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Quality of care and variability in lung cancer management across Belgian hospitals: a population-based study using routinely available data

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Abstract

Objective: To evaluate the quality of care for all patients diagnosed with lung cancer in Belgium based on a set of evidence-based quality indicators and to study the variability of care between hospitals.

Design, Setting, Participants: A retrospective study based on linked data from the cancer registry, insurance claims and vital status for all patients diagnosed with lung cancer between 2010 and 2011. Evidence-based quality indicators were identified from a systematic literature search. A specific algorithm to attribute patients to a centre was developed, and funnel plots were used to assess variability of care between centres.

Intervention: None.

Main outcome measure: The proportion of patients who received appropriate care as defined by the indicator. Secondary outcome included the variability of care between centres.

Results: Twenty indicators were measured for a total of 12 839 patients. Good results were achieved for 60-day post-surgical mortality (3.9%), histopathological confirmation of diagnosis (93%) and for the use of PET-CT before treatment with curative intent (94%). Areas to be improved include the reporting of staging information to the Belgian Cancer Registry (80%), the use of brain imaging for clinical stage III patients eligible for curative treatment (79%), and the time between diagnosis and start of first active treatment (median 20 days). High variability between centres was observed for several indicators. Twenty-three indicators were found relevant but could not be measured.

Conclusion: This study highlights the feasibility to develop a multidisciplinary set of quality indicators using population-based data. The main advantage of this approach is that not additional

registration is required, but the non-measurability of many relevant indicators is a hamper. It allows however to easily point to areas of large variability in care.

Key words: quality indicators, lung cancer, Belgium, variability of care, funnel plots, population-based cancer registries, health insurance claims data

Introduction

Lung cancer is a frequent and lethal disease. Every year, more than 8000 patients are diagnosed with lung cancer in Belgium, predominantly males (70%) with a long history of smoking [1]. Five-year survival is low, within the range of 10–20% in most countries. Because it presents most often in advanced stage, more than half of the patients die within the first year after diagnosis [2]. For early-stage disease however, treatment with curative intent is possible.

In 2013, within the framework of an integrated quality system in oncology, the Belgian Health Care Knowledge Centre (KCE) published an evidence-based guideline for the diagnosis, treatment and follow-up of patients with small cell lung cancer (SCLC) or non-small cell lung cancer (NSCLC) [3]. Subsequently, a set of process and outcome indicators to evaluate quality of care for patients with lung cancer was developed [4]. In this paper, we present the development and results for this set of quality indicators for lung cancer care, with a focus on 20 selected quality indicators, covering the diagnosis and staging phase and the short-term outcomes after treatment.This study aimed to evaluate the measurability of this set of indicators using administrative data coupled with data from the Belgian Cancer Registry. A secondary objective was to evaluate the quality of care both on a national and on a centre level with population-based data. Variability of care was studied for all indicators, and all hospitals involved in lung cancer care in Belgium received individual feedback with their proper results, allowing them to adapt practice where necessary.

Methods

Data sources

The primary data source was the Belgian Cancer Registry (BCR), an exhaustive registry of all new cancer cases diagnosed in Belgium [1, 5]. It is linked with health insurance claims data obtained via the Intermutualistic Agency (IMA) to provide details on all diagnostic and therapeutic procedures and pharmaceuticals reimbursed by the mandatory Belgian health insurance. It is furthermore linked with vital status data obtained via the Crossroads Bank for Social Security. The linkage was based on the patients' unique social security number, and has been approved by the Belgian Privacy Commission.

All patients diagnosed in 2010 or 2011 with an invasive lung cancer (ICD-10 code C34—Malignant neoplasm of bronchus and lung) were selected from the BCR database ($n = 15\,746$). IMA data covering 2009–2012 were available for the vast majority of those patients (>99.5%).

Patients with multiple tumours registered in the BCR database, i.e. ±17% of the patients, were excluded from the cohort study to maximally ensure that reimbursed oncological treatments were prescribed to treat lung cancer and not for another tumour.

