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Setting the Benchmark: Patterns of Care and Outcomes for Early-stage Non-small Cell Lung Cancer in Queensland, Australia, 2011–2017

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ABSTRACT

Aim: Treatment paradigms for early-stage non-small cell lung cancer (NSCLC) are evolving rapidly. Our aim was to document baseline patterns of care and outcomes at the population level immediately prior to the introduction of immunotherapy.

Methods: Data were obtained from the Queensland Oncology Repository. The study cohort comprised Queensland residents diagnosed with a non-metastatic primary NSCLC between 2011 and 2017, with follow-up on treatment and mortality to December 31, 2022. Poisson regression was used to determine patient and clinical characteristics associated with receiving different treatment modalities within 1 year of diagnosis. Variations in 5-year observed survival were assessed using flexible parametric modelling.

Results: A total of 4445 people were included, of whom 30% were treated with surgery only, 15% with surgery plus chemotherapy and/or radiotherapy and 44% with chemotherapy and/or radiotherapy only. The remaining 10% did not receive any recorded treatment. People in outer regional/remote areas had lower rates of radiotherapy (relative likelihood [RL] = 0.87, 95% confidence interval [CI] 0.78–0.97) and chemotherapy (RL = 0.89, 95% CI 0.81–0.98) than those in major cities, but there were no significant differences by First Nations status or socio-economic status. Five-year observed survival varied from 63% (95% CI 60%–65%) for stage I to 41% (38%–45%) for stage II and 20% (18%–22%) for stage III. The treatment modality significantly affected survival irrespective of stage at diagnosis (all $p < 0.001$).

Conclusion: Monitoring treatment outcomes for early-stage NSCLC at the population level is crucial for optimizing patient care, resource allocation and informing consumer choice. Emerging approaches involving immunotherapy are expected to further improve outcomes.

Abbreviations: CI, confidence interval; ECOG, Eastern Cooperative Oncology Group; HR, hazard ratio; NSCLC, non-small cell lung cancer; RL, relative likelihood.

1 | Introduction

Lung cancer continues to be the leading cause of cancer-related morbidity and mortality globally [1], with the majority of cases due to non-small cell lung cancer (NSCLC) [2]. Outcomes vary greatly by stage at diagnosis [3]; a high proportion (~40-50%) of people are diagnosed at an advanced stage, when cure is no longer possible [1, 4]. The latest estimates show that 5-year survival for lung cancer is around 20% or less in most countries [5].

Treatment options for lung cancer depend on the stage and include surgery, radiation therapy, systemic therapy (such as cytotoxic chemotherapy, targeted therapy, immunotherapy and antibody-drug conjugates) or a combination of these approaches [6, 7]. Over the last two decades, there has been steady progress in understanding lung cancer aetiology [8] and biology [9, 10], leading to improved targeted therapy and immunotherapy options for advanced NSCLC. Despite a multitude of new agents [11, 12], survival for advanced disease nonetheless remains poor.

Attention has shifted to non-metastatic/early-stage NSCLC over the last few years [13]. These potentially curable cases coupled with modest rates of survival represent a group for whom timely intervention and the development of novel treatment strategies tailored to individuals may significantly enhance outcomes [14–16]. Fewer breakthroughs in treatment had been made for early-stage disease however [13, 17, 18], due to the lack of testing for molecular abnormalities, heterogeneity of disease, and deficient pre-operative staging. Until recently, the only strategy to improve survival after surgery and radiotherapy was the inclusion of adjuvant or neoadjuvant platinum-based chemotherapy [19, 20]. Incorporation of consolidation durvalumab for stage III unresectable NSCLC has proven effective [21]. Several subsequent approvals have expanded the use of durvalumab [22] and introduced other immune checkpoint inhibitors (including atezolizumab, nivolumab and pembrolizumab) [23–25] for the treatment of resectable NSCLC.

The aims of this study are to establish a baseline for patterns of care among early-stage NSCLC in the period immediately preceding the introduction of immunotherapy and to examine the association of different treatments with patient and clinical characteristics. We also evaluated the effect of various combinations of treatment on stage-specific survival.

The study was conducted in Queensland, the second largest state of Australia, covering more than 1.7 million square kilometres with a population of 4.7 million in June 2016. Almost three-quarters of the population is concentrated in the southeast corner of the state. The latest data (2020) from the Australian Institute of Health and Welfare [26] show that rates of lung cancer incidence and mortality in Queensland (47.1 and 30.0 per 100,000 population, respectively) were somewhat higher than the Australian average (41.7 and 27.2 per 100,000 population).

