005 UK[22]	The date, week, or month when a symptom or health change was recalled, and actions taken as a result by the patient were recorded as well as a description of the health change or symptom	
	Dobson et al. 2017 UK[23]	The date of symptom onset was defined as the first symptom reported	
	Melling et al. 2002 UK[24]	First symptom reported by the patients to their GPs	
	Neal et al. 2015 UK[25]	Onset of first symptom	
	Smith et al. 2009 Scotland[26]	The date participant defined first symptom	
	Salomaa et al. 2005 Finland[27]	The dates of onset of symptoms	**Europe**
	Yang et al. 2015 Mainland China[28]	First symptom	**Asia**
	Yilmaz et al. 2008 Turkey[29]	Date of initial symptoms	

Timepoints	Articles	Definition of timepoint	Settings
	Özlü et al. 2004 Turkey[30]	Onset of symptoms	
First contact with healthcare provider	Baughan et al. 2009 UK[21]	Date patient of first presentation with a GP	**UK**
	Corner et al. 2005 UK[22]	Timing of first visit to the GP	
	Dobson et al. 2017 UK[23]	Date on which person consulted a GP about their symptoms.	
	Smith et al. 2009 Scotland[26]	Date of presentation to a medical practitioner	
	Melling et al. 2002 UK[24]	Presentation of the first cancer symptom to the GP	
	Neal et al. 2015 UK[25]	First presentation (Face-to-face consultations, nurse consultations, telephone consultations) to primary care	
	Vidaver et al. 2016 USA[31]	First visit to primary healthcare provider	**North America**
	Helsper et al. 2017 Netherlands[32]	First contact (physical or telephone) with the GP for suspected cancer-related signs or symptoms	**Europe**
	Salomaa et al. 2005 Finland[27]	First visit to a doctor, who was in general, a GP	
	Rankin et al. 2017 Australia[33]	First consultation with primary healthcare provider	**Australia and New Zealand**
	Largey et al. 2015 Australia[34]	Dates of first presentation as the time point the clinician started investigation or referral for possible investigation	
	Yang et al. 2015 Mainland China[28]	First contact with local doctor	**Asia**
	Yilmaz et al. 2008 Turkey[29]	Date of first doctor visit	
	Özlü et al. 2004 Turkey[30]	First presentation to a physician	
Diagnosis/ First suspicious investigation result	Corner et al. 2005 UK[22]	Date of diagnosis (the investigation procedure was not specified)	**UK**
	Neal et al. 2015 UK[25]	Date of diagnosis (CT/PET scan, a tissue diagnosis)	
	Melling et al. 2002 UK[24]	Date of Diagnosis (bronchoscopy, mediastionsocopy, CT scan, bone scan, plural cytology)	
	Vidaver et al. 2016 USA[31]	First imaging result with a lung abnormality	**North America**
	Singh et al 2010 USA[35]	Earliest date that a diagnostic clue could have been recognized by a care provider	
	Li et al. 2013 Canada[36]	Date of diagnosis	
	Maiga et al. 2017 USA[37]	Date of pathology diagnosis	
	Schultz et al. 2009 USA[38]	Date when a pathologic diagnosis of lung cancer was confirmed	
	Grunfeld et al. 2009 Canada[39]	Date of confirmed diagnosis (date of the pathology or radiology report)	
	Helsper et al. 2017 Netherlands[32]	Date of the histological confirmation of the primary tumor	**Europe**
	Rankin et al. 2017 Australia[33]	Time of the formal cancer diagnosis being made	**Australia and New Zealand**
	Largey et al. 2015 Australia[34]	Date of histological diagnosis	
	Malalasekera et al. 2018 Australia[40]	First suspicious investigation report (the investigation procedure was not specified)	
	Özlü et al. 2004 Turkey[30]	Date of histopathological diagnosis	**Asia**
	Yang et al. 2015 Mainland China[41]	Date of diagnosis (CT scan and biopsy)	
	Yilmaz et al. 2008 Turkey[29]	Date of diagnosis	
Referral to a specialist/ receipt of referral by a specialist or thoracic department	Baughan et al. 2009 UK[21]	Date of decision to refer by primary care	**UK**
	Melling et al. 2002 UK[24]	Date of referral to secondary care	
	Neal et al. 2015 UK[25]	Date of GP referral to specialist or admission to hospital	
	Grunfeld et al. 2009 Canada[39]	Referral for diagnostic assessment was received by the consultant	**North America**
	Vidaver et al. 2016 USA[31]	Date of referral to a specialist	
	Helsper et al. 2017 Netherlands[32]	The timepoint when the responsibility for the patient was transferred from a GP to secondary care	**Europe**
	Salomaa et al. 2005 Finland[27]	The date of the writing of the referral requesting consultation from a specialist	

Timepoints	Articles	Definition of timepoint	Settings
	Stokstad et al. 2017 Norway[42]	A referral letter for suspected lung cancer was received by the Department of Thoracic Medicine	
	Largey et al. 2015 Australia[34]	Date of referral by primary healthcare provider	**Australia and New Zealand**
	Malalasekera et al. 2018 Australia[40]	Date of first referral to secondary care	
	Yang et al. 2015 Mainland China[41]	Date of referral to hospital from primary physician	**Asia**
First visit to a specialist/ Hospital admission	Baughan et al. 2009 UK[21]	Date patient first seen by specialist	**UK**
	Vidaver et al. 2016 USA[31]	First visit to a specialist	**North America**
	Salomaa et al. 2005 Finland[27]	The first appointment with the specialist	**Europe**
	Largey et al. 2015 Australia[34]	First specialist visit	**Australia and New Zealand**
	Malalasekera et al. 2018 Australia[40]	First specialist visit	
	Alexander et al. 2016 Australia[43]	Date of first medical oncology or hematology review for patients with an urgent presentation	
	Yilmaz et al. 2008 Turkey[29]	Date of admission to pneumology department	**Asia**
Patient informed of the cancer diagnosis	Baughan et al. 2009 UK[21]	Date patient told the diagnosis	**UK**
	Grunfeld et al. 2009 Canada[39]	Date patient informed of diagnosis	**North America**
	Vidaver et al. 2016 USA[31]	Date patient informed of the biopsy result	
Pre-initiation of treatment	Maiga et al. 2017 USA[37]	• Date of lung nodule identification on computed tomography (CT) imaging according to the medical record • Date when a lung nodule originally less than 10 mm in size was documented as having new growth on CT imaging.	**North America**
Initiation of treatment	Melling et al. 2002 UK[24]	Date treatment started (surgery, radical radiotherapy with chemotherapy).	**UK**
	Li et al. 2013 Canada[36]	Date of first treatment, surgery and adjuvant treatment	**North America**
	Shugarman et al. 2009 USA[44]	First date recorded for treatment (surgery, radiation, or chemotherapy)	
	Vidaver et al. 2016 USA[31]	First treatment date	
	Grunfeld et al. 2009 Canada[39]	Date of initiation of neoadjuvant chemotherapy, surgery if no preoperative treatment was required, chemotherapy, radiotherapy, or a decision not to treat.	
	Maiga et al. 2017 USA[37]	Time of resection.	
	Stokstad et al. 2017 Norway[42]	The time for treatment decision as the date when such a decision was documented in the Electronic Medical Record	**Europe**
	Helsper et al. 2017 Netherlands[32]	Date of start of therapy as registered in the Network of Cancer Registries	
	Iachina et al. 2017 Denmark[45]	First day of treatment is defined as the date of initiation of surgical, oncological, or radiological treatment, whichever comes first	
	Alexander et al. 2016 Australia[43]	Time to chemotherapy should be measured from the date that chemotherapy treatment was decided. For adjuvant chemotherapy, time to chemotherapy should be measured from the date of surgery.	**Australia and New Zealand**
	Evans et al. 2016 Australia[46]	Date of initial definitive management	
	Malalasekera et al. 2018 Australia[40]	Treatment start date	
	Rankin et al. 2017 Australia[33]	Start of treatment	
	Özlü et al. 2004 Turkey[30]	Start of treatment	**Asia**
	Yang et al. 2015 Mainland China[41]	Initiation of treatment date	
	Yilmaz et al. 2008 Turkey[29]	Date of thoracotomy	

229

Intervals

Fourteen different intervals, from onset of symptom(s) to initiation of treatment were identified in this scoping review (Table 3): (1) From onset of symptoms to first contact with healthcare provider, (2) From first contact with general healthcare provider to first contact with specialist healthcare provider, (3) From first contact with secondary/tertiary healthcare provider to diagnosis, (4) From first contact with healthcare provider to diagnosis, (5) From diagnosis to contact with secondary/tertiary healthcare provider, (6) From onset of symptoms to contact with secondary/tertiary healthcare provider, (7) From contact with secondary/tertiary healthcare provider to initiation of treatment, (8) From onset of symptom(s) to referral to a specialist/ receipt of referral by a specialist or thoracic department, (9) From referral to a specialist/ receipt of referral by a specialist or thoracic department to diagnosis, (10) From onset of symptom to diagnosis, (11) From referral to a specialist/ receipt of referral by a specialist or thoracic department to treatment, (12) From first contact with healthcare provider to treatment, (13) From diagnosis to initiation of treatment, and (14) From onset of symptom to Initiation of treatment. Intervals were not measured as completion of treatment or death.

Some articles used different terminologies to label the same intervals; and similarly, the same terminology was used to label different intervals in different articles.

1. From onset of symptoms to first contact with healthcare provider interval: patient delay[27 41 47-50] and patient's application interval[29 51].
2. Duration from first contact with healthcare provider to first contact with specialist at secondary care or next level: GP delay[27 47-49], GP interval[52], primary care interval[32], referral delay[27 47 49], and referral interval[29 51].
3. From first contact with secondary or tertiary healthcare provider to diagnosis interval: specialist interval[52], specialist's delay (second doctor's delay)[27 48 49], diagnosis delay[53] and diagnosis interval[51].

4. From first contact with healthcare provider to diagnosis: diagnostic interval[32 33 40 52] and delay in diagnosis[54].
5. From diagnosis to contact with secondary/tertiary healthcare provider: referral interval in one study[55].
6. Interval between onset of symptom to contact with secondary/tertiary healthcare provider: patient delay[56].
7. Interval between contact with secondary/tertiary healthcare provider and initiation of treatment: hospital delay[49 53] and treatment interval[55].
8. From onset of symptoms to referral to a specialist thoracic department: referral delay[57], specialist delay[53].
9. From referral to a specialist or receipt of referral by a specialist or thoracic department to diagnosis: referral interval[32].
10. Interval between onset of symptom to diagnosis: total diagnostic delay[52] and time to diagnosis[58].
11. From referral to a specialist/receipt of referral by a specialist or thoracic department to treatment interval: time to treatment (hospital delay)[59] and delay in secondary healthcare[41].
12. Interval between first contact with healthcare provider to treatment: healthcare interval[32], system delay[41] and doctor's interval[29 51].
13. From diagnosis to initiation of treatment: therapeutic delay[47], treatment delay[41 53], treatment interval[32 40], system interval[60], pretreatment interval[33], diagnosis-to-treatment delay[61] and diagnosis-to-treatment interval[37].
14. From onset of symptom(s) to initiation of treatment: global delay[62], total delay[49], and symptom to treatment delay[61].

Table 3: Intervals in the lung cancer care pathway

Intervals	Articles	Study setting
From Onset of symptoms To First contact with healthcare provider	Baughan et al. 2009 UK [21]	**UK**
	Corner et al. 2005 UK [22]	
	Neal et al. 2015 UK [25]	
	Smith et al. 2009 Scotland [26]	
	Brocken et al. 2012 Netherlands [47]	**Europe**
	Helsper et al. 2017 Netherlands [32]	
	Koyi et al. 2002 Sweden [48]	
	Salomaa et al. 2005 Finland [27]	
	Sawicki et al. 2013 Poland [63]	
	Rolke et al. 2007 Norway [49]	
	Ezer et al. 2017 Canada [64]	**North America**
	Ellis & Vandermeer 2011 Canada [62]	
	Verma et al. 2018 Australia [65]	**Australia and New Zealand**
	Thapa et al. 2014 Nepal [50]	**Asia**
	Yang et al. 2015 Mainland China [41]	
	Yilmaz et al. 2008 Turkey [29]	
	Özlü et al. 2004 Turkey [30]	
	Sulu et al. 2011 Turkey [51]	
From First contact with general healthcare provider To First contact with specialist healthcare provider	Forrest et al. 2014 UK [66]	**UK**
	Baughan et al. 2009 UK [21]	
	Barrett & Hamilton 2008 UK [67]	
	Devbhandari et al. 2007 UK [68]	
	Melling et al. 2002 UK [24]	
	Girolamo et al. 2018 UK [69]	
	Rolke et al. 2007 Norway [49]	**Europe**
	Hueto Pérez De Heredia et al. 2012 Spain [70]	
	Koyi et al. 2002 Sweden [48]	
	Helsper et al. 2017 Netherlands [32]	
	Salomaa et al. 2005 Finland [27]	
	Brocken et al. 2012 Netherlands [47]	
	Vidaver et al. 2016 USA [31]	**North America**
	Olsson et al. 2009 USA [71]	
	Ellis & Vandermeer 2011 Canada [62]	
	Grunfeld et al. 2009 Canada [39]	
	Verma et al. 2018 Australia [65]	**Australia and New Zealand**
	Emery et al. 2013 Australia [52]	
	Sood et al. 2009 New Zealand [72]	
	Yilmaz et al. 2008 Turkey [29]	**Asia**
	Thapa et al. 2014 Nepal [50]	
	Sulu et al. 2011 Turkey [51]	
From First contact with secondary/tertiary healthcare provider To Diagnosis	Salomaa et al. 2005 Finland [27]	**Europe**
	Rolke et al. 2007 Norway [49]	
	Koyi et al. 2002 Sweden [48]	
	Gozalez et al. 2014 Spain [53]	
	Ellis & Vandermeer 2011 Canada [62]	**North America**
	Emery et al. 2013 Australia [52]	**Australia and New Zealand**
	Sulu et al. 2011 Turkey [51]	**Asia**
	Özlü et al. 2004 Turkey [30]	
From First contact with healthcare provider To Diagnosis	Barrett & Hamilton 2008 UK [67]	**UK**
	Corner et al. 2005 UK [22]	
	Devbhandari et al. 2007 UK [68]	
	Forrest et al. 2014 UK [66]	
	Neal et al. 2015 UK [25]	
	Helsper et al. 2017 Netherlands [32]	**Europe**
	Ezer et al. 2017 Canada [64]	**North America**
	Vidaver et al. 2016 USA [31]	
	Emery et al. 2013 Australia [52]	**Australia and New Zealand**