More details on these databases and the linkage process can be found in the Supplementary file.

Indicators selection

OVID Medline and websites from (national or international) agencies working on quality of care were searched in June 2014 to identify published quality indicators (QI) for lung cancer. The resulting list of quality indicators was complemented by quality indicators derived from recommendations of the Belgian lung cancer guideline [3]. Indicators not in accordance with Belgian guidelines were removed. A preliminary list of 120 indicators was then formally assessed by an expert panel of 19 clinicians (see [4] for the composition of the expert panel), and the most 47 most relevant QI were selected for assessment of their measurability. A total of 24 indicators were found to be measurable, of which 20 are presented in this study. The most frequent reasons for non-measurability were the non-availability of results from diagnostic procedures or from the pathology reports and the lack of specificity of billing data, especially for surgical interventions and for radiotherapy. Other indicators, covering patterns of treatments for patients with NSCLC or volume-outcome relationship for patients treated surgically, are presented elsewhere [6, 7].

More details on the selection process of QI can be found in the Supplementary file.

Statistics

The majority of the indicators were binary (yes/no) and were described with proportions. One process indicator involved the number of days between incidence data (i.e. date of first diagnostic test) and start of treatment, and was described with mean, median and standard deviation.

All analyses were performed with SAS 9.3 (SAS Institute, Cary, North Carolina, USA).

Algorithm to assign patients to a centre and assessing variability between centres

The diagnosis and staging process includes in the majority of patients at least one (and in many cases all) of the following tests or procedures: a bronchoscopy (or EBUS—endobronchial ultrasound if no bronchoscopy was billed), a puncture biopsy, lung function tests and a CT scan of the chest. In addition, patients are often discussed at an MDT meeting to plan the treatment. In 96.9% of the patients, the diagnostic centre was identified based on the centre where most of the diagnosis and staging work-up took place.

For the remaining 3.1% of the patients, an algorithm was created to assign patients to one diagnostic centre based on the following priority order: priority for the centre of MDT, then the centre where bronchoscopy (or EBUS) was performed, the centre of puncture biopsy, the centre of lung function tests and finally to the centre of CT scan. This algorithm has been tested and validated during the pilot study, and eventually allowed the assignment of 99.1% of the

cohort to a single diagnostic centre. The remaining 0.9% was not taken into account in the analysis of the variability between centres. For the indicators which were specific to a certain treatment (surgery or radiotherapy) the patient was assigned to the centre where that treatment was performed.

The variability between centres was graphically represented using funnel plots [8]. Each hospital's result is plotted against the hospital volume, with control limits of 95% and 99.8% around the overall result at national level. Hospitals within the control limits are assumed to be subject to 'common-cause' variability, whereas those that are 'out-of-control' will exhibit 'special cause' variability and may deserve further scrutiny. The categorization of the variability between centres (from 'limited' to 'very large' variability) was based on a visual assessment of the funnel plots (see supplementary file). Hospitals with too few eligible patients were not represented in the plots.

Results

In total, the data of 12 839 lung cancer patients without another primary tumour could be linked to the claims and vital status databases. Table 1 presents the characteristics of this population. The results of the 20 quality indicators are presented in Table 2, with the magnitude of the variability of care between centres. Funnel plots for 3 selected indicators are presented in Fig. 1 to Fig. 3, while funnel plots for all indicators are presented in the supplementary file.

Time to first active treatment

The national median is 20 days (QI-1), and depends on the extent of staging phase: 26 days for surgery and 17 days for chemotherapy. For one third of patients, active treatment is started more than 4 weeks after the incidence date. The median delay increases with 5 days in case patients are referred to another centre, which can be considered as acceptable (all those subgroups analyses are shown in [4]). There was also a large variability between centres (Fig. 1 in Supplementary file). The time to active treatment in Belgium compares favourably to what is reported in the international literature: median time to surgery of 50 days in Italy [9] and around 40 days (for any treatment) in Canada and Spain [10, 11]. The way the indicator is measured may be somewhat different, however.