2 | Materials and Methods

The Hospital and Health Boards Act (2011) allows the Queensland Cancer Control Safety and Quality Partnership to analyse information to fulfil its functions, including clinical research (https://www.legislation.qld.gov.au/view/whole/html/inforce/current/act-2011-032). Specific approval for this study from a human research ethics committee was therefore not required.

Unit record data were drawn from the Queensland Oncology Repository, a population-based resource developed to inform and evaluate cancer control and related quality assurance initiatives across the state. The repository is continuously updated and brings together comprehensive details on patient demographics, cancer diagnoses, deaths and treatment from both public and private facilities. More than 60 data sources feed into the repository. Records for the same person are linked using complex matching algorithms. The linked data are then cleaned and converted into a uniform dataset.

People eligible for inclusion in the study were residents of Queensland diagnosed with early-stage (i.e. stages I, II and III) primary NSCLC at any age between 2011 and 2017. The inclusion of stage III cases allows an important benchmark for the treatments provided and associated outcomes, prior to the introduction of immunotherapy. The stage was assigned according to the TNM 7th edition [27] based on either clinical or pathological results. In situations where multiple notifications for stage were obtained for the same person, the staging category recorded was determined through an approach that gave greater priority to information that was likely to be of higher quality.

Information on treatment (apart from oral systemic therapy) and mortality was available until December 31, 2022. Note that oral systemic therapy is not available within the Queensland Oncology Repository due to inconsistent recording in hospital systems. Radiotherapy and chemotherapy were further defined according to whether they were given concurrently (i.e. overlapping treatment dates), sequentially (where chemotherapy commenced within 45 days of radiotherapy ending, or vice versa), distinct therapies (both treatments given but there were more than 45 days between the end of one and start of the other) or only one of the two therapies was administered. Any therapies that commenced more than 1 year after diagnosis were excluded.

Other variables of interest considered in the study included: sex; age group; First Nations status (whether a person self-identified as being an Aboriginal or Torres Strait Islander); remoteness of residence (defined according to the Australian Statistical Geography Standard, Edition 3 [28]); area-based socio-economic status (using the Index of Relative Socio-Economic Advantage and Disadvantage [29]); the number of comorbidities (counted using the Quan algorithm [30], and including conditions that were reported in any hospital admission within Queensland between 1 year before to 1 year after the NSCLC diagnosis); performance status (measured on the Eastern Cooperative Oncology Group [ECOG] Performance Status Scale [31]); and morphological subtype of NSCLC (based on the 2021 World Health Organisation Classification of Lung Tumors [32] and categorised as adenocarcinoma, squamous cell carcinoma and other carcinomas—see Table S1).

2.1 | Data Analyses

Multivariable analysis using Poisson regression models with robust error variance was conducted by broad type of treatment

(i.e. any treatment, surgery, radiotherapy or chemotherapy) to assess the likelihood of receiving that treatment according to key personal and clinical characteristics. Results were expressed in terms of the relative likelihood (RL) compared to the reference category.

Five-year observed survival by stage/substage at diagnosis was estimated using the Kaplan-Meier method, with equality of the survival curves evaluated by the log-rank test. Differences in survival by stage/substage were evaluated by fitting multivariable flexible parametric survival models based on the cohort approach, including adjustment for the type of treatment received. Flexible parametric modelling has several advantages over traditional proportional hazard survival models, such as allowing for changes in the hazard ratio (HR) over time [33]. Models were fitted separately for stage III NSCLC according to whether or not surgery was performed. Differences with respect to the reference category for each covariate were expressed as the adjusted excess mortality HR at 5 years after diagnosis.

The selected reference categories for each of the personal and clinical characteristics in the Poisson and flexible parametric survival analyses are outlined in Table S2. These were generally the most common category and/or the characteristic associated with better survival. Point estimates are presented along with 95% confidence intervals (95% CIs) and *p*-values where relevant. Statistical significance was set at $p \leq 0.05$.

3 | Results

3.1 | Study Cohort

The selection process for the study cohort is illustrated in Figure S1. Of the 13,052 people diagnosed with NSCLC in Queensland between 2011 and 2017, 2350 (18%) were excluded due to unknown stage and a further 6257 (48%) were diagnosed with metastatic disease, leaving 4445 eligible cases with early-stage NSCLC.

The stage was based on clinical information only for 2555 people (57%), pathological information only for 1829 people (41%) and both sources for the remaining 61 people (1%). For those with both clinical and pathological staging data, the stage was concordant for 43 people (70%).