Intervals	Articles	Study setting
	Rankin et al. 2017 Australia [33]	
	Özlü et al. 2004 Turkey [30]	**Asia**
	Hsieh et al. 2012 Taiwan [54]	
From Diagnosis To Contact with secondary/tertiary healthcare provider	Kanarek et al. 2014 USA [55]	**North America**
	Wai et al. 2012 Canada [73]	
	Winget et al. 2007 Canada [74]	
	Zullig et al. 2014 USA [75]	
From Onset of symptoms To Contact with secondary/tertiary healthcare provider	Bjerager et al. 2006 Denmark [76]	**Europe**
	Ampil et al. 2014 USA [56]	**North America**
	Thapa et al. 2014 Nepal [50]	**Asia**
From Contact with secondary/tertiary healthcare provider To Initiation of treatment	Devbhandari et al. 2008 UK [77]	**UK**
	Girolamo et al. 2018 UK [69]	
	Gozalez et al. 2014 Spain [53]	**Europe**
	Rolke et al. 2007 Norway [49]	
	Hueto Pérez De Heredia et al. 2012 Spain [70]	
	Hubert et al. 2018 Canada [78]	**North America**
	Kanarek et al. 2014 USA [55]	
	Winget et al. 2007 Canada [74]	
	Vidaver et al. 2016 USA [31]	
	Ellis & Vandermeer 2011 Canada [62]	
	Ampil et al. 2014 USA [56]	
	Olsson et al. 2009 USA [71]	
	Wai et al. 2012 Canada [73]	
	Verma et al. 2018 Australia [65]	**Australia and New Zealand**
From Onset of symptoms To Referral to specialist/ receipt of referral by a specialist or thoracic department	Lee et al. 2002 UK [79]	**UK**
	Gozalez et al. 2014 Spain [53]	**Europe**
	Buccheri & Ferrigno 2004 Italy [57]	
From Referral to a specialist/ receipt of referral by a specialist or thoracic department To Diagnosis	Barrett & Hamilton 2008 UK [67]	**UK**
	Smith et al. 2009 Scotland [26]	
	Helsper et al. 2017 Netherlands [32]	**Europe**
	Grunfeld et al. 2009 Canada [39]	**North America**
	Evans et al. 2016 Australia [46]	**Australia and New Zealand**
	Largey et al. 2016 Australia [80]	
	Sood et al. 2009 New Zealand [72]	
From Onset of symptoms To Diagnosis	Corner et al. 2005 UK [22]	**UK**
	Lee et al. 2002 UK [79]	
	Walter et al. 2015 UK [58]	
	Koyi et al. 2002 Sweden [48]	**Europe**
	Wai et al. 2012 Canada [73]	**North America**
	Emery et al. 2013 Australia [52]	**Australia and New Zealand**
	Sachdeva et al. 2014 India [81]	**Asia**
	Chandra et al 2009 India [61]	
	Dubey et al 2016 India [82]	
From Referral to a specialist/ receipt of referral by a specialist or thoracic department To Treatment	Devbhandari et al. 2007 UK [68]	**UK**
	Smith et al. 2009 Scotland [26]	
	Forrest et al. 2014 UK [66]	
	Bozcuk & Martin 2001 UK [59]	
	Iachina et al. 2017 Denmark [45]	**Europe**
	Olsson et al. 2009 USA [71]	**North America**
	Grunfeld et al. 2009 Canada [39]	
	Ampil et al. 2014 USA [56]	
	Evans et al. 2016 Australia [46]	**Australia and New Zealand**
	Largey et al. 2016 Australia [80]	
	Sood et al. 2009 New Zealand [72]	
	Yang et al. 2015 Mainland China [41]	**Asia**
From First contact with	Melling et al. 2002 UK [24]	**UK**

Intervals	Articles	Study setting
healthcare provider To Treatment	Helsper et al. 2017 Netherlands [32] Sawicki et al. 2013 Poland [63]	**Europe**
	Vidaver et al. 2016 USA [31] Ezer et al. 2017 Canada [64]	**North America**
	Yang et al. 2015 Mainland China [41] Yilmaz et al. 2008 Turkey [29] Özlü et al. 2004 Turkey [30] Sulu et al. 2011 Turkey [51]	**Asia**
From Diagnosis To Initiation of treatment	Forrest et al. 2014 UK [66]	**UK**
	Brocken et al. 2012 Netherlands [47] Gozalez et al. 2014 Spain [53] Salomaa et al. 2005 Finland [27] Helsper et al. 2017 Netherlands [32] Iachina et al. 2017 Denmark [45]	**Europe**
	Schultz et al. 2009 USA [38] Kanarek et al. 2014 USA [55] Grunfeld et al. 2009 Canada [39] Borrayo et al. 2016 USA [83] Kim et al. 2016 Canada [60] Olsson et al. 2009 USA [71] Ost et al. 2013 USA [84] Yorio et al. 2009 USA [85] Zullig et al. 2014 USA [75] Li et al. 2013 Canada [36] Maiga et al. 2017 USA [37] Vidaver et al. 2016 USA [31] Winget et al. 2007 Canada [74]	**North America**
	Largey et al. 2016 Australia [80] Malalasekera et al. 2018 Australia [40] Evans et al. 2016 Australia [46] Rankin et al. 2017 Australia [33]	**Australia and New Zealand**
	Özlü et al. 2004 Turkey [30] Yang et al. 2015 Mainland China [41] Yilmaz et al. 2008 Turkey [29] Sulu et al. 2011 Turkey [51] Chandra et al 2009 India [61]	**Asia**
From Onset of symptoms To Initiation of treatment	Salomaa et al. 2005 Finland [27] Koyi et al. 2002 Sweden [48] Rolke et al. 2007 Norway [49] Sawicki et al. 2013 Poland [63]	**Europe**
	Ellis & Vandermeer 2011 Canada [62] Olsson et al. 2009 USA [71]	**North America**
	Verma et al. 2018 Australia [65]	**Australia and New Zealand**
	Yilmaz et al. 2008 Turkey [29] Özlü et al. 2004 Turkey [30] Sulu et al. 2011 Turkey [51] Chandra et al 2009 India [61]	**Asia**

Table 4 presents the time intervals commonly studied in the included articles. The most frequently studied interval was “diagnosis to initiation of treatment”, followed by “first contact with healthcare provider to specialist” and “symptom onset to first contact”. Both “diagnosis to specialist” and “specialist to diagnosis” paths were studied. Very few studies have researched

onset of symptom to referral and specialist consultation. The timepoint "patient informed of diagnosis" and intervals involving this timepoint were rarely studied.

Table 4: Time intervals commonly studied – Dark blue>10 (most commonly), Light blue>7 (commonly), Lighter blue>3 (occasionally), White = none

	Ending point					
Starting point	**First contact with healthcare provider**	**Referral**	**Specialist consultation**	**Diagnosis**	**Patient informed of diagnosis**	**Initiation of Treatment**
Onset of symptom	18	3	3	9	-	11
First contact with healthcare provider	X	-	22	12	-	9
Referral		X	-	7	-	12
Specialist consultation			X	7	-	14
Diagnosis			4	X	3	28
Patient informed of Diagnosis					X	3

Timeliness measures

The review identified 30 articles which conceptualized delay in the care pathway by adapting benchmarks from established guidelines to set cutoff values. The benchmarks were guided by British Thoracic Society (BTS) recommendations on organizing the care of patients with lung cancer [86], National Institute for Clinical Excellence (NICE) guideline[87 88], United Kingdom National Cancer Plan (UKNCP)[89], United Kingdom National Health Service (UKNHS) guideline[90 91], United Kingdom Department of Health guideline[92], RAND Corporation guideline[93], Canadian Strategy for Cancer Control (CSCC)[94], Canadian guidelines[95], Standing Medical Advisory Committee (SMAC)[96], Cancer Council Australia and Cancer Australia[97], Danish Lung Cancer Group and Registry[98], Swedish Lung Cancer Group[99], and Scottish Executive Health Department (SEHD)[100 101], Institute of Medicine (IOM)[102], Dutch Association of Physicians for Pulmonary Disease and Tuberculosis[103], Joint Council for Clinical Radiology[104], American College of Chest Physicians (ACCP)[105], and Norwegian National Guidelines[106].

Six articles referenced cutoff values from other articles to compare timeliness[35 44 48 55 61 80] and one article proposed a benchmark cutoff value based on their findings[31]. Fifteen articles used single guidelines and fifteen articles used more than one guideline to conceptualize timeliness measures. Out of 30 articles, BTS was adopted by 14 articles[29 30 35 38 40 47 49 51 61 68 70 72 79 84], UKNHS was used seven times[40 43 46 66 69 70 80], NICE guideline by four articles[21 64 68 72], RAND corporation guideline by four articles[38 40 84 107] and Canadian guidelines by four articles[29 39 51 61], SEHD guidelines by three articles[21 24 40], Danish Lung Cancer Group guidelines by three articles[40 45 80], UKNCP guidelines by two articles[68 77], SMAC guideline by two articles[24 40], Norwegian National Guidelines by two articles[42 49], and Swedish Lung Cancer Group guidelines by two articles[40 51]. Supplementary file 3 describes the 'measures of timeliness'/'benchmark for intervals' with cutoff values adopted from different guidelines. Table 5 presents the timeliness measures according to study settings.

Table 5: Most frequently cited guidelines used to measure timeliness across settings

	Guidelines	Articles included	Settings
1.	BTS: British Thoracic Society	Lee et al. 2002 UK [79] Forrest et al. 2014 UK [66]	**UK**
		Singh et al 2010 USA[35] Schultz et al. 2009 USA[38] Olsson et al. 2009 USA [71] Ost et al. 2013 USA [84]	**North America**
		Brocken et al. 2012 Netherlands [47] Rolke et al. 2007 Norway [49]	**Europe**
		Malalasekera et al. 2018 Australia[40] Sood et al. 2009 New Zealand [72]	**Australia and New Zealand**
		Özlü et al. 2004 Turkey [30] Yilmaz et al. 2008 Turkey [29] Sulu et al. 2011 Turkey [51] Chandra et al 2009 Indian [61]	**Asia**
2.	UKNHS: United Kingdom National Health Service	Barrett & Hamilton 2008 UK [67]	**UK**
		Hueto Pérez De Heredia et al. 2012 Spain [70]	**Europe**
		Malalasekera et al. 2018 Australia [40] Alexander et al. 2016 Australia [43] Evans et al. 2016 Australia [46] Sood et al. 2009 New Zealand [72] Largey et al. 2016 Australia [80]	**Australia and New Zealand**
3.	National Institute for Clinical Excellence (NICE) guideline	Baughan et al. 2009 UK [21] Forrest et al. 2014 UK [66]	**UK**
		Olsson et al. 2009 USA [71]	**North America**

	Guidelines	Articles included	Settings
		Verma et al. 2018 Australia [65]	**Australia and New Zealand**
4.	RAND corporation	Schultz et al. 2009 USA[38] Ost et al. 2013 USA [84] Bullard et al. 2017 USA[107]	**North America**
		Malalasekera et al. 2018 Australia [40]	**Australia and New Zealand**
5.	Canadian guidelines	Grunfeld et al. 2009 Canada[39]	**North America**
		Yilmaz et al. 2008 Turkey [29] Sulu et al. 2011 Turkey [51] Chandra et al 2009 India [61]	**Asia**
6.	SEHD: Scottish Executive Health Department	Baughan et al. 2009 UK[21] Melling et al. 2002 UK[24]	**UK**
		Malalasekera et al. 2018 Australia [40]	**Australia and New Zealand**
7.	Danish Lung Cancer Group	Iachina et al. 2017 Denmark [45]	**Europe**
		Malalasekera et al. 2018 Australia [40] Largey et al. 2016 Australia [80]	**Australia and New Zealand**
8.	UKNCP: United Kingdom National Cancer Plan	Forrest et al. 2014 UK [66] Devbhandari et al. 2008 UK [77]	**UK**
9.	SMAC: Standing Medical Advisory Committee	Melling et al. 2002 UK[24]	**UK**
		Malalasekera et al. 2018 Australia[40]	**Australia and New Zealand**
10.	NNG: Norwegian National Guidelines	Stokstad et al. 2017 Norway [42] Rolke et al. 2007 Norway [49]	**Europe**
11.	SLCG: Swedish Lung Cancer Group	Malalasekera et al. 2018 Australia [40]	**Australia and New Zealand**
		Sulu et al. 2011 Turkey [51]	**Asia**
12.	Cutoff values referenced from other articles	Singh et al 2010 USA [35] Shugarman et al. 2009 USA[44] Kanarek et al. 2014 USA [55]	**North America**
		Koyi et al. 2002 Sweden [48]	**Europe**
		Largey et al. 2016 Australia [80]	**Australia and New Zealand**
		Chandra et al 2009 India [61]	**Asia**

British Thoracic Society (BTS) guidelines were those most frequently cited in the included studies (20%). Studies guided by the BTS guidelines adapted the definition of intervals and measurement of timeliness depending on the interval of interest. Common timeliness measures adapted from BTS included the length of time that should elapse from initial GP referral of suspected lung cancer to evaluation/respiratory assessment (≤1 week), primary care referral to receiving diagnostic tests (bronchoscopy/histology/cytology) (≤2 weeks), presentation of symptom to diagnosis (≤8 weeks), diagnosis to initiation of treatment (≤6 weeks), GP referral to specialist

consultation (≤1 week), GP referral and initiation of any type of treatment (≤62 days), specialist consultation and surgery (thoracotomy) (≤8 weeks), surgical waiting list and thoracotomy (4 weeks), referral to surgeons (≤4 weeks), oncology referral to commencement of radiotherapy or chemotherapy (≤2 weeks), decision-to-treat to initiation of treatment (31 days).