Multidisciplinary team consultation

Multidisciplinary team consultation (MDT) is important to assure optimal clinical decision making and quality of care for all patients, whatever their stage or condition [12]. MDT is especially important in determining the best treatment option for a patient, when careful patient selection for a treatment modality is critical and complex, e.g. the selection of clinical stage III patients eligible for surgery. With results of 73% for all patients (QI-2, large variability between centres, see Fig. 2 in Supplementary file) and 66% for cIII patients considered for surgery (QI-3), both indicators show room for improvement, However, caution is needed when analysing MDT billing data. Delays in billing these meetings and limitations in the number of reimbursed MDT's may somewhat underestimate the real frequency of MDT meetings, a well-known issue with these data in Belgium [13].

Pathologic confirmation of diagnosis and molecular testing

In the domain of pathology, results are excellent, with the three indicators showing results above 90% (QI-4, QI-5 and QI-6). Histopathological

Table 1 Characteristics of the study population: lung cancer patients diagnosed in 2010–2011

	Study population (N = 12 839)	
	n	%
Sex		
Male	9053	70.5
Female	3786	29.5
Age		
Mean (± SD) (years)	67.7 (± 11.1)	
<50 years	643	5.0
50–59 years	2419	18.8
60–69 years	3889	30.3
70–79 years	3884	30.3
80+ years	2004	15.6
WHO performance status		
0 – Asymptomatic	1436	11.2
1 – Symptomatic but completely ambulatory	6685	52.1
2 – Symptomatic, up and about more than 50% of waking hours	1429	11.1
3 – Symptomatic, confined to bed or chair more than 50% of waking hours	570	4.4
4 – Completely disabled; totally confined to bed or chair	194	1.5
Missing	2525	19.7
Tumour localization		
C34.0 Main Bronchus	773	6.0
C34.1 Upper Lobe, lung	4699	36.6
C34.2 Middle Lobe, lung	448	3.5
C34.3 Lower Lobe, lung	2399	18.7
C34.8 Overlapping lesion of lung	34	0.3
C34.9 Lung, NOS	4486	34.9
Tumour laterality		
Left	4847	37.8
Right	6553	51.0
Unknown	1439	11.2
Clinical stage[a]		
Stage known		
I	1412	14.4
II	748	7.6
III	2535	25.8
IV	5142	52.3
Stage missing/unknown (X)[a]	3002	23.4
Combined Stage[a,b]		
Stage known		
I	1721	16.3
II	955	9.0
III	2639	24.9
IV	5275	49.8
Stage missing/unknown (X)[a]	2249	17.5
Histology		
Small cell lung cancer	2004	15.6
Non-small cell lung cancer	9817	76.5
Squamous cell carcinoma	3144	24.5
Adenocarcinoma	5152	40.1
Large cell carcinoma	550	4.3
Other specified carcinoma	387	3.0
Unspecified non-small cell lung cancer	584	4.5
Other types of lung cancer	28	0.2
Sarcoma	16	0.1
Other specified malignant neoplasm	12	0.1
Unspecified malignant neoplasm	990	7.7

NOS, not otherwise specified; SD, Standard Deviation.

[a]X(missing/unknown) category includes 28 tumours with staging not applicable (NA). The % for stages I, II, III and IV are computed excluding the X category.

[b]Combined stage combines information from the clinical and pathological stage. The pathological stage prevails over the clinical stage except when the clinical stage is stage IV.