Almost half ($n = 2030$, 46%) of the study cohort were diagnosed at stage I. There was a higher percentage of males overall (58%), particularly for stages II and III ($p < 0.001$)—see Table 1. The overall median age was 69 years (interquartile range 63–76 years), ranging from 67 years for stage III to 70 years for both stages I and II. Poor performance status was highest for stage III (13%) compared to 7% for stage I ($p < 0.001$). In the overall study cohort, 3% ($n = 133$) identified as being a First Nations person, 12% ($n = 539$) were from outer regional, remote or very remote regions, 31% ($n = 1357$) lived in disadvantaged areas and 24% ($n = 1081$) had two or more comorbid conditions; there were no significant differences by stage at diagnosis for each of these characteristics.

The overall percentage of the study cohort with adenocarcinoma or squamous cell carcinoma was 50% and 29%, respectively, but varied by stage ($p < 0.001$); adenocarcinomas comprised 60% of stage I cases compared to 40% of stage III cases. A large portion ($n = 523/956$, 55%) of the "Other" morphological subtype group was due to cases classified as morphology code 8046/3, which is a general code used when no specific type of NSCLC is specified in the pathology report. The use of this code decreased over time, from 73% of the "Other carcinomas" group in 2011 to under 50% from 2014 onwards.

3.2 | Type of Treatment

Details of the treatments received within 1 year of diagnosis, stratified by stage, are shown in Figure 1 and Table S3. About half ($n = 2305$, 46%) of all people with early-stage NSCLC were treated with surgery (with or without chemotherapy and/or radiotherapy), varying from 68% for stage I to 13% for stage III disease. The majority of people with stage I disease who received surgery did not have other treatments ($n = 1163$ of 1389, 84%), compared to 36% for stage II ($n = 164$ of 450) and 14% for stage III ($n = 28$ of 196). Of those who received surgery, only 4% ($n = 75$) had neoadjuvant chemotherapy, ranging from 1% ($n = 18$ of 1389) for stage I to 6% ($n = 26$ of 450) for stage II and 16% ($n = 31$ of 196) for stage III disease (data not shown). A review was conducted for the 18 individuals with stage I disease who received neoadjuvant treatment, which identified 5 people who had been reclassified from stage III based on clinical findings to stage I following pathological examination. The remaining 13 patients did not have sufficient clinical information available to determine pre-operative stage.

A further 44% of people with early-stage NSCLC ($n = 1972$) were treated without surgery, most notably for stage III disease ($n = 1145$ of 1553, 74%). Concurrent radiotherapy and chemotherapy were the most common treatment combination among unresectable cases (see Table S3).

Approximately one in 10 ($n = 438$, 10%) of the study cohort did not receive any recorded treatment within 1 year of diagnosis, ranging from 7% for stage I to 14% for stage III (noting that oral systemic therapies are not currently captured). Some of these people ($n = 56$, 13%) had radiotherapy and/or chemotherapy more than 1 year after diagnosis.

The personal or clinical characteristics that were associated with not receiving any recorded treatment within 1 year of diagnosis were being aged 80 years or over (RL = 0.79 compared to <60 age group, 95% CI 0.76–0.83) or having poor performance status (RL = 0.75 compared to good performance status, 95% CI 0.71–0.81)—see Figure 2. People from outer regional or remote areas were somewhat less likely to receive treatment within the first year compared to residents in major cities (RL = 0.96, 95% CI 0.93–0.99), due to lower rates of radiotherapy (RL = 0.87, 95% CI 0.78–0.97) and chemotherapy (RL = 0.89, 95% CI 0.81–0.98). There were no significant differences in receiving treatment by either First Nations status or area-based socio-economic status. People with stage III disease were around 80% less likely to have surgery than stage I (RL = 0.20, 95% CI 0.18–0.23), but were far more likely to receive either radiotherapy (RL = 2.26, 95% CI 2.09–2.44) or chemotherapy (RL = 5.14, 95% CI 4.58–5.78). Squamous cell carcinoma was treated less often with surgery than adenocarcinoma (RL = 0.80, 95% CI 0.75–0.86) but more often with radiotherapy (RL = 1.22, 95% CI 1.14–1.31).

TABLE 1 | Key characteristics of people with early-stage non-small cell lung cancer (NSCLC) by stage at diagnosis, Queensland, 2011–2017.