Table 6 presents the frequently used intervals and guidelines to measure timeliness in the included articles.

Table 6: Guidelines and interval benchmarks referenced in included articles

	BTS	NICE	UKNCP	UKNHS	UKDoH	RAND	CSCC	SMAC	SEHD	SIGN	NOLCP	CCA	SLCG	DLCG	DAPPDT	NNG	ACCP	IOM
Onset of symptoms to first doctor visit	■																	
First clinical presentation to first suspicious investigation																		
First abnormal investigation (CXR) to confirmation of diagnosis/ specialist visit	■					■												
GP to Specialist	■	■		■	■		■	■		■		■	■		■	■	■	■
Primary care to initiation of treatment	■		■	■		■	■						■			■		
Referral to secondary care to Diagnosis	■				■		■											
First referral to secondary care to treatment start	■	■		■					■		■	■						
First clinical presentation to Diagnosis						■	■											
First investigation to treatment																		
Diagnostic investigation to patient informed of diagnosis	■																	
Diagnosis to Treatment start				■		■	■				■	■	■		■			
First clinical presentation to treatment start					■			■		■								
Decision to treatment to initiation of treatment	■		■	■														
Surgery to chemotherapy (Adjuvant chemotherapy)				■														
Referral receipt to specialist consultation		■		■					■									
Oncology referral to radiotherapy/ chemotherapy	■	■																

	BTS	NICE	UKNCP	UKNHS	UKDoH	RAND	CSCC	SMAC	SEHD	SIGN	NOLCP	CCA	SLCG	DLCG	DAPPDT	NNG	ACCP	IOM
Specialist consultation to surgery	■	■																
Surgeon consultation/ Surgical waiting list to surgery	■	■					■											
Onset of symptoms to treatment	■						■											
Primary care referral to first diagnostic evaluation of symptom	■																	
Primary care referral to completion of evaluation at referral center	■																	

IOM: Institute of Medicine, CSCC: Canadian Strategy for Cancer Control, NHMRC: National Health and Medical Research Council, ACCP: American College of Chest Physicians, BTS: British Thoracic Society, UKDoH: United Kingdom Department of Health, UKNHS: United Kingdom National Health Service, NICE: National Institute for Health and Care Excellence, UKNCP: United Kingdom National Cancer Plan, SLCG: Swedish Lung Cancer Group, RAND: Research and Development USA, NOLCP: National Optimal Lung Cancer Pathway, SEHD: Scottish Executive Health Department, DLCG: Danish Lung Cancer Group, SMAC: Standing Medical Advisory Committee, SIGN: Scottish Intercollegiate Guideline Network, CCA: Cancer Council Australia, DAPPDT: Dutch Association of Physicians for Pulmonary Disease and Tuberculosis, NNG: Norwegian National Guidelines.

Differences between Asian and Western countries

There were nine studies from five Asian countries/territories included in the scoping review. There were no differences in the terminology for labelling time points and intervals in the lung cancer care pathway between studies from Asian and Western countries. Studies from Asian countries/territories adapted timeline for intervals from Western guidelines in many instances. One study from India [61] and several Turkish [29 30 51] studies measured timeliness by adapting guidelines from the BTS, Canada, and Sweden. The reporting of timeliness was not described as being guided by any specific guideline in studies from mainland China [41], Nepal [50], Taiwan [54] and two other studies from India [81 82].

Discussion

The lung cancer care journey is not linier. Eight timepoints found to be most frequently used timepoints in the included studies, which leads to variations in selection of timepoints and measurements of intervals (determined by the context) in different studies. Which introduces challenges in assessing timeliness due to lack of appropriate benchmarking, in particular in Asian countries. Moreover, different timepoints and intervals were defined, and different guidelines were used depending on the interest of the study objectives. This also makes comparisons across studies difficult.

Timepoints

Different timepoints were studied depending on the objective of the research in the included studies. ‘Onset of symptoms’, ‘first contact with a healthcare provider, ‘specialist consultation’, ‘diagnosis’ and ‘initiation of treatment’ were the most frequently studied timepoints . The first event in any health-seeking behaviour relates to the first health changes or the onset of symptom(s). It is difficult to capture the exact timepoint of onset of symptom(s) except by asking respondents directly. It may also be difficult to establish a link between onset of symptoms and health-seeking behaviour relating to the diagnosis of lung cancer as similar symptoms are shared by other

respiratory diseases. Included studies obtained data from a variety of sources including cancer registries, longitudinal surveillance data, insurance claims data, and hospital records. Not all the studies included the time point 'onset of symptoms' because of the differences in the interval of interest or objective of the study. The relevance and importance of the first time point to understanding the overall patient care pathway is likely to vary across countries with different health systems and resources. In contrast, clinical processes post diagnosis are highly standardised. As a result, research about timeliness in healthcare is focused primarily on the timepoints prior to diagnosis.

After onset of symptom(s) the next timepoint in the care seeking pathway is first contact with any healthcare provider. The studies included in this review reported only contact with formal healthcare providers. This may have been because of the difficulty involved in capturing reliable information on seeking healthcare from informal healthcare providers in the absence of any specific record management system and because of the potential for recall bias associated with self-report. Nonetheless, informal healthcare providers (including provision of over-the-counter medicines from unregulated pharmacies, village doctors and traditional or herbal remedies) are predominant in developing countries where, sometimes, informal healthcare is the only available healthcare option accessible[108]. It was evident from the included studies that patients' movement across different tiers of the health system is dynamic and complex. These different tiers within the systems are often not interlinked and using different medical record systems. However, the studies do not necessarily interpret or present this information in a way that makes it easy to understand why the timepoints are not consistently recorded.

After first contact with any healthcare provider the next timepoint in the lung cancer care pathway is diagnosis or referral to the next level of healthcare for evaluation of the disease. The way this occurs will depend on the characteristics of the healthcare system and patient behaviour. In some settings, there may be multiple contacts with different providers and the diagnosis could be made

at any point , not just as an 'endpoint' before hospital admission. Furthermore, the way patients move across different sectors and services will vary across health systems but may not be described clearly in studies. Patients do not necessarily move through timepoints in sequential order. In some systems, patients may bypass certain timepoints. Most included studies were conducted in countries with a 'gate keeper' system consisting of GPs as the first point of contact for healthcare. However, this pathway is not common to all healthcare systems, and was generally not seen in studies from Asian countries. In these countries, confirmatory investigation requisition can be initiated before the referral to a specialist. For instance, a request for a CT and fine needle aspiration cytology can be initiated by a primary care physician and hence, a patient can be diagnosed with lung cancer by a GP before referral to secondary healthcare. Some of the studies included a timepoint reflecting hospital admission or first specialist visit date. Inclusion of referral time and hospital admission time or first specialist consultation time helped to measure the time elapsed from date of referral to consultation with a specialist or hospital admission. The date when a patient was informed of his/her diagnosis was mentioned by three studies. The last timepoint in the disease care pathway is the date of initiation of any oncological treatment.

Intervals

Studies have segmented the lung cancer care pathway into different intervals depending on the objectives of those studies and sources of data. 'Onset of symptom' to 'first contact with any healthcare provider', 'first contact with any healthcare provider to 'specialist consultation', 'first contact with any healthcare provider to 'diagnosis' and 'diagnosis' to 'initiation of treatment' were the most commonly used intervals in the included articles. However, there were marked differences in how the intervals were named and this heterogeneity in typologies can be misleading as the same name is used for different intervals. For instance, the 'patient's application interval' and 'the time between onset of symptoms to first contact with primary health care provider' were descriptions of the same interval in two studies[29 51] while the term 'patient delay'

was used to measure both 'onset of symptom to primary healthcare provider'[27 41 47-50] and 'onset of symptom to secondary healthcare provider'[56] intervals. 'Patient delay' may not be entirely related to patient factors as lack of health resources can influence the time lapse from onset of symptom to contact with a healthcare provider.

Similarly, the interval 'first contact with a primary healthcare provider to secondary healthcare provider' was measured to reflect 'referral delay'[27 47 49] in some studies [55] and 'diagnosis to secondary/tertiary healthcare provider' and 'referral or receipt of referral by a specialist to diagnosis'[32]in others. There were also differences in defining diagnostic intervals including 'from first contact with the secondary healthcare provider to diagnosis'[51 53], 'from first contact with primary healthcare provider to diagnosis'[32 33 40 52 54], and 'from onset of symptom to diagnosis'[52 58]. The interval between 'first contact with primary healthcare provider' and 'treatment initiation' was labelled as 'system delay'[41] and 'system interval' and was also described as the 'diagnosis to initiation of treatment' interval[60]. 'Treatment delay' was measured using the intervals 'diagnosis to initiation of treatment'[41], and 'onset of symptoms to initiation of treatment'[61]. Use of different terminology for the same intervals and use of the same terminology to label different intervals is confusing and can lead to difficulties in interpretating results. Standardised typology would be helpful in order to streamline consistency and enable comparability across studies.

Timeliness

The terms 'delay' and 'interval' were both used in studies to describe timeliness. The term 'delay' conveys a negative connotation, despite most articles using the term in the absence of benchmarking. It would seem more appropriate to use the term 'time interval' rather than 'delay' as this may imply, inaccurately, that the patient has not sought help promptly. Therefore, several articles suggested using the term 'time interval' as a neutral alternative to 'delay'[11 12 109]. In contrast, other researchers have argued that the term 'time interval' should not be replaced by 'delay' unless the results are compared with others or against benchmarks.

There are some differences in the recommended timeframes for each interval between the guidelines. There were similarities in timeliness measures between the BTS guidelines and most of the European guidelines, with some differences compared to the North American guidelines.

More than half of the included studies (38) did not quantify upper limits for intervals based on existing guidelines. Studies which did not compare their results to any guideline generally compared their results with other timeliness of lung cancer treatment related studies and among the subgroups of patients within the study. Studies also have used different time intervals with different time points. As a result, they were not always comparable between studies. The comparison and interpretation of the results were difficult and created confusion when the studies were not from similar context and health system strength.

Asian and Western country differences

There were no differences between Asian and Western countries in the way they defined timeliness of care. Among 68 studies included in this review, nine studies were from Asian countries and/or territories[29 30 41 50 51 54 61 81 82]. Four of nine Asian studies used Western lung cancer guidelines to measure timeliness[29 30 51 61] and the other five studies did not use a guideline. It remains unclear how effective and relevant Western guidelines are for Asian countries, especially those with low and middle income. The lack of qualified providers, low availability of surgery and radiotherapy services, and poor access to and affordability of up-to-date treatments remain a prevailing concern for lung cancer care in Low-Middle Income Countries (LMICs) compared to High Income Countries (HICs) [8 9]. Moreover, universal health care and health insurance mechanisms are still in the development phase in many Asian countries and LMICs. Western guidelines were developed in a context where such health system factors contribute to the effectiveness of guidelines. Using a guideline meant for highly resourced health systems in a resource-constrained country may not accurately reflect expectations and goals for timeliness of lung cancer care; culturally sensitive and resource-sensitive guidelines are likely required[8]. As

most of the existing guidelines do not account for diversity in health resources, economic disparities or healthcare infrastructure, their applicability could be limited[110 111]. The articles included from Asian countries/territories did not discuss the compatibility of Western guidelines in terms of relevance and appropriateness of recommended time limits for intervals in the disease care pathway in their context. Although the use of Western guidelines for LMICs with different health systems may not be appropriate, there is currently no guideline for lung cancer care which dictates standard time limits that considers the limitations of weaker health systems. The Asian Oncology Summit 2009 proposed a resource-stratified management guideline for non-small cell lung cancer treatment; however, it does not provide benchmarking for intervals in the care pathway, which need to be developed by respective countries adapting this guideline[10]. Informal healthcare is a unique feature of the diverse healthcare system in Asian countries and LMICs, whereas Western guidelines do not have to consider the inclusion of informal healthcare in the care pathway for lung cancer. Considering inclusion of a timepoint related to informal healthcare seeking and a measure of the number of times patients sought care from informal healthcare providers could be useful for Asian countries and LMIC settings.