Table 2 Quality indicators for diagnosis and management of lung cancer patients: results at national level and indication of variability between centres

ID	Category and QI description	*N*	Result at national level	Variability between centres[a]
Timeliness to start treatment				
QI-1	Median time from incidence date to first active treatment	10 100	20 days	Very large
Multidisciplinary team meetings				
QI-2	Proportion of patients discussed in MDT within 6 weeks after incidence date	12 839	72.8%	Large, with many low outliers
QI-3	Proportion of cIII NSCLC patients with surgery discussed in MDT before start of treatment	258	66.3%	Could not be assessed due to small sample size
Pathology				
QI-4	Proportion of patients with histopathologically confirmed diagnosis	12 839	92.7%	Moderate, with some low outliers
QI-5	Proportion of patients with histopathologically confirmed diagnosis for whom the tumour type is identified	11 904	99.5%	Very limited, uniformly high
QI-6	Proportion of NSCLC patients for whom the subtype has been identified	9817	94.1%	Moderate, some low outliers
EGFR testing				
QI-7	Proportion of stage IV non-squamous NSCLC patients for whom EGFR-mutation analysis was performed	1535[b]	52.7%	Moderate, with some low outliers
QI-8	Proportion of NSLCL patients tested for EGFR mutation before receiving anti-EGFR treatment	714[b]	58.1%	Could not be assessed due to small sample size
Medical Imaging				
QI-9	Proportion of cI–III NSCLC patients who had a PET-CT prior to treatment with curative intent	2471	94.4%	Limited
QI-10	Proportion of cIII patients who had brain imaging (CT or MRI) before treatment with curative intent	1295	78.7%	Moderate, some low outliers
QI-11	Proportion of cI–III NSCLC patients who had a bone scintigraphy performed after a PET-CT	3477	5.2%	Moderate, with some high outliers
Mediastinal staging				
QI-12	Proportion of cII–III NSCLC patients who had minimally invasive mediastinal staging (EBUS or EUS or mediastinoscopy) before treatment with curative intent	1518	46.0%	Moderate, with some low outliers
QI-13	Proportion of cII–III NSCLC patients who had mediastinoscopy before treatment with curative intent, for whom mediastinoscopy was preceded by EBUS or EUS	312	30.1%	Could not be assessed due to small sample size
Pulmonary function				
QI-14	Proportion of NSCLC patients who had FEV1 and DLCO performed before surgery	2084	88.9%	Limited, with some low and high outliers
Safety of care (60-day mortality after treatment)				
QI-15	Proportion of NSCLC patients who died within 60 days after primary surgery	2083	3.9%	Limited, with a few high outliers
QI-16	Proportion of stage I–II–III patients who died within 60 days after end of primary (chemo)radiotherapy with curative intent	1414	9.3%	Very limited, with no outliers
Aggressiveness of care at the end of life				
QI-17	Proportion of patients who received chemotherapy or targeted therapy within 2 weeks of death	9114	12.9%	Could not be assessed because centre not known for all patients
Quality of data reporting to Belgian Cancer Registry				
QI-18	Proportion of patients with clinical TNM stage reported to the BCR	12 811	76.8%	Large, with many low outliers
QI-19	Proportion of patients with surgery, with pathological TNM stage reported to the BCR	2162	80.1%	Large, with many low outliers
QI-20	Proportion of NSCLC patients whose WHO performance status was reported to the BCR	9817	80.0%	Large, with many low outliers

BCR, Belgian Cancer Registry; EBUS, Endobronchial ultrasound; EGFR, Epidermal growth factor receptor; EUS, Endoscopic ultrasound; MDT, Multidisciplinary team meeting; NSCLC, Non-small cell lung cancer; WHO, World health organization.

[a]Based on visual inspection of the funnel plot (all funnel plots are presented in the Supplementary file).

[b]Only patients diagnosed in 2011 (the test was not yet reimbursed in 2010).

confirmation of diagnosis was present in 93% of the cases (QI-4), which is much higher than the 75% reported by the UK National Lung Cancer Audit, a constant rate in the last 5 years [14]. Despite good results at national level, funnel plots show however that some centres are low outliers (Figs 3–5 in Supplementary file).