Characteristic	Stage I ($N = 2030$)		Stage II ($N = 862$)		Stage III ($N = 1553$)		Total ($N = 4445$)	
	n	Col %	*n*	Col %	*n*	Col %	*n*	Col %
Sex ($p < 0.001$)								
Males	1080	53.2	549	63.7	946	60.9	2575	57.9
Females	950	46.8	313	36.3	607	39.1	1870	42.1
Age group at diagnosis ($p < 0.001$)								
<60 years	281	13.8	135	15.7	337	21.7	753	16.9
60–69 years	666	32.8	272	31.6	566	36.5	1504	33.8
70–79 years	820	40.4	322	37.4	484	31.2	1626	36.6
≥80 years	263	13.0	133	15.4	166	10.7	562	12.6
First Nations status ($p = 0.19$)								
Aboriginal and/or Torres Strait Islander	51	2.5	27	3.1	55	3.5	133	3.0
Other Queenslander	1979	97.5	835	96.9	1498	96.5	4312	97.0
Residential location ($p = 0.42$)								
Major city	1319	65.0	549	63.7	996	64.1	2864	64.4
Inner regional	460	22.7	220	25.5	362	23.3	1042	23.4
Outer regional/Remote/Very remote	251	12.4	93	10.8	195	12.6	539	12.1
Area-based socioeconomic status ($p = 0.08$)								
Advantaged	158	7.8	64	7.4	88	5.7	310	7.0
Middle SES	1276	62.9	537	62.3	965	62.1	2778	62.5
Disadvantaged	596	29.4	261	30.3	500	32.2	1357	30.5
Number of comorbidities[a] ($p = 0.21$)								
None	888	43.7	411	47.7	709	45.7	2008	45.2
One	619	30.5	254	29.5	483	31.1	1356	30.5
Two or more	523	25.8	197	22.8	361	23.2	1081	24.3
Performance status ($p < 0.001$)								
Good (ECOG score 0–1)	1217	60.0	568	65.9	1050	67.6	2835	63.8
Poor (ECOG score 2–4)	149	7.3	67	7.8	206	13.3	422	9.5
Unknown	664	32.7	227	26.3	297	19.1	1188	26.7
Morphological subtype ($p < 0.001$)								
Adenocarcinoma	1213	59.8	365	42.3	628	40.4	2206	49.6
Squamous cell carcinoma	471	23.2	290	33.6	522	33.6	1283	28.9
Other carcinomas	346	17.0	207	24.0	403	26.0	956	21.5

Abbreviations: ECOG, Eastern Cooperative Oncology Group; NSCLC—non-small cell lung cancer; SES—socio-economic status.
Note: a.) Comorbidities were based on the Charlson Comorbidity Index (excluding second primary cancers) and include clinical conditions that have the potential to significantly affect the prognosis of a patient with cancer, coded in any admission episode between 12 months before and 12 months after the date of cancer diagnosis.

3.3 | Survival by Stage at Diagnosis

A total of 18,672 years of follow-up were accumulated, with a median of 3.7 years per patient (interquartile range 1.3–6.6 years). Median follow-up varied by stage, from 1.5 years for stage III to 5.7 years for stage I.

The combined 5-year observed survival for early-stage NSCLC was 44% (95% CI 42%–45%). Survival decreased considerably as stage increased, ranging from 63% (95% CI 60%–65%) for stage I to 41% (95% CI 38%–45%) for stage II and 20% (95% CI 18%–22%) for stage III ($p < 0.001$). Kaplan-Meier survival curves and 5-year estimates by substage are shown in Figure 3.