This scoping review is not devoid of limitations. The broad search strategy enabled inclusion of different study designs. This scoping review used a robust and established method guided by a published protocol. Independent screening and assessment of articles against inclusion and exclusion criteria by authors ensured minimisation of selection bias. As this review followed a scoping review methodology, it did not assess the quality of the included articles. Excluding Arksey and O'Malley's optional stage of conducting stakeholder consultation might have limited this scoping review from reaching a consensus, however, the authors intended to undertake stakeholder consultation in the next phase of the research project based on the availability of funding. The majority of the included studies were from high-income countries, thus limiting the generalisability for low-income countries. Only studies published in English were included in the

review, which could have missed potentially relevant literature in other languages. The search strategy used the most widely used databases; however, articles which were not identified through those databases could have been missed. Although we used common search terms for our search, missing a pertinent term could have limited the search results. Other potential limitations were limiting the search and inclusion of articles published in the last 20 years.

Conclusion

Although this review identified similarities in most of the timepoints and intervals of the included studies, there were substantial variations in selection and interpretation of the meaning of intervals. This lack of consistency creates a challenge for researchers who are trying to undertake research about timeliness of care for lung cancer. As timeliness of care studies are mostly carried out in Western countries and guidelines appear unsuited to weaker healthcare delivery systems, there is a need to revisit existing definitions to conduct timeliness of care related studies and a unified set of definitions needs to be set which can accommodate different structures and characteristics of health systems. The differences in healthcare delivery systems of Asian and Western countries, and between HICs and LMICs may suggest different sets of timepoints and intervals that reflect resources and feasibility need to be developed. The lack of data capture points in weaker resource-poor health systems and the presence of unregulated and untrained health care providers in LMICs make it difficult to conduct research on timeliness of lung cancer care. Differences in the structure and strength of health systems create challenges when comparing results of health service research in lung cancer between HICs and LMICs., Existing frameworks for understanding healthcare pathways such as The Aarhus Statement and Andersen's model of health service utilization could support synthesis of research but would need to be revisited and modified to be applicable to LMIC-specific contexts.

Patient and public involvement

Patients and the public were not involved in the design or planning of the study.

Data availability

Not applicable.

Ethics and dissemination of review findings

This study does not require ethical approval since the scoping review methodology aims at synthesizing information from secondary data sources (publications). Dissemination of findings at relevant national and international conferences will be planned to ensure the findings from the review are brought to the appropriate stakeholders. Results will provide key information to health professionals on operational definitions of the timeliness of seeking care and to policy makers in planning, funding and delivering evidence based and effective interventions to reduce delay in seeking care and develop health system- appropriate guidelines for lung cancer care.

Acknowledgements

The authors would like to acknowledge Lauren Zarb and Bijaya Pokharel for their collaboration and assistance with article screening for this review. We would like to thank the La Trobe University library for giving the access to the database for search.

Contributors

AA conceived the study, developed the protocol and search strategy, conducted the data charting, interpretation and manuscript development. MAR and VL contributed to screening the articles, CL, CMcD, MAR and VL contributed to analysis, interpretation and critical feedback in manuscript finalization. All authors provided critical comments and input to revisions to the paper and approved the final manuscript for submission.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interest

None declared.

Provenance and peer review

None declared. Not commissioned, externally peer reviewed.

Figure 1: PRISMA flow chart

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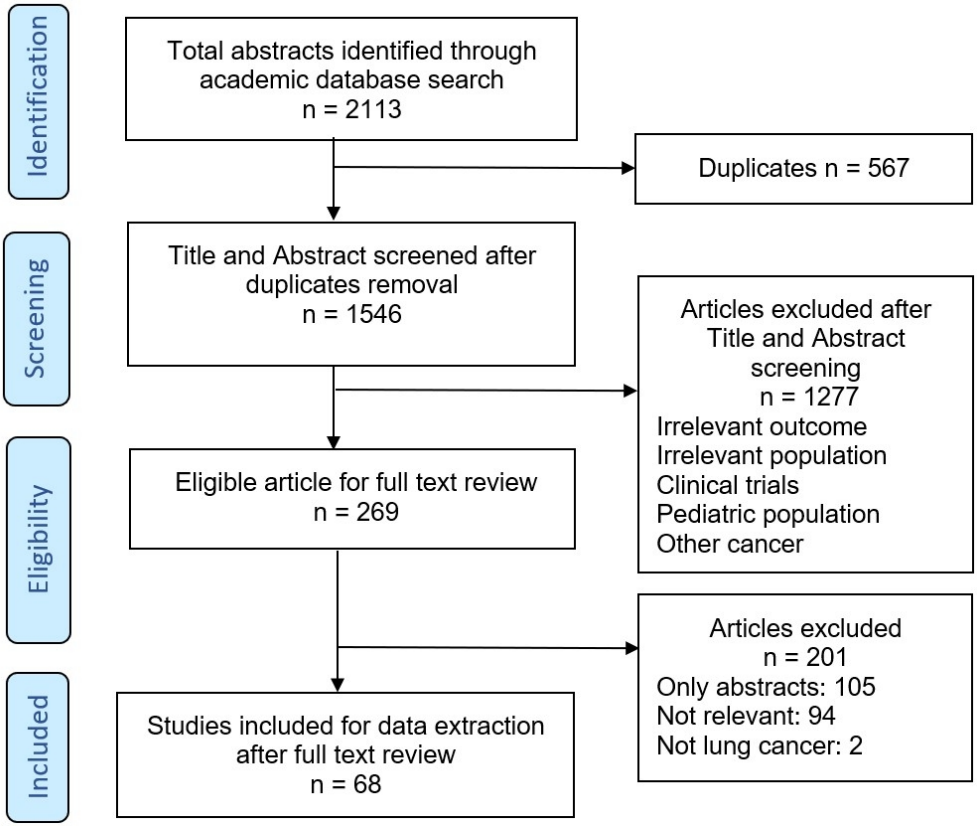

Figure1 PRISMA flow chart

213x179mm (120 x 120 DPI)

Search strategy for different database

Database	Search strategy
Medline	exp Lung Neoplasms/ OR exp Carcinoma, Non-Small-Cell Lung/ OR exp Carcinoma, Small Cell/ OR adenocarcinoma/ OR exp adenocarcinoma, bronchiolo-alveolar/ OR exp pulmonary adenomatosis, ovine/ AND General Practitioners/ OR Family Practice/ OR General Practice/ OR Primary Health Care/ OR Secondary healthcare.mp. OR Patient Admission/ OR exp Tertiary Healthcare/ OR Hospitals, Public/ OR Hospitals, Private/ OR Hospitals, Special/ OR Palliative Care/ OR exp Pulmonologists/ OR exp Oncologists/ OR exp surgical oncology/ OR exp thoracic surgery/ OR "Referral and Consultation"/ AND Diagnostic timelines.mp. OR Delay.mp. OR exp "Early Detection of Cancer"/ OR Primary delay.mp. OR Secondary delay.mp. OR Tertiary delay.mp. OR Health system delay.mp. OR Timeliness.mp. OR Interval.mp. OR Patient interval.mp. OR Patient delay.mp. OR Clinician delay.mp. OR Physician delay.mp. OR *"Referral and Consultation"/ OR Referral delay.mp. OR exp *Delayed Diagnosis/ OR Diagnosis delay.mp. OR Diagnostic evaluation.mp. OR exp *Time-to-Treatment/ OR Treatment initiation.mp. OR Treatment initiation.mp. OR Treatment delay.mp OR exp *Waiting Lists/ OR Wait time.mp. OR exp *"Appointments and Schedules"/ OR Wait time intervals.mp. OR Help seeking intervals.mp. OR *Prognosis/ OR Lung cancer Survival.mp. OR Prognostic implication.mp. AND limit 43 to (English language and humans and last 20 years)
Embase	exp lung tumor/ OR exp non-small cell lung cancer/ OR exp small cell lung cancer/ OR exp lung adenocarcinoma/ AND General Practitioners.mp. or exp general practitioner/ OR exp primary health care/ OR exp secondary health care/ OR exp tertiary health care/ OR exp public hospital/ OR exp private hospital/ OR exp cancer center/ OR exp palliative therapy/ OR exp pulmonologist/ OR exp thoracotomy/ OR exp lung lobectomy/ OR exp *patient referral/ OR exp consultation/ AND exp delayed diagnosis/ OR Primary delay.mp. OR Secondary delay.mp. OR tertiary delay.mp. OR health care system/ OR health care system delay.mp. OR timeliness.mp. OR Patient interval.mp. OR Patient delay.mp. OR Clinician delay.mp. OR Physician delay.mp. OR delayed lung cancer diagnosis.mp. OR time to diagnosis.mp. OR time to treatment.mp. or *time to treatment/ OR Treatment initiation.mp. OR treatment delay.mp. OR *hospital admission/ OR Help seeking intervals.mp. OR Lung cancer Survival.mp. OR lung cancer prognosis.mp. AND limit 41 to (human and English language and last 20 years)
PsycINFO	exp neoplasm/ OR (Lung Neoplasms or (lung adj3 neoplasm)).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR (lung cancer or (lung adj3 cancer)).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR Respiratory tract cancer.mp. OR Bronchogenic carcinoma.mp. OR Non-Small-Cell Lung Cancer.mp. OR Non-Small-Cell Lung Carcinoma.mp. OR Small Cell lung Cancer.mp. OR Small Cell lung Carcinoma.mp. OR (Lung cancer symptom* or (lung cancer adj3 symptom*)).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] AND physicians/ or exp family physicians/ or exp general practitioners/ OR (General Practitioner* or General practice or Family Practice or Family Physician*).mp. OR (Primary healthcare or Secondary healthcare or Tertiary healthcare).mp. OR (Public hospital* or Private hospital* or Special hospital* or Cancer hospital* or Cancer Center* or cancer centre*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR exp palliative care/ OR Cancer Palliative care.mp. OR (Pulmonologist* or oncologist* or thoracic surger*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR (Thoracotom* or Lung lobectom* or Pneumonectom*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR (Cancer surgical resection* or Surgical resection*).mp. OR (Referral or consultation).mp. OR ((Healthcare adj2 delivery) or patient admission).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] AND (Diagnostic timeline* or Timeliness).mp. OR (((early detection adj3 cancer) or delay* detection) adj5 cancer).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR (Primary delay* or

Database	Search strategy
	Secondary delay* or Tertiary delay* or Health system delay*).mp. OR (Patient interval* or Patient delay* or Clinician delay* or Physician delay*).mp. OR Referral delay*.mp. OR ((diagnos* adj3 delay*) or diagnostic evaluation).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR ((time adj3 treatment) or treatment initiation).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR Treatment delay*.mp. OR (wait* time* or wait* time* interval or wait* list* or appointment).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] OR Health service accessibility.mp. OR Help seeking intervals.mp. OR (Prognostic implication* or Lung cancer Survival*).mp. AND limit 38 to (human and English language and last 20 years)
CINAHL	(MH "Respiratory Tract Neoplasms+") OR (MH "Lung Neoplasms+") OR (MH "Carcinoma, Non-Small-Cell Lung/DI/DT/EP/HI/MO/PR/RA/RT/RH/SU/SS/TH") OR (MH "Carcinoma, Small Cell/DI/DT/EP/HI/MO/PR/RA/RT/SU/SS/TH") OR "carcinoma, non-small-cell lung OR Carcinoma, Small Cell lung" OR "lung adenocarcinoma" AND (MH "Physicians, Family") OR (MH "Primary Health Care") OR (MH "Family Practice") OR "general practitioner or gp or family doctor or primary care" OR (MH "Secondary Health Care") OR (MH "Multidisciplinary Care Team") OR (MH "Tertiary Health Care") OR (MH "Hospitals, Public") OR (MH "Hospitals, Private") OR (MH "Hospitals, Veterans") OR (MH "Hospitals, Military") OR (MH "Hospitals, Special") OR (MH "Hospitals, Urban") OR (MH "Hospitals, Rural") OR (MH "Cancer Care Facilities") OR (MH "Oncologic Care+") OR (MH "Pulmonologists") OR (MH "Oncologists") OR "pulmonologist OR oncologist" OR (MH "Surgery, Lung+") OR (MH "Thoracic Surgery+") OR (MH "Pneumonectomy") OR (MH "Referral and Consultation+") OR (MH "Patient Admission") AND "Diagnostic timelines" OR (MH "Early Detection of Cancer") OR "early detection of cancer" OR (MH "Diagnosis, Delayed") OR "delayed diagnosis of cancer" OR "health system delay" OR "timeliness" OR "timeliness in healthcare" OR "timeliness of care" OR "patient delay" OR "patient interval" OR "Physician delay" OR (MH "Treatment Delay") OR "diagnostic delay" OR "diagnostic evaluation" OR "time to treatment" OR "treatment initiation" OR (MH "Waiting Lists") OR "wait* times" OR (MM "Appointments and Schedules") OR "prognostic implication" OR "lung cancer survival" Limiters - English Language; Published Date: 19990101-20190528; Human