Two indicators (QI-7 and QI-8) assess the use of EGFR-mutation analysis. Ideally, stage IV non-squamous NSCLC patients should have their tumour tested for the presence of EGFR-activating mutations to guide treatment decisions (QI-7) [3]. Anti-EGFR treatment should only be started for NSCLC patients if an activating mutation is present, although Belgian reimbursement criteria for second-line treatment also allow drugs prescription based on immunohistochemistry (IHC) testing. For the studied period (data available for 2011 only), the number of mutation analyses performed is considered low (52.7%, QI-7). However, in 2011, the national guideline recommending EGFR-mutation analysis was not yet available and mutational testing was not yet routinely available, limiting the interpretation of the data. Future evaluations should show a clear improvement. The appropriate use of anti-EGFR therapy in tumours with an activating mutation only could not be assessed due to the unavailability of the test's result in the databases.

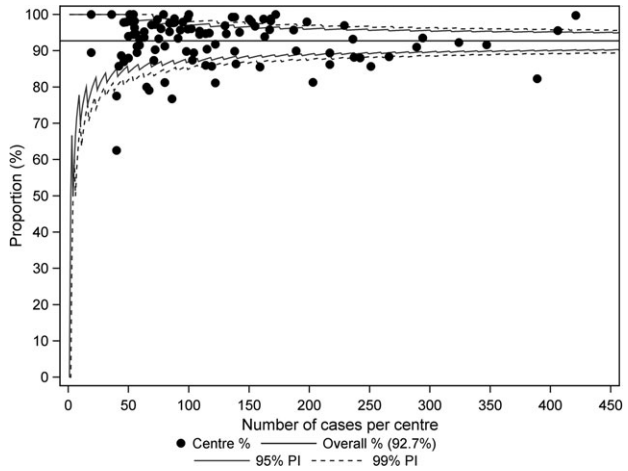

Figure 1 (QI-4) Proportion of patients with histopathologically confirmed diagnosis, by centre (funnel plot). Note: 110 patients were not shown in the figure because they could not be assigned to a diagnostic centre.

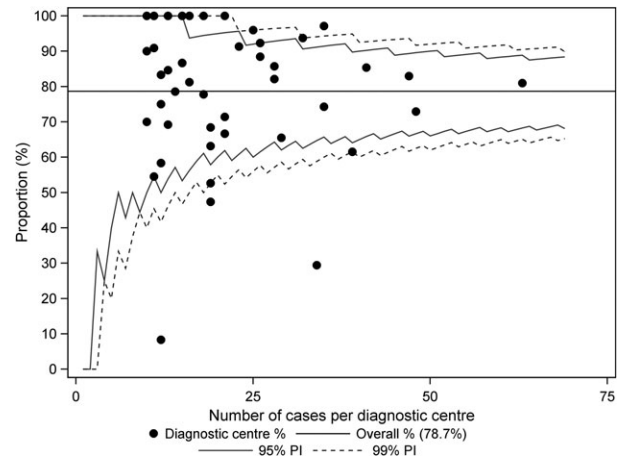

Figure 2 (QI-10) Proportion of cIII patients who had brain imaging (CT or MRI) before treatment with curative intent, by centre (funnel plot). Note 1: 1 patient was not shown in the figure because he/she could not be assigned to a diagnostic centre. Note 2: 10 centres were not shown in the figure because they reported less than 50% of clinical stages. Note 3: 43 centres were not shown in the figure because the denominator was smaller than 10. Note 4: 2 centres were not shown in the figure because it had no cIII patients.

The use of PET-CT and brain imaging in stage III lung cancer

Results are excellent for the use of PET-CT prior to treatment in cIII NSCLC patients (94.4%, QI-9) and moderate for the use of brain imaging prior to treatment in cIII lung cancer patients (78.7%, QI-10), with moderate variability between centres (Fig. 2). Brain imaging is higher however than what is internationally reported, based on a limited number of publications: around 60% from studies in Taiwan and Florida [15, 16]. The third indicator on medical imaging (bone scintigraphy performed after PET-CT, QI-11) assesses the non-appropriateness of care, and hence should be as low as possible. Reassuringly, it is relatively low (5.2%). A sensitivity analysis showed that the percentage of patients receiving both PET-CT and bone scan (around 20%) as well as the total percentage of patients receiving bone scans (37.2%) were much higher. This