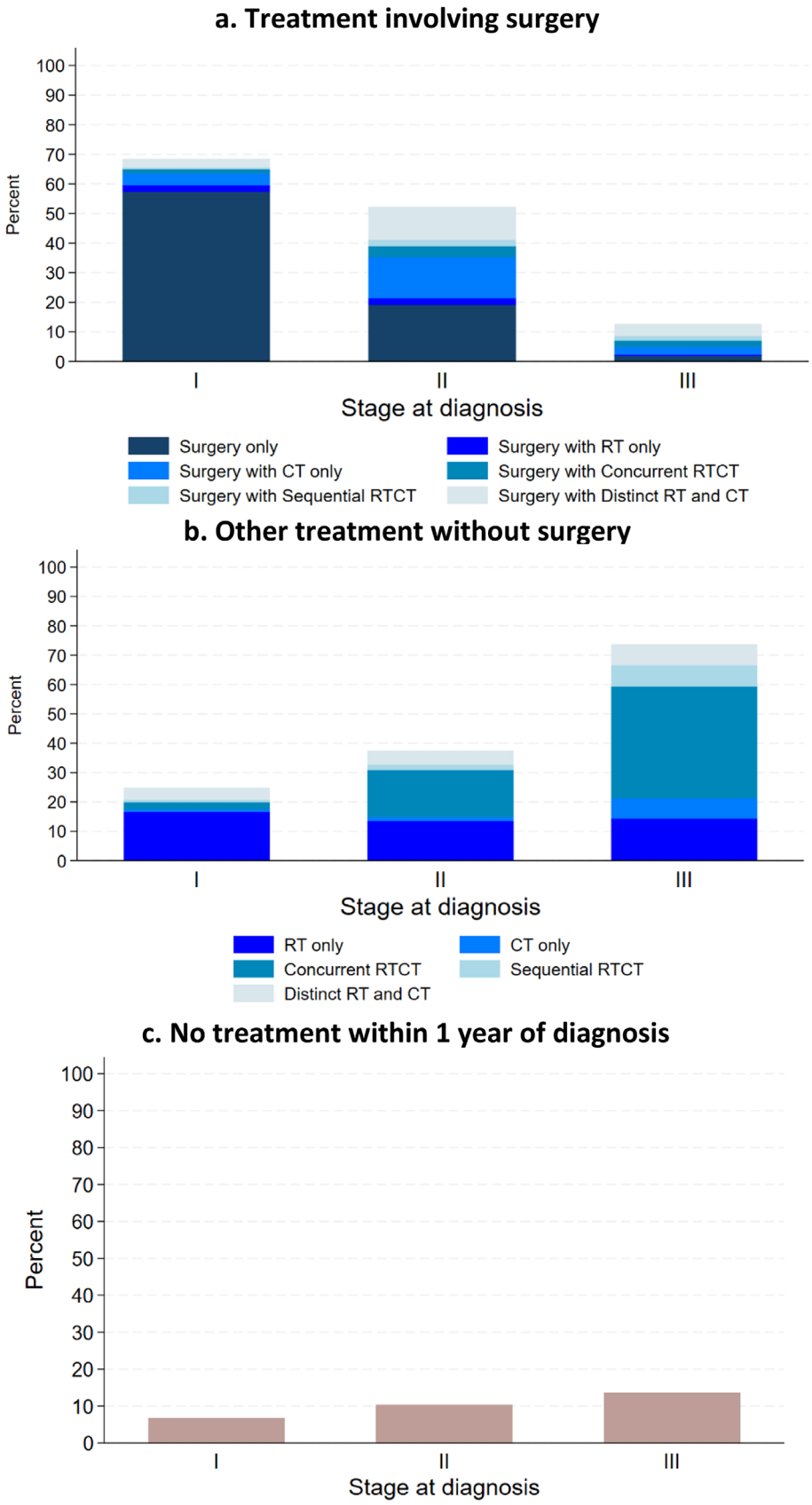


FIGURE 1 | Type of treatment within 1 year of diagnosis by stage at diagnosis for early-stage non-small cell lung cancer (NSCLC), Queensland, 2011–2017. Abbreviations: CT, chemotherapy; RT, radiotherapy. *Notes:* RT and/or CT given within 1 year of diagnosis, excluding any oral systemic therapy. Concurrent RTCT—dates of the treatments overlap). Sequential RTCT—one therapy is commenced within 45 days of the other ending, in either order). Distinct RT and CT—both treatments were given in any order but there were more than 45 days between the end of one and the start of the other.