Table 1 of 18 Timeliness definition and timepoints identified

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
1	Alexander et al 2016 Australia	Position paper	Recommendations for the timely triage, review and treatment of cancer patients receiving systemic chemotherapy for six priority cancer groups (breast cancer, colorectal cancer, lung cancer (non-small-cell and small cell), ovarian cancer, lymphoma and myeloma)						The first medical oncology or haematology review for patients with an urgent presentation (Category 1) should occur immediately, within no longer than 48 h of referral receipt. Patients with suspected cancer, not classed as Category 1 or 2 (Category 3), should be seen in a medical oncology or haematology clinic within 14 days of referral receipt as recommended by existing local and international guidelines.			When chemotherapy is the first anti-cancer treatment for a patient, time to chemotherapy should be measured from the date that chemotherapy treatment was decided and the patient was prepared to receive chemotherapy (ready for care) to the date when chemotherapy was first administered (chemotherapy start date). However, in the setting of adjuvant chemotherapy, time to chemotherapy should be measured from the date of surgery.	
2	Ampil et al 2014 USA	Cross sectional	Evaluating the types of delay in the management of people with SVCO-L Ca and the impact of palliative thoracic radiotherapy (PTR) delay on patient outcomes.										
3	Barrett & Hamilton 2008 UK	Nested retrospective case-control study	Aimed at identifying and quantifying clinical features of lung cancer										
4	Baughan et al 2009 UK	Cross sectional	The aim of this study is to gain a better understanding of how quickly patients with cancer initially present to their GP, and how they are then referred to secondary care for further investigation and treatment.		Date patient first noticed symptoms	Date patient first reported symptoms to primary care		Date of decision to refer	Date patient first seen by specialist		Date patient told the diagnosis		
5	Bjerager et al 2006 Denmark	Population based observational case series	To explore diagnostic delay in primary health care among patients with lung cancer.	Delay in general practice: the time from the patient's presentation of the first symptoms or signs that could be related to the lung cancer until referral to hospital. Delay in general practice was subdivided into: doctor delay: time elapsed without investigation of cancer-related symptoms and signs. System delay: time elapsed due to waiting times related to investigation of cancer-related symptoms and administration.									
6	Borrayo et al 2016 USA	Mixed Method	To better understand the institution- and the patient-level determinants associated with the timely initiation of cancer treatment among underserved Hispanic patients diagnosed with lung and head and neck cancers.										
7	Bozcuk & Martin 2001 UK	Retrospective medical record review	to analyse survival in relation both to time to treatment (hospital delay) and other known prognosticators, in a cohort of NSCLC patients presenting in 1 year in a UK Hospital with thoracic surgery and clinical oncology departments.										

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
8	Brocken et al 2012 Netherlands	Retrospective medical record review	To compare various delays in a rapid outpatient diagnostic program (RODP) for suspected lung cancer patients with those described in literature and with guideline recommendations, to investigate the effects of referral route and symptoms on delays, and to establish whether delays were related to disease stage and outcome.	Timeliness of lung cancer care starts with timely recognition of symptoms by patients themselves, which is often inadequate or delayed									
9	Buccheri & Ferrigno 2004 Italy	Retrospective medical record review	1) provide a more recent profile of the clinical manifestations of lung cancer; 2) evaluate possible time-related changes in the occurrence of symptoms; and 3) explore the possible relationship between symptoms and time to specialist referral.										
10	Bullard et al 2017 USA	Retrospective medical record review	To evaluate the impact that the initiation of timely treatment has on patient survival among a cohort of privately insured patients with NSCLC in South Carolina	Analysis of treatment timeliness was informed by the Andersen and Cacioppo model of delays in seeking cancer care.16 Delay in seeking cancer care is defined as the number of days from the identification of the first symptom to visiting a physician, being diagnosed as having a condition, or beginning a regimen for treating the condition. The model interprets delay as an aggregate of underlying decision-making processes imposed by the patient. Treatment delay is the time between receiving medical attention and when care or treatment is initiated.Timely care was defined according to the RAND Corporation as a maximal time limit of 6 weeks (≤42 days) from diagnosis to treatment.									
11	Corner et al 2004 UK	Exploratory study	To explore the pathway to diagnosis among a group of patients recently diagnosed with lung cancer.		Symptoms were recalled as having started between 4 months and more than 2 years	timing of their visits to the GP	Date of diagnosis						
12	Devbhandari et al 2007 UK	Prospective Cohort	To compare our waiting times with national recommendations										
13	Devbhandari et al 2008 UK	Prospective Cohort	To ascertain the causes of delays in treatment to all patients presenting to our centre with a working diagnosis of lung cancer										
14	Dobson et al 2017 UK	Qualitative study	to explore the patient intervals of people with symptoms of lung or colorectal cancer, considering how symptom appraisal and help-seeking experiences were influenced by the wider context of people's lives, such as family and work.		The date of symptom onset was defined as the first symptom reported	The end of the patient interval was defined as the date on which they consulted about their symptoms.							
15	Ellis & Vandermeer 2011 Canada	Cross sectional	Our objective was to establish the time delays in each phase to help inform strategies to reduce overall diagnostic delays.										

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16	Emery et al 2013 Australia	Mixed methods study	The overall objective of this study was to identify the major subcomponents of the diagnostic interval for rural cancer patients in WA to inform the design of an intervention aimed at reducing time to diagnosis.										
17	Evans et al 2016 Australia	Retrospective cohort study	To assess factors associated with second-line delays in the management of patients diagnosed with lung cancer										
18	Ezer et al 2017 Canada	Cross sectional	The aim of the study was to assess the impact of this model of care (Rapid Investigation Clinic) on timeliness of lung cancer diagnosis , staging and treatment.										
19	Forrest et al 2014 UK	Population-based, data-linkage study	To investigate the factors (socioeconomic position (SEP), age, sex, histology, co-morbidity, year of diagnosis, stage and performance status (PS)) that may influence the likelihood of post-primary care referral, diagnosis and treatment within target times.										
20	Kanarek et al 2014 USA	Retrospective cohort	Evaluated the hypothesis that delay to first surgery and other time-related factors reduce survival after treatment (surgery). Then assessed the hypothesis that age, race, gender, place of residence, tumor characteristics, and morbidity confound the relationship between these factors and survival.										
21	Kim et al 2016 Canada	Retrospective medical record review	The aim of this study was to quantify the time intervals that NSCLC patients in Alberta with stage IeIII disease spend waiting for diagnosis (diagnostic interval), treatment (treatment interval) and their sum (system interval) and to determine which factors are associated with delays.										
22	Koyi et al 2001 Sweden	Cross sectional	The aim of the present study was to prospectively investigate a material of lung cancer patients in order to measure the delays, both by the patient and by the doctors.										
23	Kudjawu et al 2016 France	Retrospective medical record review	To describe time delays in each phase of lung cancer treatment after bronchoscopy.										
24	Largey et al 2015 Australia	Pilot study.	The audit was conducted as part of routine cancer quality improvement activities at Southern Metropolitan Integrative Cancer Services.			Dates of first presentation as the time point the clinician started investigation or referral for possible investigation		Referral	First specialist appointment	Diagnosis		Referral.	

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25	Largey et al 2016 Australia	Retrospective medical record audit	(1) examine the current interval times for lung cancer patients from the point of initial referral to the start of first treatment at three large public principal referral hospitals in Victoria; (2) assess the effects difference treatment type (surgery, radiotherapy and chemotherapy) and health service had on interval times across the selected components of the lung cancer pathway; and (3) compare interval times and identify the proportion of patients who met the established target measures.										
26	Lee et,al. 2002 UK	Retrospective medical record audit	assessed the delays in their care against BTS guidelines.										
27	Li et al 2012 Canada	Retrospective medical record review	The purpose of this study was to assess the value in measuring specific time intervals across cancer sites to identify potentially important variation in the timeliness of cancer care that may inform needed changes and/or improvements incoordination of care.							dates of diagnosis			first treatment, surgery and adjuvant treatment.
28	Maiga et al 2017 USA	Retrospective cohort study	Investigation of the reasons for delays in treatment and the impact these delays have on tumor-stage progression.										
29	Malalasekera et al 2018 Australia	Scoping review	1) synthesise health system related waiting times to milestones of lung cancer care using standardised definitions; 2) benchmark measures of performance against relevant guidelines for timeframes; 3) supplement quantitative findings with barriers to timely care described in the literature; and 4) explore the impact of facilitators such as fast-track referral systems on waiting times.			First clinical presentation	First suspicious investigation	First referral to secondary care	First specialist visit	Diagnosis			Treatment start
30	Melling et al 2002 UK	Cross sectional	The purpose of this study was to find out what proportion of patients are referred as lung cancer guidelines assume, whether different referral pathways result in different management and what proportion of patients are seen within recommended time intervals between referral and treatment.	Definitive treatment was defined as surgery (pneumonectomy or lobectomy), radical radiotherapy (radiotherapy directed at treating lung cancer itself) and chemotherapy. Palliative treatment recorded was palliative radiotherapy (for symptom control only), palliative surgery or best supportive care.	Symptom	Presentation	Diagnosis	referral					treatment
31	Neal et al 2015 UK	Mixed method	aims to provide a detailed analysis of the diagnostic process of lung cancer from a primary-care perspective.		Onset of first symptom	face-to-face consultations, nurse consultations, telephone consultations, out of hours, home visits before initial referral or investigation request First presentation to primary care	Date of diagnosis CXR requested CXR report received Diagnosis	Referal or admission					

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32	Girolamo et,al. 2018 England	Retrospective medical record review	To assess the association between meeting waiting time targets, as currently available to the policymakers, and individual patients' cancer survival, and measure the time to different types of treatments.	Maximum two-week wait (TWW) between an urgent referral for a suspicion of cancer from a general practitioner (GP) to being seen by a specialist, a maximum 62 days from the referral to the start of the first treatment, and a maximum 31 days from the decision taken to treat a patient to the start of the first treatment, irrespective of the route to diagnosis the patient went through .									
33	Gozalez et,al. 2014, Spain	Retrospective medical record audit	To analyse the delays in the diagnosis and treatment of LC and the factors associated with the timeliness of care and their possible relationship with the survival of these patients										
34	Grunfeld et al 2009 Canada	Cross sectional	To prospectively measure peri-diagnostic and surgical time intervals for patients with suspected colorectal, lung, or prostate cancer				date of the pathology or radiology report	the date the referral for diagnostic assessment was received by the consultant		date of first relevant investigation initiated by consultant, whichever came first; relevant investigations included biopsy, bronchoscopy, chest X-ray, colonoscopy, sigmoidoscopy, CT scan, MRI, PSA, pulmonary function test, transrectal ultrasound, and other	date patient informed of diagnosis		date of initiation of first treatment (first treatment was definedas neoadjuvant chemotherapy, surgery if no preoperativetreatment was required, chemotherapy, radiotherapy, or a decisionfor no treatment
35	Helsper et al. 2017 Netherlands	Retrospective medical record review	To chart the diagnostic pathway for the five most common cancers in the Netherlands			The date of the first cancer-related GP consultation was defined as the first contact (physical or telephone) with the GP for suspected cancer-related signs or symptoms		The date of referral was defined as the moment when the responsibility for the patient was transferred from a GP to secondary care			the date of diagnosis was the date of the histological confirmation of the primary tumour.		The date of treatment initiation denotes the date of start of therapy as registered in the NCR
36	Hsieh et al 2012 Taiwan	Retrospective medical record review	To understand the delay in the diagnosis of lung cancer under the healthcare system in Taiwan, and to identify the factors associated with it										
37	Hubert et al 2018 Canada	Retrospective medical record review	To measure the timeliness of care with a standardized Rapid diagnostic assessment programs (DAP) in patients with early-stage non-small cell lung cancer (NSCLC) and to evaluate the impact of an ERP (enhanced recovery protocols) in these patients.										