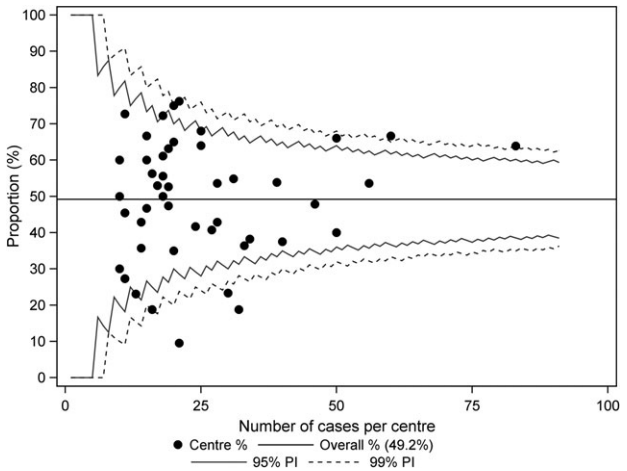

Figure 3 (QI-12) Proportion of cII–III NSCLC patients who had minimally invasive mediastinal staging (EBUS or EUS or mediastinoscopy) before treatment with curative intent, by centre (funnel plot). Note 1: 1 patient was not shown in the figure because he/she could not be assigned to a diagnostic centre. Note 2: 10 centres were not shown in the figure because they reported less than 50% of clinical stages. Note 3: 41 centres were not shown in the figure because the denominator was smaller than 10. Note 4: 2 centres were not shown in the figure because they had no cI–III NSCLC patients.

may be explained by waiting times or the limited access to PET scans at the time of diagnosis.

Mediastinal staging

Forty-six percent of cII–III patients had minimally invasive mediastinal staging before treatment with curative intent (QI-12) and for 30% of patients mediatisnoscopy was preceded by EBUS or EUS (QI-13). Because the need for this procedure depends on the result of the PET-CT, which is unavailable in our database, it is not possible to define a patient group that should have had invasive mediastinal staging, and we cannot define a clear target for this indicator. Nevertheless, variability between centres can be instructive (Fig. 3), especially for centres that perform invasive mediastinal staging less frequently. Recommendations have changed since 2010–2011 [3], hence higher results are expected in the future.

Functional evaluation

Overall, the proportion of operated patients who underwent both recommended lung function tests (FEV1 and DLCO) is high (88.9%, QI-14), and compares favourably to studies in the UK (67.1%) [14] and in the US (74.2–89.0%) [17, 18]. This reflects the fact that the majority of lung cancer is diagnosed by lung specialists, who have direct access to these tests. In some cases, performing both tests may have been perceived as unnecessary. The NICE guideline on lung cancer for example, recommends to perform a DLCO test only if breathlessness is disproportionate or if another lung pathology coexists (for example, lung fibrosis) [19].

Post-treatment mortality

The 60-day post-operative mortality for NSCLC patients obtained good results (3.9%, QI-15), below the target of 5% published by NHS Scotland [20]. Results for 30-day mortality (2.0%, data not reported in the table) are similar to those reported in four other

countries (1.1% in Italy in 2006 [21], 2.1% in USA in 2005 [17], 3.4% in Spain in 2007 [22], and 3.6% in Denmark in 2007 [23]).

The 60-day mortality after the end of primary (chemo)radiotherapy in our study was higher, i.e. 9.3% (QI-16), with no comparable studies found in the literature to benchmark these results. They may be a result of the toxicity of the treatment, as well as an indication of the poor prognosis and frail general health of many cIII NSCLC patients.

End-of-life care

Intensity of treatment near the end of life is proposed as a quality indicator in the international literature [24]. Thirteen percent of patients received chemotherapy or targeted therapy within two weeks of death (QI-17). This is similar to what is observed in lung cancer patients in other countries [25]. Death within two weeks after the last administration of systemic treatment may be due to fatal toxicity, disease progression, patient preferences (euthanasia, which is legalized in Belgium) or causes not related to lung cancer and its treatment.