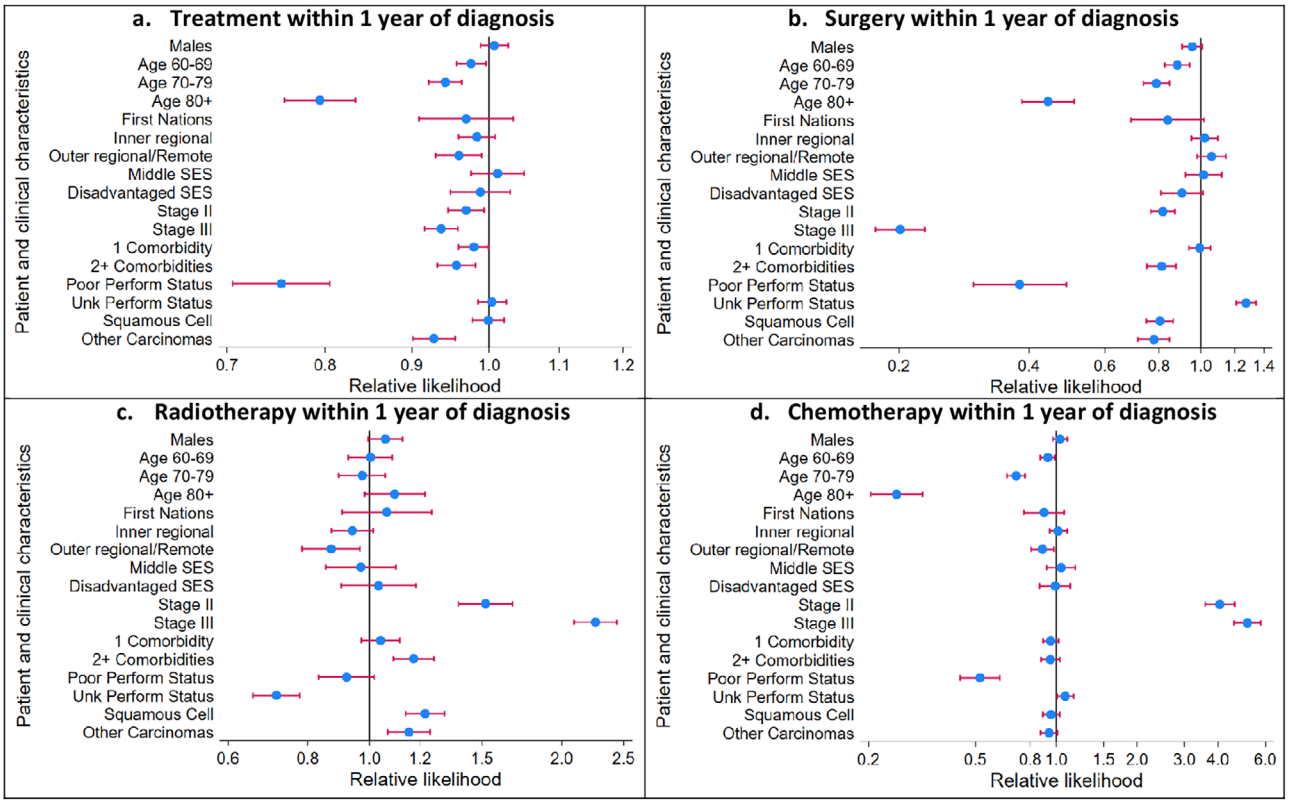


FIGURE 2 | Relative likelihood of receiving treatment within 1 year of diagnosis for early-stage non-small cell lung cancer (NSCLC) by selected patient and clinical characteristics, Queensland, 2011–2017. *Notes:* Relative likelihood is shown on differing scales. Radiotherapy and chemotherapy were given within 1 year of diagnosis, excluding any oral systemic therapy. Comorbidities were based on the Charlson Comorbidity Index (excluding second primary cancers) and include clinical conditions that have the potential to significantly affect the prognosis of a patient with cancer, coded in any admission episode between 12 months before or after the date of cancer diagnosis. Poor performance status was an Eastern Cooperative Oncology Group (ECOG) score of 2 or higher.

The personal and clinical factors that were important in determining survival for NSCLC varied by stage (Table S4a–d). For example, age group at diagnosis was highly predictive of survival for stages I and II, but not for stage III. People with two or more comorbidities or poor performance status generally had a significantly higher risk of death within 5 years of diagnosis compared to those with no comorbidities or good performance status, respectively. Squamous cell carcinoma was an unfavourable prognostic factor for stage I and stage III without surgery. First Nations status, residential location and area-based socioeconomic status did not have a bearing on survival irrespective of stage.

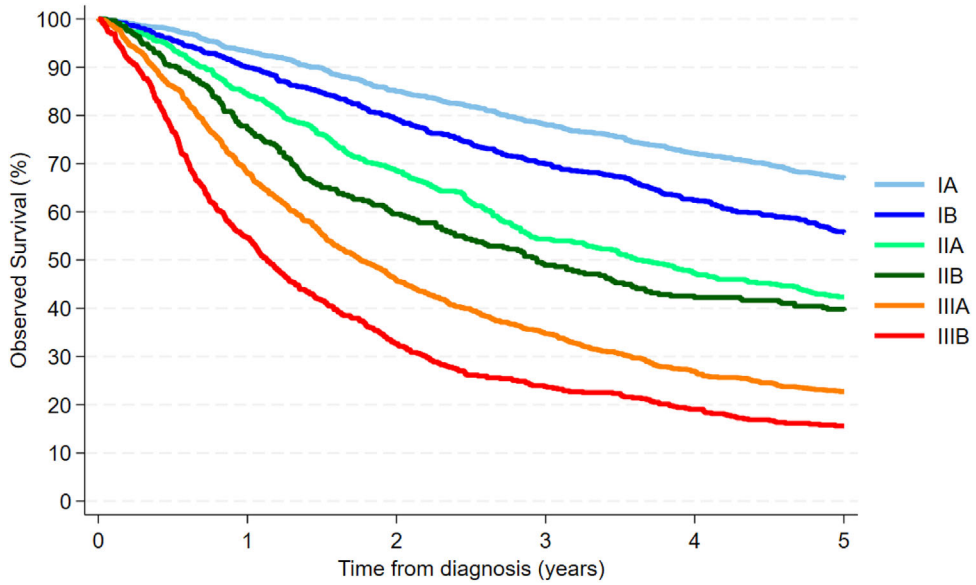
After adjustment for other key covariates, treatment with either surgery alone or surgery plus chemotherapy was associated with the best survival for both stage I and II NSCLC, with excess mortality between 2 and 6 times higher for most other treatment modalities (Table S4a,b). Among people with resectable stage III disease (Table S4c), the best outcomes were achieved for surgery plus chemotherapy (5-year adjusted excess mortality HR = 0.33 compared to surgery only, 95% CI 0.14–0.77). For unresectable stage III cases (Table S4d), the use of both radiotherapy and chemotherapy was optimal compared to radiotherapy only, particularly when received concurrently (HR = 0.45, 95% CI 0.38–0.54).