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38	Heredia et al 2012 Spain	Cross sectional	To analyze the results obtained in a lung cancer (LC) screening program since its inception five years ago regarding correct referrals, diagnostic and therapeutic delay times and days of hospitalization. To compare the diagnostic–therapeutic delays and hospital stays with those obtained in patients evaluated with the standard system										
39	Iachina et al 2017 Denmark	Retrospective cohort study	To investigate the significance of primary investigation and treatment at two or more hospitals on the delay in Danish patients with Non-Small Cell Lung Cancer (NSCLC).	** Time from referral (time of diagnosis) to end of primary investigation = 28 days **Time from referral (time of diagnosis) to first day of treatment = 42 days End of primary investigation is defined as the date of decision on treatment. Referral is defined as the date where the investigating department receives the referral.									First day of treatment is defined as the date of initiation of surgical, oncological, or radiological treatment, whichever comes first
40	Ju et al 2017 USA	Computer process modelling	To evaluate delays in care delivery, in order to identify potential 'bottlenecks' in waiting time, the reduction of whichcould produce greater care efficiency.										
41	Olsson et al 2009 USA	Systematic review	To summarise all recently published studies that described the timeliness of care in patients with lung cancer, identified factors that were associated with more or less timely care, or examined the association between the timeliness of care and lung cancer outcomes, including stage distribution and survival. In addition, we aimed to identify studies that evaluated interventions to improve the timeliness of care for patients with lung cancer.										
42	Ost et al 2013 USA	Guideline/review	This guideline is intended to provide an evidence-based approach to the initial evaluation of patients with known or suspected lung cancer. It also includes an assessment of the impact of timeliness of care and multidisciplinary teams on outcome.										
43	Özlü et al 2004 Turkey	Retrospective medical record review	To determine the delay between the onset and the diagnosis and treatment of patients with lung cancer in two cancer centres in the Eastern Black Sea Region of Turkey.		onset of symptoms	first presentation to a physician				histopathological diagnosis			start of treatment
44	Rankin et al 2017 Australia	Qualitative study	To describe the lung cancer diagnostic pathway, focusing on the perspective of patients and general practitioners about diagnostic and pretreatment intervals			first consultation with HCP	diagnosis						start of treatment

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45	Rolke et al 2006 Norway	Cross sectional	to evaluate the delays in the diagnostic pathways for primary lung cancer in Southern Norway, and to compare results with recommendations from the British Thoracic Society (BTS) and the Swedish Lung Cancer Group (SLCG).	Patients referred by general practitioners, who have obvious clinical evidence of lung cancer, should be seen within 1 week of referral receipt in a respiratory physician's clinic, i.e. Referral delay. The results of bronchoscopy or any other similar diagnostic test, including the histological or cytological result, should be available and communicated to the patient within 2 weeks of a decision to do it, i.e. Informed diagnostic delay. Suspected lung cancer should wait no more than 1 week before they are investigated by a specialist, i.e. Referral delay. Diagnosed lung cancer should wait no more than 3 weeks since first specialist investigation to a treatment decision is made and no more than 10 days from a treatment decision was made until start of treatment, summarised as Hospital delay.									
46	Thapa et al 2014 Nepal	Cross sectional, prospective observational study.	To identify the steps through which the patients passed before he/she finally arrived to specialist care at Manmohan Cardiothoracic Vascular and Transplant Center (MCVTC) and also determine the time lost in each step.										
47	Verma et al 2018 Australia	Cross sectional	to identify any differences in time delays in lung cancer referral pathways between rural and urban patients and explore patients' perceived barriers to timely lung cancer diagnosis and management.										
48	Vidaver et al 2017 USA	Mixed method	This study explored when and why delays occur in lung cancer care and compared timeliness between two states with divergent disease incidence.	The RAND Corporation suggested that the diagnosis of lung cancer should be established within 2 months of abnormal radiography, and treatment should begin within 6 weeks of diagnosis. British Thoracic Society recommended that patients with suspected lung cancer be seen by a respiratory specialist within 7 days of referral; a specialist visit should occur within 2 weeks of an abnormal radiograph, and surgery should be within 8 weeks of a visit to a respiratory specialist.		A—first visit to health care provider with symptoms	B— first imaging result with a lung abnormality	C— referral to a specialist	D— first visit to a specialist	E— first diagnostic test F— last diagnostic test	G— patient informed of the biopsy result	H— first referral to treatment	I— first treatment
49	Wai et al 2012 Canada	A case-control study	The primary goal of this study is to investigate if delays in care may decrease the curability of patients with stage III NSCLC. The secondary goal is to describe the patterns of staging and diagnostic evaluation for palliatively and radically treated patients with stage III NSCLC in British Columbia.										

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50	Walter et al 2015 UK	Prospective cohort study	To investigate the symptoms and other clinical and sociodemographic factors associated with lung cancer diagnosis, time to diagnosis and stage at diagnosis.	The total diagnostic interval (TDI), or 'time to diagnosis', defined as the time from the first symptom/s to the date of diagnosis.									
51	Wilcock et al 2016 UK	Mixed-methods	to identify areas where there may be potential to improve the care provided so as to inform the need for further focused research.										
52	Winget et al 2007 Canada	Stakeholders workshop	1) identify a set of criteria and variables needed to create comparable measures of important time-to-cancer-care intervals that could be applied across provinces and 2) use the measures to compare time-to-care across participating provinces for lung cancer patients diagnosed in 2004.										
53	Yang et al 2015 China	Case control	In this study, we determined the total time from the first symptoms to the initial treatment for lung cancer patients at the Department of Respiratory Disease of Zhongshan Hospital (Fudan University, Shanghai, China), a tertiary health care medical center	In China, a diagnosis delay for lung cancer has been defined as more than 1 month between the first symptom or radiological change and the clinical diagnosis or suspicion for lung cancer.	First symptom	First contact with local doctor		Referral to hospital		Diagnosis/ referral to treatment			Initiation of treatment
54	Yilmaz et al 2009 Turkey	Cross sectional	The aims of this study were to investigate the delays in patients with lung cancer from the first symptom to thoracotomy and to examine whether the delays affect the stage of lung cancer at the time of thoracotomy.	The application interval that exceeded 30 days was considered indicative of a patient's delay. The interval that exceeded 14 days was considered indicative of a referral delay. The diagnosis interval that exceeded 14 days was considered as indicative of a delayed diagnosis. The interval that exceeded 14 days was considered as indicative of a delayed treatment. The interval that exceeding 6 weeks was considered as indicative of a doctor's delay. If exceeding 72 days it was considered indicative of a total delay	date of initial symptoms	date of first doctor visit			date of admission to pneumology department of our hospital	date of diagnosis			date of thoracotomy
55	Yorio et al 2009 USA	Cross sectional	to examine the predictors and impact of the timing of lung cancer care in this context, we examined diagnostic and treatment intervals at a large American medical center providing care to a diverse patient population within two different hospital systems.	Date of tissue diagnosis was defined as the date of final pathology report. Date of treatment was defined as the date of surgery, initial date of chemotherapy, or initial date of radiation therapy, whichever occurred first.									
56	Zullig et al 2013 USA	Cross sectional	Aim 3: Examine patient-level factors associated with (a) receipt of timely lung cancer care and (b) subsequent health outcomes										
57	Sachdeva et al 2017 India	Cross sectional	To determine time delay from the onset of initial symptoms to diagnosis of primary lung cancer.										

#	Author, pub date and country	Type/ design of study	Aim of study	Definition/ concept of timeliness in seeking care	Onset of symptom	First visit to healthcare provider	First imaging result with suspicion/ diagnosis	Referral to a specialist	First visit to a specialist	Invasive diagnostic test (e.g. FNAC, biopsy)	Patient informed of the biopsy result	Referral for treatment	Initiation of treatment
58	Salomaa et al 2001 Finland	Retrospective medical record review	To measure delays of diagnosis and to assess the causes for those delays in patients with lung cancer. To evaluate whether the lengths of the delays were acceptable according to the British recommendations, and To examine the relations between delays and survival			the first symptoms until the first visit to a doctor, who was in general, a GP		the date the consultation request for a specialist was written	the first appointment with the specialist				
59	Sawicki et al 2013 Poland	Cross sectional	To compare the differences in the periods of time and reasons for delay in diagnosisand initiation of treatment of lung cancer among patients who are inhabitants of the rural and urban regions of LublinVoivodeship, and who were consulted in Thoracic Surgery Department										
60	Schultz et al 2009 USA	Cross sectional	To evaluate timeliness of lung cancer care and identify institutional characteristics associated with timely care within the Veterans Affairs (VA) health care system	**British Thoracic Society guidelines)** *Specialist visit within 2 wk of abnormal CXR *Surgery within 8 wk of specialist visit **RAND guidelines** *****Diagnosis within 8 wk of abnormal CXR *Treatment within 6 wk of diagnosis							Time to diagnosis is the time from the first suspicious chest x-ray or CT scan to the date when a pathologic diagnosis of lung cancer was confirmed		
61	Shugarman et al 2009 USA	Cohort study	To evaluate the relationship of sex and race with the receipt of timely and clinically appropriate NSCLC treatment for each stage of diagnosis	Timely treatment as a 6-week timeframe from the date diagnosis to receipt of treatment (surgery, chemotherapy or radiation therapy)									
62	Singh et al 2010 USA	Cohort study	To evaluate characteristics and predictors of missed opportunities for earlier diagnosis of lung cancer in a health care system with an advanced integrated EHR		the first appearance of a diagnostic clue as the earliest date that the clue could have been recognized by the care providers, regardless of when the patient first started experiencing symptoms								
63	Smith et al 2009 Scotland	Cross sectional	To determine what factors are associated with the time people take to consult with symptoms of lung cancer, with a focus on those from rural and socially deprived areas		the date participant defined first symptom	date of presentation to a medical practitioner							
64	Sood et al 2009 NZ	Retrospective medical record review	To determine the patient characteristics, referral patterns and delays in assessment and treatment of patients with primary lung cancer in South Auckland, New Zealand and compare with international standards										

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65	Stokstad et al 2017 Norway	Retrospective medical record review	To quantify the proportion of patients who started treatment within the recommended timeframes; and to assess the proportion of non-complex patients for which there were no good reasons for delays.	For suspected lung cancer, the first hospital appointment should be offered within seven calendar days of receiving a referral letter; a treatment decision should be made within 28 calendar days; systemic therapy should start within 35 calendar days, and surgery or radiotherapy within 42 calendar days. According to Norwegian recommendations, start of treatment within 42 days (surgery or radiotherapy) or 35 days (systemic therapy) was considered “timely treatment”				start time as the date when a referral letter for suspected lung cancer was received by the Department of Thoracic Medicine – or the date when the decision was made to start diagnostic workup in patients with a known single pulmonary nodule (SPN)					the time for treatment decision as the date when such a decision was documented in the EMR
66	Sulu et al 2011 Turkey	Cross sectional	To investigate patterns of delays among patients with non-small-cell lung cancer and to identify reasons for the delays.	**An application interval that exceeded 30 days was considered indicative of a patient’s delay. **The referral interval that exceeded 14 days was considered indicative of a referral delay. **A diagnosis interval that exceeded 14 days was considered as indicative of a delayed diagnosis. **A treatment interval that exceeded 14 days was considered as indicative of a delayed treatment **Doctor's interval that exceeded 6 weeks was considered as indicative of a doctor’s delay. ** Total interval exceeded 72 days was considered indicative of a total delay									
67	Chandra et al 2009 India	Retrospective review	To determine the average time period required at various steps for diagnosing lung cancer from the onset of symptoms at a tertiary referral centre in Northern India										
68	Dubey et al 2015 India	Cross sectional	The aim was also to study the time duration for confirming the diagnosis, the relative yield of the investigations in diagnosis of lung cancer and the lung cancer stage in which patients are presenting.										

Table 2: Intervals identified

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
1	Alexander et al 2016 Australia																								
2	Ampil et al 2014 USA								Patient delay was inferred from the duration of presenting symptoms until hospital admission		In-hospital delay was defined as the interval from the date of hospitalization to the date of referral for therapy		Professional delay was defined as the interval from the date of referral to first treatment												
3	Barrett & Hamilton 2008 UK						First symptom presented to primary care to diagnosis							Interval between first presentation to primary care with a symptom of lung cancer and referral		Interval from referral to diagnosis	The intervals between first symptom presentation and diagnosis								
4	Baughan et al 2009 UK	time from patient first noticing symptoms to first presentation with a GP																Time from first presentation to time of referral							
5	Bjerager et al 2006 Denmark																		First symptom until referral to secondary care						
6	Borrayo et al 2016 USA																					Diagnosis to treatmentinitiation			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
7	Bozcuk & Martin 2001 UK												Time to treatment (*measure of hospital delay*): time from receipt of referral letter from GP /referring physician to first treatment. *Referral time (measure of referral delay):* time from receipt of GP /referring physician referral letter to first appointment on Norfolk & Norwich Hospital. It actually is a component of time to treatment.												
8	Brocken et al 2012 Netherlands	Patient delay as the time from first symptom until the first visit to a GP	GP delay as the time between first GP visit and referral to a chest physician		referral delay as the time between referral (written or by phone) and first rapid outpatient diagnostic program (RODP) day	Diagnostic delay as the time between first RODP day and date of final (accurate) diagnosis																Therapeutic delay as the time between diagnosis and start of treatment.			
9	Buccheri & Ferrigno 2004 Italy														Referral delay was defined as the time interval between the occurrence of the first symptom of alarm (as reported by the patients and confirmed by their relatives) and the date of the first specialist referral made to the study group) (normally made to the									

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
															study group).										
10	Bullard et al 2017 USA																								
11	Corner et al 2004 UK	Time between first change in health status and onset of symptom that prompted patient to visit GP or other service Time between onset of symptom prompting patient to visit GP and date of visit to GP or other service					Visit to GP or other service and date of diagnosis										Time between first recalled change in health status and date of diagnosis								
12	Devbhandari et al 2007 UK		Urgent GP referral to date first seen in outpatient clinics was calculated by subtracting the date of urgent referral from the date first seen in chest outpatient clinics													Intervals for investigations such as bronchoscopy were calculated by subtracting the date of urgent GP referral from the date of investigation			GP referral to date of first definitive treatment was calculated by subtracting the date of urgent GP referral from the date of commencement of the first definitive treatment.						
13	Devbhandari et al 2008 UK																					The intervals from out-patient to decision-to-treat	Decision-to-treat to treatment		
14	Dobson et al 2017 UK																								