Reporting of clinical and pathological stage to cancer register

Clinical and pathological stage are crucial parameters in the evaluation of quality as they are used in the technical definition of most indicators. Underreporting may bias the results, as patients with unknown TNM stage cannot be included in the calculation of many indicators. For both clinical and pathological TNM stages, the reporting was 77% (QI-18) and 80% (QI-19), denoting that there is ample room for improvement to reach a 100% target. The same comment holds for the coverage of the reporting of performance status to BCR, which attains only 80% (QI-20). In some centres the reporting rate are terribly low (around 30–40%, Figs 14–15 in Supplementary file). This failure to report data to the BCR can be due either to the absence of formal assessment and recording in the medical file, which reflects bad quality of care, or due to errors in the transfer of data from the medical file to the BCR, which reflects bad data transfer processing and IT organization.

Discussion

The main strength of our study lies in its population-based approach. It assessed the quality of care for all lung cancer patients diagnosed in Belgium during 2010–2011, allowing to draw conclusions both at a national level and at an individual centre level. Our study did not require additional data registration efforts, as it used health insurance claims data linked to national cancer registry data at the individual patient level.

The results of the present study suggest an overall good quality of care for lung cancer patients, despite some areas for improvement. Good results are achieved in terms of short-term post-surgical mortality. Excellent results are achieved for the histopathological confirmation of diagnosis and for the use of PET-CT before treatment with curative intent. Areas to be improved include the reporting of staging information to the Belgian Cancer Registry, the use of brain imaging for clinical stage III patients eligible for curative treatment, and the time between diagnosis and start of first active treatment (curative or palliative). High variability between centres was observed for several indicators, and individual feedback was sent to all Belgian hospitals, allowing them to adapt practice where necessary

While the main strength of the study has been mentioned above, this study has also several limitations. First, the use of retrospective administrative data to evaluate quality of care has some disadvantages. Claims data are often not specific enough, and do not allow detailed analysis of clinical care: no information was for instance available on the type of surgery performed (pneumonectomy versus lobectomy) nor on the indication and dose schedules of radiotherapy. Moreover, the data do not include the results of the tests or imaging procedures performed, further limiting detailed analysis. The lack of clinical variables, or the lack of information on patient comorbidities, often resulted in the most pertinent quality indicators not being measurable (23 out of 47 indicators). Consequently, we sometimes had to rely on proxy indicators (indicators that are less accurate but measurable).

Second, most indicators measure a process of care, whose main advantage is to be directly actionable, but whose link with outcome is variable and their use by clinicians for benchmarking is controversial. Several internationally validated outcome indicators, including patient-reported outcome data that are important to evaluate the results of the care delivered could not be measured. International quality improvement initiatives recommend to primary collect information on outcomes that matter for the patient [26, 27], and this has already been successfully implemented for lung cancer in the Netherlands [28]. Prospective data collection on patient-reported outcomes and patient-reported experience measures (PROMs and PREMs) would thus certainly be an asset for future quality assessments in Belgium.

Third, the results are based on relatively old data: patients were diagnosed in 2010 and 2011, the most recent data available at the time the study started. In Belgium, the use of administrative data implies a time lag of several years, due to the registration delays, the transfer and linkage of health insurance claims data, and the calculation, interpretation and publication of results. This time delay should obviously be drastically reduced in the future if these data are to be used to provide regular feedbacks to centres.

Conclusion

The present study highlights the feasibility to develop a multidisciplinary set of quality indicators for lung cancer and to measure them, using population-based data from a national cancer registry linked to health insurance claims data. The main advantage of this approach is that no additional registration is required, but the non-measurability of many relevant indicators is a hamper. It allows however to measure several indicators on a national and institutional level, to provide data on the variability of care and to provide individual feedback to all centres.

Supplementary material

Supplementary material is available at *International Journal for Quality in Health Care* online.

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