4 | Discussion

Given the rapidly evolving clinical landscape and ongoing challenges posed by lung cancer for both individuals and the health system, a clearer understanding of the influence of patterns of care on survival for early-stage NSCLC is essential for optimizing patient management and resources. A national lung cancer screening program is set to be introduced in Australia by mid-2025. This is expected to lead to a shift towards earlier detection [34], further underlining the importance of understanding treatment pathways and outcomes for early-stage NSCLC.

The results of the study are also important from the perspective of lung cancer consumers by helping to inform their treatment choices. Those diagnosed with early-stage NSCLC generally have a strong desire to explore curative options involving surgery, along with multi-modality approaches due to fear of recurrence. However, when this is not possible, many consumers are left to bear the burden of a terminal illness and all of its impacts. Robust multidisciplinary assessment is therefore crucial, including specialist surgical input on resectability [35].

The proportion of people with stage I NSCLC in Queensland who had surgery (68%) was similar to published rates from Ontario between 2007 and 2015 (63%) [36] and the United States



Stage	Five-year observed survival (95% CI)
IA	67.1% (64.4%-69.6%)
IB	55.8% (52.3%-59.1%)
IIA	42.4% (38.1%-46.6%)
IIB	39.8% (34.5%-45.1%)
IIIA	22.7% (20.2%-25.4%)
IIIB	15.6% (12.7%-18.8%)

FIGURE 3 | Kaplan-Meier curves for observed survival by substage at diagnosis for early-stage non-small cell lung cancer (NSCLC), Queensland, 2011–2017. *Note:* Follow-up for survival was available to December 31, 2022 for all cases.

between 2010 and 2016 (67%) [37] but substantially higher than for the Netherlands between 2008 and 2018 (48%) [38]. Conversely, radiotherapy alone was much higher in the Netherlands, where the field of stereotactic body radiotherapy was pioneered, for both stage I (40% vs. 17%) and stage II (29% vs. 14%) compared to Queensland [38]. Only 13% of people with stage III NSCLC in our cohort underwent surgery, similar to the Netherlands (11%) [38], England (13% in 2016) [39] and Alberta (15% between 2010 and 2015) [40], but lower than in the United States (22%) [37] or Victoria, Australia (30% between 2012 and 2019) [41]. Reasons for lower surgical rates for stage III could include geographical issues, such as the lack of thoracic surgeons in many regional and rural areas of Queensland, where residents may be hundreds of kilometres away from the nearest major hospital [42], or inconsistent attendance at multidisciplinary team meetings [35], which increases the chances of stage III patients being excluded from consideration for surgery by non-surgical physicians.

We found that 7% of people with stage I disease did not have any treatment recorded, equal to or better than the published results in other jurisdictions [36–38]. This subgroup tended to include older people, those with a poor performance score and/or people with multiple comorbidities. Additionally, we know that some patients with small nodules or ground glass opacities will be observed for a period of time before eventually undergoing definitive treatment later [43]. For those who are medically inoperable, other local therapies, such as ablation through interventional radiology, may have been employed but are not captured in our dataset. We note that there was a much lower percentage of NSCLC cases with no recorded treatment for stage III disease in Queensland (14%) compared to the Netherlands, Alberta (both 25%) [38, 40] or England (36%) [39]; however, our result was almost three times higher than in Victoria (5%) [41]. In this instance, some of the differences could be explained by the fact that a proportion of these patients harbour an actionable genomic alteration that can be targeted by oral systemic therapies, which are not collected in the Queensland Oncology Repository.