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
15	Ellis & Vandermeer 2011 Canada	T1: time from initial symptoms to first presentation to a family doctor or emergency department	T3: time from initial presentation to the first appointment with a specialist, either directly to the JCC or to a respirologist or thoracic surgeon		T5. Time from JCC referral to initial consultation	T4: time between the initial appointment with the specialist and the last date of additional diagnostic testing	T2: time from initial presentation to the last date of diagnostic testing ordered by the family physician			T6: time from initial contact with a medical or radiation oncologist to the starting date of treatment, defined as chemotherapy, radiation therapy, or the decision not to pursue treatment															T7: Overall time from onset of symptoms to commencement of defiitive therapy was also calculated as a global delay
16	Emery et al 2013 Australia		Fist presentation in general practice to referral (GP interval)	From date of referral to fist attendance at specialist (specialist access interval)		Time from fist attendance at the specialist to date of diagnosis (specialist interval)	The diagnostic interval is the time from fist presentation until cancer diagnosis										Total diagnostic interval was defied as the time from fist symptom to diagnosis.								
17	Evans et al 2016 Australia															Referral to diagnosis				Referral to initial definitive management		Diagnosis to initial definitive management				
18	Ezer et al 2017 Canada	time interval (in days) between first contact with a local physician for suspected lung cancer (T0)					time interval (in days) between first contact with a local physician to date of tissue diagnosis														Time interval (in days) between first contact with a local physician to date of first treatment					
19	Forrest et al 2014 UK		GP referral date to first hospital appointment date			First hospital appointment date to diagnosis date	GP referral date to diagnosis date														GP referral date to first treatment date	Diagnosis date to first treatment date				
20	Kanarek et al 2014 USA							Time from diagnosis to first contact at SKCCC was defined as the referral interval.					Time from first contact at SKCCC to first surgery is defined as the treatment interval									Diagnosis to first surgery interval			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
21	Kim et al 2016 Canada											**Diagnostic imaging interval:** From Date of the chest X-ray which preceded the last computed tomography scan prior to the first diagnostic biopsy attempt to Date of the last computed tomography scan prior to the first diagnostic biopsy attempt**Diagnostic biopsy interval:** From Date of the last computed tomography scan priorto the first diagnostic biopsy attempt to Date of the diagnostic biopsy procedure whichprovided pathological diagnosis											**System interval:** From Date of the chest X-ray which preceded the last computed tomography scan prior to the first diagnostic biopsy attempt to First day of treatment**Treatment interval:** From Date of diagnostic biopsy procedure which provided pathological diagnosis to First day of treatment			
22	Koyi et al 2001 Sweden	the patient's delay is the time from the first symptom(s) until the date he /she visits the doctor, in general the GP	GP delay, from the time a visit was arranged with the GP until the patient was referred to the specialist			specialist's delay (Second doctor's delay) is the time from when the lung specialist received the referral papers until the diagnosis was made.											Time symptom-diagnosis							Time symptom-treatment
23	Kudjawu et al 2016 France																								
24	Largey et al 2015 Australia																								
25	Largey et al 2016 Australia															Referral to-diagnosis				Referral-to-treatment		Diagnosis-to-treatment			
26	Lee et,al. 2002 UK																Onset of symptoms and their first chest radiograph	Onset of symptoms and referral to a surgeon by a chest physician							
27	Li et al 2012 Canada																					Time from diagnosis to first treatment			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
28	Maiga et al 2017 USA																					The interval between T2 and T3 is the diagnosis-totreatment interval for patients with a tissue diagnosis before resection.			
29	Malalasekera et al 2018 Australia		Primary care interval				Diagnostic interval													Secondary care interval		Treatment interval			
30	Melling et al 2002 UK			Referral by GP to first seen by specialist				1 week of a CXR request to first hospital visit													First visit to any treatment				
31	Neal et al 2015 UK	'Patient interval' (time from symptom onset to presentation)					Date of request of first GP-initiated chest X-ray and date report received																		
32	Girolamo et,al. 2018 England			urgent referral for a suspicion of cancer from a general practitioner (GP) to being seen by a specialist																			The decision taken to treat a patient to the start of the first treatment		
33	Gozalez et,al. 2014, Spain	from the first symptom to the first specialist consultation (specialist delay)				from the first specialist consultation until confirmation of the diagnosis (diagnosis delay)														From the first specialist consultation until the start of treatment (hospital delay)	From the confirmation of the diagnosis up to the start of the first treatment (treatment delay)				

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
34	Grunfeld et al 2009 Canada			Date of referral to date of first diagnostic consultation											Date of referral to date of confirmed diagnosis				Date of referral to date of initation of first treatment (first tx was defined as neoadjuvant chemotherapy, surgery if no preoperative treatment was required, chemotherapy, radiotherapy, or a decision for no tx							**Date the referral for diagnostic assessment was received by the consultant ('date of referral') to date patient informed of diagnosis ** Date of first diagnostic consultation to date patient informed of diagnosis **Date of referral to date of surgery or decision for no surgery ** Date of confirmed diagnosis to date of surgery or decision for no surgery **Date of referral to date of surgery**Date of surgery to date of first oncology consultation or decision for no consultation
35	Helsper et al. 2017 Netherlands		the time between the first cancer symptom related contact with the general practitioner (GP) and its corresponding referral to secondary care (Primary care interval (ICP)				the time from the first presentation to the GP to diagnosis (diagnostic interval (ID)								The time from referral to histological diagnosis (refferal interval (IR)					The time from the first presentation to the GP to initial treatment (health care interval (IHC)	The time from diagnosis to initiation of the treatment (Treatmnet interval (IT)				
36	Hsieh et al 2012 Taiwan																								Delay in diagnosis' has been defined as the period from a patient's initial medical visit to any hospital to his/her confirmed diagnosis of lung cancer

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
37	Hubert et al 2018 Canada																								**The first one was the interval between the moment that the green file was opened until all lung cancer staging and clinical tests were performed, and patient was referred for surgery after discussion with the respirologist . **The second interval was the time between the referral to the thoracic surgery department the consult with the surgeon ** The last interval was from the surgical consult to the date of surgery
38	Heredia et al 2012 Spain																								
39	Iachina et al 2017 Denmark																						Time from end of primary investigation to first dayof treatment = 14 days		
40	Ju et al 2017 USA																								
41	Olsson et al 2009 USA			from referral to first respiratory specialist visit																GP referral to initial treatment		from diagnosis to treatment		specialist consultation to surgery	symptom onset to initial treatment
42	Ost et al 2013 USA																					Diagnosis to treatment			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
43	Özlü et al 2004 Turkey	From first symptom to presentation				admission and tissue diagnosis	From presentation to tissue diagnosis														From presentation to first treatment	From diagnosis to treatment			From symptoms to treatment
44	Rankin et al 2017 Australia						The diagnostic interval is defined as “the time between first appointment with a health-care provider (HCP) and the formal cancer diagnosis being made.”															The pretreatment interval is defined as “the time between formal cancer diagnosis and initiation of treatment”			
45	Rolke et al 2006 Norway	Patient delay: Time from first symptom to first personal contact with doctor	GP delay: Time from first contact with general practitioner (GP) to date on written referral.	Referral delay: Time from dated referral receipt to first contact with pulmonary consultant.		Specialist delay: Time from first contact with pulmonary consultant to dated diagnostic histology/cytology																		Hospital delay: Time from first contact with pulmonary consultant to start of treatment.	Total delay: Time from first symptom to start of treatment.
46	Thapa et al 2014 Nepal	D1=Time from onset of symptoms to fist contact with a doctor (T1-T2) or patient delay						D 2=Time from fist contact with doctor to referral to MCVTC (T2-T3) or doctor delay																	
47	Verma et al 2018 Australia	T2: Time between first symptoms to first GP consultation	T3: Time between GP and specialist consultation							T4: Time between specialist consultation and commencement of treatment.															T1: Time from first symptoms to commencement of treatment.
48	Vidaver et al 2017 USA		Initial presentation-specialist referral	Specialist referral-specialist consultation			Initial presentation-confirmed diagnosis			Specialist consultation-treatment											Initial presentation-treatment	Abnormal radiograph-treatment Confirmed diagnosis-treatment		Treatment consultation-treatment	

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
49	Wai et al 2012 Canada							Diagnosis to cancer centre referral Diagnosis to radiation oncology consult									First symptom to diagnosis							Radiation oncology consult to start of radiation treatment	
50	Walter et al 2015 UK																'time to diagnosis', defined as the time from the first symptom/ sto the date of diagnosis								
51	Wilcock et al 2016 UK																							time from lung cancer MDT treatment recommendation to commencement of an 'active' oncological treatment	
52	Winget et al 2007 Canada																					1) diagnosis to first treatment in a cancer facility (that is, radiation or chemotherapy)		3) first consult with an oncologist to first treatment in a cancer facility.	
53	Yang et al 2015 China	Patient delay: First symptom to first contact with a local doctor	Delay in primary care: first contact with a local doctor to referral to hospital													Diagnostic delay in secondary healthcare: referral to hospital to diagnosis				Delay in secondary health care: referral to hospital to initiation of treatment	System delay: First contact with a local doctor to initiation of treatment	Treatment delay: Diagnosis to initiation of treatment			
54	Yilmaz et al 2009 Turkey	patient's application interval was defined as the time passed between the onset of symptoms and the first doctor visit.	The referral interval was defined as the time from the first doctor visit to admission to one of the pneumology departments of our hospital for the further investigation																		Doctor's interval was defined as the time from the first doctor visit to thoracotomy	The treatment interval was the time passed from the diagnosis to thoracotomy			The total interval was the time between the onset of symptoms and thoracotomy
55	Yorio et al 2009 USA																					diagnosis to treatment.			

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptom to initiation of treatment
56	Zullig et al 2013 USA							Days from diagnosis to referral to palliative care or hospice														Days from diagnosis to initiation of treatment			
57	Sachdeva et al 2017 India																Delay in diagnosis from the onset of initial symptoms to histological confirmation								
58	Salomaa et al 2001 Finland		Patient's delay is the time from the first symptoms until the first visit to a doctor, who was in general, a GP	GP delay, which is the time from the date the patient visited the first doctor until the date the consultation request for a specialist was written	The referral delay is the time between the writing of the referral and the first appointment with the specialist		The specialist's delay is the time from the first appointment until the diagnosis was made															The treatment delay is the time from the diagnosis until the treatment began			symptom-to-treatment delay
59	Sawicki et al 2013 Poland	Time from the first signs of the disease to the first medical examination																			the time from the first visit to a doctor to the start of treatment, or disqualification from the causative treatment				
60	Schultz et al 2009 USA	Time to treatment was the time from the first suspicious radiograph to the date on which any treatment was first initiated ** In patients who refused treatment, we used the date of refusal as the endpoint for time to treatment																							
61	Shugarman et al 2009 USA	first date recorded for treatment																							
62	Singh et al 2010 USA																								

#	Author, pub date and country	Symptom to doctor/ GP	GP to LCS/ Chest clinic/ referral/GP to first hospital appointment/ admission	Referral to first attendance to specialist	Chest clinic to referral for Chest Physician	Chest Physician/ hospital appointment to Diagnosis	GP to diagnosis	Diagnosis to referral to LCS/ or hospital	Symptom to hospital admission	LCS to treatment	Hospitalization to treatment referral	Diagnostic intervals (imaging/ biopsy)	Referral for treatment to initiation of treatment	Symptom to 'referral for diagnosis'	Symptom to referral to LCS	Referral for diagnosis' to diagnosis	Symptom to diagnosis	Symptom to referral (by GP or chest physician to next Mx)	Symptom to secondary care	Referral to treatment	GP to treatment	Diagnosis to initiation of treatment	Outpatient to decision to treat	Decision to treat/ specialist consultation to treatment	Symptoms to initiation of treatment
63	Smith et al 2009 Scotland	The number of days from date of first symptom defined by the participant until date of presentation of symptoms to a medical practitioner																							
64	Sood et al 2009 NZ																								
65	Stokstad et al 2017 Norway																								
66	Sulu et al 2011 Turkey		Patient's application interval was defined as the time elapsed from the onset of symptoms to the first doctor's visit		The referral interval was defined as the time from the first doctor's visit to admission to our hospital for the further investigation.		The diagnosis interval was regarded as the time elapsed from admission to our hospital to the pathological diagnosis.														Doctor's interval was defined as the time elapsed the first doctor's visit to treatment	The treatment interval was the time elapsed from the diagnosis to treatment			The total interval was the time elapsed from the onset of symptoms to treatment
67	Chandra et al 2009 India																symptom-to-diagnosis delay, between the onset of symptoms to confirmed diagnosis					diagnosis-to-treatment delay, between diagnosis and treatment started			symptom-to-treatment delay, between onset of symptoms and treatment
68	Dubey et al 2015 India																The onset of symptoms to the confirmation of diagnosis								