Stage-specific survival in Queensland was slightly but consistently lower than reported for the United States [37]–63% compared to 68% for stage I, 41% compared to 45% for stage II, and 23% compared to 26% for stage IIIA, while survival was similar for stage IIIB (16% and 17%, respectively). At least part of this difference may be explained by Ganti et al. [37]. using the period method for calculating survival in the United States, which tends to give higher estimates in situations where survival has improved over time, as opposed to the more traditional cohort approach used here. It is also possible that variations in patterns of care between Queensland and the United States may have contributed to these modest survival differences, as mentioned above.

Adjuvant chemotherapy was observed to improve survival in resected stage III NSCLC compared to surgery alone (HR = 0.33). A meta-analysis published in 2010 [19] showed a 14% reduction in mortality for operable NSCLC when chemotherapy was added after surgery. However, the results were combined by stage and therefore not directly comparable with our findings. As expected, the use of neoadjuvant systemic therapy varied

with stage, peaking at 16% for stage III. We anticipate that this percentage will rise once neoadjuvant and perioperative chemo-immunotherapy approaches are approved and reimbursed in Australia, translating to significant gains in long term survival for those with resectable tumours.

Post-operative radiation was generally associated with excess mortality, suggesting that its requirement pertained to negative prognostic indices such as positive margins or more advanced disease; that is, the better survival observed for people with stage I and II NSCLC who had surgery without subsequent radiotherapy may simply reflect their suitability for surgery and that no additional treatments were required to achieve cure. On the other hand, there is evidence to suggest that radiotherapy for lung cancer may be underutilised in Australia, particularly for inoperable disease [44, 45], with a recent study into actual versus optimal rates of stereotactic ablative body radiotherapy in New South Wales revealing potential gaps in service delivery [44]. In the non-surgical management of stage III NSCLC, we found that radiotherapy alone was inferior to radiotherapy plus chemotherapy, regardless of the timing of delivery.

A positive finding that emerged from our study was that population groups of interest, including First Nations people and those from regional/remote or lower socioeconomic areas, had equivalent rates of survival to other people with NSCLC after adjustment for other factors that may impact mortality, and despite some differences in receipt of radiotherapy and chemotherapy for people from outer regional/remote localities. This contrasts with continuing racial and socio-economic disparities for NSCLC treatment and outcomes in some other high-income countries [46–48].

Access to data from the Queensland Oncology Repository was a major strength of our study, providing comprehensive longitudinal records for people affected by early-stage NSCLC at the population level, thus enabling detailed analysis of treatment (excluding oral systemic therapy) and outcomes. Note that findings from other studies on patterns of care for early-stage NSCLC are not always directly comparable with our results, because of differences in data availability or methodology (for example, a lack of any chemotherapy data [49] or excluding people who did not receive any treatment [50]). A relatively large portion of NSCLC cases (18%) were excluded from our study due to unknown stage. Further, the mix of clinical and pathological staging data should be taken into consideration when interpreting our results given that they are not always concordant. It is unclear what effect these unavoidable drawbacks may have had on our findings. Chemotherapy usage within the study cohort will be somewhat under-reported due to the lack of information on oral systemic therapy (including tyrosine kinase inhibitors). Another limitation is that detailed data on the type of radiotherapy was not collected within the Queensland Oncology Repository during the study period, and so we were unable to distinguish between external beam and stereotactic ablative body radiotherapy.

To conclude, this work has evaluated patterns of care for people diagnosed with early-stage NSCLC in Queensland prior to the introduction of immunotherapy. It thereby provides a benchmark for outcomes and factors associated with survival along with an understanding of prevailing treatment strategies at that time. Consequently, as we move forward into the next time phase incorporating immunotherapy [13, 21–25], we will be in a better position to assess the incremental benefits for the entire population and help plan workforce and resource allocation needed for the new treatment paradigms. With further gains expected from the imminent implementation of a national lung cancer screening program, our goal as clinicians, researchers and consumers is to soon be able to cure more people affected by lung cancer.

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Conflicts of Interest

Bryan A Chan declares the following financial interests/personal relationships which may be considered as potential competing interests:

- AstraZeneca (consulting or advisory relationship)
- Merck Sharp & Dohme (Australia) Pty Limited (consulting or advisory relationship)
- Roche (consulting or advisory relationship)
- Genentech Inc (consulting or advisory relationship)

The other authors declare no conflicts of interest.

Data Availability Statement

The unit record data used in this study are not publicly available to protect patient privacy and confidentiality. Deidentified data may be available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.