Table 3: Other uncommon timepoint and intervals

#	Author, pub date and country	Other time point or Intervals
1	Alexander et al 2016 Australia	**NSCLC:** Where systemic chemotherapy is the first anti-cancer treatment modality, in either definitive or palliative treatment settings, chemotherapy should commence within 3 weeks of the ready for care date (level III, grade C †). Adjuvant chemotherapy should commence as soon as the patient is medically fit following surgery and within 8 weeks of the date of surgery (level III, grade C †). **SCLC:** Patients with severe or life-threatening symptoms should be regarded as a medical emergency and chemotherapy initiated immediately, within no longer than 48 h ‡ of the ready for care date – hospitalisation may be required (good practice point †). All other patients should commence chemotherapy within 2 weeks of the ready for care date (good practice point †)
12	Devbhandari et al 2007 UK	GP referral to chest outpatient GP referral to decision to treat GP referral to treatment Oncology referral to chemotherapy Waiting on surgical waiting list Oncology referral to radiotherapy
23	Kudjawu et al 2016 France	1) from bronchoscopy to: (a) first neo-adjuvant chemotherapy, (b) first combined neo-adjuvant radiotherapy chemotherapy, (c) surgery, (d) first chemotherapy (in patients who underwent chemotherapy only), (e) first radiotherapy (in patients who underwent radiotherapy only), (f) first treatment (irrespective of treatment type);2) from last neo-adjuvant chemotherapy to surgery; 3) from last combined neo-adjuvant radiotherapy-chemotherapyto surgery; 4) from surgery to: a) first chemotherapy, and b) first radiotherapy.1- Patients with surgical pathwayTime from bronchoscopy to surgery, Time from bronchoscopy to first neo-adjuvant chemotherapy, Time from bronchoscopy to first neo-adjuvant radiotherapy (combined to chemotherapy), Time from surgery to first chemotherapy, Time from last neo-adjuvant chemotherapy to surgery 2- Patients with non-surgical pathwayTime from bronchoscopy to first chemotherapy, Time from bronchoscopy to first radiotherapy 3- Treatment combinationTime from bronchoscopy to first treatment, Time from bronchoscopy to surgery as first treatment, Time from bronchoscopy to surgery as only treatment, Time from bronchoscopy to first chemotherapy as only treatment, Time from bronchoscopy to first radiotherapy as only treatment, Surgery followed by chemotherapy, Time from bronchoscopy to surgery, Time from surgery to first chemotherapy, Surgery followed by radiotherapy, Time from bronchoscopy to surgery, Time from surgery to first radiotherapy Chemotherapy followed by surgery and chemotherapy, Time from bronchoscopy to first neo-adjuvant chemotherapy, Time from last neo-adjuvant chemotherapy to surgery, Time from surgery to first chemotherapy, Time from bronchoscopy to surgery Chemotherapy followed by surgery, Time from bronchoscopy to first neo-adjuvant chemotherapy, Time from last neo-adjuvant chemotherapy to surgery, Time from bronchoscopy to surgery, Surgery followed by chemotherapy and radiotherapyTime from bronchoscopy to surgery, Time from surgery to first chemotherapy, Time from surgery to first radiotherapy
26	Lee et,al. 2002 UK	interval between referral by a respiratory physician and surgical out-patient attendance between referral by a respiratory physician and the surgical procedure time from surgical out-patient attendance to the surgical procedure
27	Li et al 2012 Canada	Time from surgery to post-surgical treatment. Time from surgery to consultation with an oncologist.
28	Maiga et al 2017 USA	**Timepoints:**Time zero (T0) is the date of lung nodule identification on computed tomography (CT) imaging according to the medical record; T1 is the date when a lung nodule originally less than 10 mm in size was documented as having new growth on CT imaging. T2 is the date of pathology diagnosis. T3 is time of resection and final pathology diagnosis.**Intervals:**Date of lung nodule identification on CT (T0) or date when a lung nodule originally less than 10 mm (T1) to time of resection and final pathology diagnosis (T3) is the time-totreatment interval.
29	Malalasekera et al 2018 Australia	Doctor interval: First clinical presentation to First suspicious investigation System interval: First suspicious investigation to Treatment start
38	Heredia et al 2012 Spain	**Interval in days between the 1st evaluation and staging **Interval in days between the first evaluation and the start of treatment **Interval in days between the referral date and staging **Interval in days between the staging date of the tumor and the start of treatment **Therapeutic delays in days since the first evaluation : Interval until surgical treatment, Interval until the start date of oncologic treatment, Interval until the start date of palliative treatment
39	Iachina et al 2017 Denmark	** Time from referral (time of diagnosis) to end of primary investigation = 28 days **Time from referral (time of diagnosis) to first day of treatment = 42 days **End of primary investigation is defined as the date of decision on treatment. Referral is defined as the date where the investigating department receives the referral.
40	Ju et al 2017 USA	1. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) tp diagnostic biopsy (Step 2), 2. diagnostic biopsy (Step 2) to radiologic staging (Step 3), 3. radiologic staging (Step 3) to invasive staging (Step 4), 4. invasive staging (Step 4) to surgery (Step 5). 5. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) to radiologic staging (Step 3) 6. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) to invasive staging (Step 4) 7. initial radiologic lesion detection by chest x-ray or CT scan (Step 1) to surgery (Step 5)
41	Olsson et al 2009 USA	Waiting list for surgery Decision-to-treat to treatment other than surgery
42	Ost et al 2013 USA	Suspicion to treatment
45	Rolke et al 2006 Norway	Informed diagnostic delay: Time from decision of doing a diagnostic procedure to informing patient of diagnosis.
46	Thapa et al 2014 Nepal	T1=Time since the onset of symptoms to assessment at hospital (MCVTC) T2=Time since fist contact with a doctor to assessment at Hospital T 3=Time since referral to MCVTC with suspicion of Lung Cancer
48	Vidaver et al 2017 USA	First diagnostic test-last test
49	Wai et al 2012 Canada	Driving times to the nearest cancer center at the time of diagnosis First symptom to first abnormal test First abnormal test to diagnosis
51	Wilcock et al 2016 UK	From emergency admission to diagnosis From emergency admission to discussion at the lung cancer MDT
52	Winget et al 2007 Canada	2) diagnosis to first consult with an oncologist
54	Yilmaz et al 2009 Turkey	The diagnosis interval was regarded as the time passed between the admission to our hospital and the pathological diagnosis was made.
55	Yorio et al 2009 USA	Survival time was defined as the interval between the date of treatment and the date of death or censoring. The intervals included in this analysis were image to diagnosis. Image to treatment
56	Zullig et al 2013 USA	Days from diagnosis to death
62	Singh et al 2010 USA	Two types of missed opportunities that could result in diagnostic delays: (1) type I missed opportunities, defined as episodes of care in which there was failure to recognize a predefined clinical clue (ie, no required action or work-up was initiated within 7 days of clue appearance); appropriate decisions to watch and wait were not considered missed opportunities; and (2) type II missed opportunities, defined as episodes of care in which there was failure to complete within 30 days a diagnostic procedure, consultation, or other requested follow-up action in response to a predefined clue.
63	Smith et al 2009 Scotland	Two definitions of first symptom were used—participant-defined and health professional defined—using a checklist of symptoms compiled from CancerResearch UK lung cancer symptoms and SIGN guidelines. **the number of days from date of earliest symptom from the symptom checklist until date of presentation of symptoms to a medical practitioner

#	Author, pub date and country	Other time point or Intervals
64	Sood et al 2009 NZ	** postal delay (time taken to receive the referral at the outpatient clinic from the referrer) **grading delay (time taken to grade the referral) **clinic delay (interval between date of receiving referral and to date of patient assessment) **interval from initial chest physician assessment to bronchoscopy **interval from initial respiratory assessment to CT chest **interval from initial CT chest to CT-guided fine needle aspiration (CT FNA) ** First respiratory assessment to final diagnosis **Date referral received to diagnosis achieved **Date of GP referral to first respiratory assessment **First respiratory assessment to surgery **Date referred to surgeons to surgery **Date of oncology referral to commencement of radiotherapy **Date of oncology referral to commencement of chemotherapy
65	Stokstad et al 2017 Norway	Timepoint: Start of treatment as date of surgery, first fraction of radiotherapy, first day of intra-venous chemotherapy, or date of prescription of oral cancer therapy. Time to start of treatment was defined as the number of calendar days from start time until start of treatment ** time to treatment decision: start time to the date when such a decision was documented in the EMR

Table: Measures of timeliness with cutoff values from different guidelines

Interval	Cutoff value	Guidelines	Naming of interval
Onset of symptoms to first doctor visit[28 51]	30 days	BTS	Patient's Application interval [28 51]
First clinical presentation to first suspicious investigation[35 80]	28 days	DLCG	
First abnormal investigation (CXR) to confirmation of diagnosis/specialist visit[41]	14 days	BTS	
	56 days	RAND	
GP to Specialist[24 28 35-37 42 49 51 61 69 70 84]	1 day for urgent referrals, 10 days for standard referrals	IOM	Referral delay[49] or Referral Interval[28 51]
	80% within 3–5 days	ACCP, DLCG, DAPPDT	
	7 days	BTS, NICE, NNG	
	14 days	UKNHS, Australian, UKDoH, SIGN, SMAC, CSCC, SLCG	
Primary care to initiation of treatment [28 35 42 51 63 67 68 77]	14 days	DLCG	System interval[35] or Doctor's interval [28 51]
	42 days	SLCG, CSCC	
	62 days	UKNHS, UKNCP, BTS, Joint Council for Clinical Radiology	
	98 days	RAND	
	28 days for treatment decision, 35 days for systemic therapy 42 days for surgery or radiotherapy	Norwegian National Guidelines	
Referral to secondary care to Diagnosis[28 36 45 51 61 84]	28 days	UKDoH, CSCC, DLCG	Diagnosis Interval[28 51]
	14 days	BTS	
First referral to secondary care to treatment start [21 35 44 69-71 80]	42 days	Australian	Secondary care interval [35]
	49 days	NOLCP	
	62 days	UKNHS, SEHD, NICE, BTS	
	42 days in ≥85% patients	DLCG	
First clinical presentation to Diagnosis [35 84]	28 days	CSCC	Diagnostic interval[35]
	60 days	RAND	
First investigation to treatment[45]	14 days	DLCG	
Diagnostic investigation to patient informed of diagnosis [49]	7 days	BTS	Informed diagnostic delay [49]
Diagnosis to Treatment start [28 35 41 45-47 51 55 68 80 84 110]	14 days	Australian, DLCG	Treatment interval [28 35 51 55 68] or Therapeutic delay[47]
	14 days in ≥80% patients, 35 days if mediastinoscopy	SLCG, DAPPDT	
	14 days until surgery	CSCC	
	21 days	DLCG, DAPPDT	
	28 days	NOLCP	
	31 days	UKNHS	
	42 days for NSCLC/14 days for SCLC	RAND	
	42 days	DLCG, *Other study	

Interval	Cutoff value	Guidelines	Naming of interval
First clinical presentation to treatment start[24 34 35]	56 days for surgery	SMAC, UKDoH, SIGN,	Total interval [35]
	52 days	Cutoff value proposed by authors	
Decision to treatment to initiation of treatment [43 67 71 77]	21 days	UKNHS	
	31 days (28 days for surgery & radiotherapy, 7 days for chemotherapy)	UKNCP, BTS, Joint Council for Clinical Radiology	
Surgery to chemotherapy (Adjuvant chemotherapy)[43]	48 days	UKNHS	
Referral receipt to specialist consultation[21 43]	14 days	UKNHS, SEHD, NICE	
Oncology referral to radiotherapy/ chemotherapy[70]	14 days	BTS, NICE	
Specialist consultation to surgery[41 69 70 79]	56 days	BTS, NICE	
Surgeon consultation/Surgical waiting list to surgery [61 70 79]	28 days	BTS, NICE	
	14 days	CSCC, *Other study	
Onset of symptoms to treatment[28 51]	72 days	BTS, Canadian guidelines	Total interval [28 51]
Primary care referral to first diagnostic evaluation of symptom[37]	7 days	BTS	Type I missed opportunity (No evaluation or work-up was initiated within 7 days of appearance of a predefined clinical clue) [37]
Primary care referral to completion of evaluation at referral center[37]	30 days	BTS, *Other article	Type II missed opportunity (Failure to complete within 30 days a diagnostic procedure or consultation or the follow-up action requested in response to a predefined clue)[37]

*Cutoff value adapted from other studies. IOM: Institute of Medicine, CSCC: Canadian Strategy for Cancer Control, NHMRC: National Health and Medical Research Council, ACCP: American College of Chest Physicians, BTS: British Thoracic Society, UKDoH: United Kingdom Department of Health, UKNHS: United Kingdom National Health Service, NICE: National Institute for Health and Care Excellence, UKNCP: United Kingdom National Cancer Plan, SLCG: Swedish Lung Cancer Group, RAND: Research and Development USA, NOLCP: National Optimal Lung Cancer Pathway, SEHD: Scottish Executive Health Department, DLCG: Danish Lung Cancer Group, SMAC: Standing Medical Advisory Committee, SIGN: Scottish Intercollegiate Guideline Network, CCA: Cancer Council Australia, DAPPDT: Dutch Association of Physicians for Pulmonary Disease and Tuberculosis, NNG: Norwegian National Guidelines.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Page 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Page 4-6
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Page 7
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Page 8
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Page 7
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Page 7
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Page 8
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Page 8
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Page 8-9
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Page 8-9
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Page 8-9
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Page 10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Page 10-12, 14-17, 19-20
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	-
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Page 9-10
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Page 9-21
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Page 21-26
Limitations	20	Discuss the limitations of the scoping review process.	Page 26
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Page 26-27
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	Page 28

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.