NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

Final appraisal determination

Pembrolizumab for treating PD-L1-positive non-small-cell lung cancer after chemotherapy

1 Recommendations

1.1 Pembrolizumab is recommended as an option for treating locally advanced or metastatic PD-L1-positive non-small-cell lung cancer in adults who have had at least one chemotherapy (and targeted treatment if they have an epidermal growth factor receptor [EGFR]- or anaplastic lymphoma kinase [ALK]-positive tumour), only if:

- pembrolizumab is stopped at 2 years of uninterrupted treatment and no documented disease progression, and
- the company provides pembrolizumab with the discount agreed in the patient access scheme revised in the context of this appraisal.

1.2 This guidance is not intended to affect the position of patients whose treatment with pembrolizumab was started within the NHS before this guidance was published. Treatment of those patients may continue without change to whatever funding arrangements were in place for them before this guidance was published until they and their NHS clinician consider it appropriate to stop.

2 The technology

Description of the technology	Pembrolizumab (Keytruda, Merck, Sharp & Dohme) is a humanised monoclonal antibody that acts on the 'programmed death ligand 1' protein (PD-L1). The PD-L1 protein is part of the immune checkpoint pathway, and blocking its activity may promote an anti-tumour immune response.
Marketing authorisation	Pembrolizumab has a marketing authorisation for treating locally advanced or metastatic non-small cell lung cancer (NSCLC) in adults whose tumours express PD-L1 (that is, with a tumour proportion score [TPS] ≥1%) and who have had at least 1 chemotherapy regimen. Patients with epidermal growth factor receptor (EGFR)- or anaplastic lymphoma kinase (ALK)-positive tumour mutations should also have had approved therapy for these mutations before having pembrolizumab.
Adverse reactions	The most common treatment-related adverse events associated with pembrolizumab include fatigue, decreased appetite, nausea, rash and pruritus. For full details of adverse reactions and contraindications, see the summary of product characteristics.
Recommended dose and schedule	2 mg/kg every 3 weeks by intravenous (IV) infusion. The summary of product characteristics recommends treatment with pembrolizumab until disease progression or unacceptable toxicity.
Price	Pembrolizumab is available at a cost of £1,315.00 per 50 mg vial (excluding VAT; 'British national formulary' [BNF] online, accessed November 2016). The company has agreed a patient access scheme with the Department of Health. This scheme provides a discount to the list price of pembrolizumab applied at the point of purchase or invoice. The level of the discount is commercial in confidence. The Department of Health considered that this patient access scheme would not constitute an excessive administrative burden on the NHS.

3 Evidence

The appraisal committee (section 7) considered evidence submitted by Merck Sharp & Dohme and a review of this submission by the evidence review group. See the committee papers for full details of the evidence.

4 Committee discussion

The appraisal committee reviewed the data available on the clinical and cost effectiveness of pembrolizumab, having considered evidence on the nature of non-small-cell lung cancer (NSCLC) and the value placed on the benefits of pembrolizumab by people with the condition, those who represent them, and clinical experts. It also took into account the effective use of NHS resources.

Clinical management

4.1 The committee noted that people with locally advanced or metastatic NSCLC that has progressed after platinum-based chemotherapy have a poor prognosis. It is a debilitating condition with many distressing symptoms. The committee heard from clinical experts that people with this condition have limited treatment options and that existing treatments such as docetaxel can cause severe adverse effects. It heard from the experts that premedication is not needed before pembrolizumab. The committee noted that pembrolizumab was better tolerated than docetaxel although a small proportion of people have immune-related adverse effects such as rash and colitis. The committee heard from the clinical experts that some people whose disease progresses rapidly after initial treatment or who cannot tolerate docetaxel currently have best supportive care and pembrolizumab may be considered suitable for these patients. The committee was aware that in their submissions the patient experts stated that the current outlook for patients with NSCLC whose disease has relapsed after platinum-based chemotherapy is poor. It noted that improving quality of life and even small extensions in duration of life are of considerable importance to this patient group. The committee concluded that pembrolizumab is an important treatment option for people with locally advanced or metastatic NSCLC whose tumours express PD-L1 and who have had platinum-based chemotherapy, and a targeted

treatment if the person has an epidermal growth factor receptor tyrosine kinase (EGFR-TK)- or anaplastic lymphoma kinase (ALK)-positive tumour.

4.2 The committee noted that the marketing authorisation for pembrolizumab states that people should have treatment based on their tumour's expression of PD-L1, confirmed by a validated test. It heard from the clinical experts that trial evidence suggested that the higher the level of PD-L1 expression, the greater the clinical response in people with locally advanced or metastatic NSCLC. The clinical experts also noted that although PD-L1 testing is not part of standard NHS clinical practice, it is a straightforward immunohistochemical assay. It could be standardised quickly and, with training, quickly implemented as standard practice in the NHS. The clinical experts highlighted that re-biopsy on progression is becoming standard practice in lung oncology, but that re-biopsies for analysis of PD-L1 expression may not always be needed because testing of stored samples is possible. The committee noted that the costs of testing for PD-L1 expression were included in the company's economic analysis. The committee concluded that PD-L1 testing could be standardised quickly and, with training, implemented as standard clinical practice in the NHS.

4.3 The committee discussed the clinical management of locally advanced or metastatic NSCLC. It understood that platinum therapy is given as a first treatment for NSCLC in people whose tumours are not EGFR-TK-positive, followed by docetaxel or docetaxel plus nintedanib for people with adenocarcinoma. The committee understood that pembrolizumab would be considered as an alternative option to docetaxel or docetaxel plus nintedanib. For people with EGFR-TK-positive tumours, treatment starts with a tyrosine kinase inhibitor, followed by platinum therapy. For people with ALK-positive tumours, platinum combination therapy followed by an ALK inhibitor are the standard treatment choices. The committee heard from the clinical experts that pembrolizumab would be an alternative to

docetaxel or to docetaxel plus nintedanib in people who have had targeted treatment for EGFR-TK- or ALK-positive tumours. The committee agreed with the company's approach of not comparing pembrolizumab with nivolumab, ceritinib or ramucirumab which, at the time of committee's first discussion, were the subject of ongoing NICE appraisals. The committee noted that the company had not compared pembrolizumab with best supportive care. It concluded that for a small proportion of patients who declined docetaxel, or could not tolerate it, best supportive care could be a relevant comparator but there was no direct evidence for this comparison. The committee also concluded that pembrolizumab was appropriately positioned in the clinical pathway as a treatment option for people who have had previous chemotherapy with or without a targeted therapy and as an alternative to docetaxel or to docetaxel plus nintedanib.

Clinical effectiveness

4.4 The committee noted that the clinical effectiveness evidence for pembrolizumab compared with docetaxel came from 2 studies:

- KEYNOTE-01 and
- KEYNOTE-010.

The committee considered that the KEYNOTE-010 evidence was the most applicable to the decision problem because the KEYNOTE-010 population consisted only of people with PD-L1 positive NSCLC, whereas KEYNOTE-01 is a non-randomised cohort study of pembrolizumab which retrospectively identified PD-L1 status and used the docetaxel arm of KEYNOTE-010 as a comparator; this can lead to a greater risk of bias. The committee understood from the company submission that the trial was designed to assess the efficacy and safety of pembrolizumab in patients with advanced PD-L1-positive NSCLC in 2 populations according to tumour proportion score (TPS), that is, the overall population with TPS 1% or greater and a population with TPS 50% or greater. The committee

heard from the company that KEYNOTE-010 was powered to detect a difference between pembrolizumab and docetaxel in the population with TPS 50% or more and in the overall TPS 1% or more population, but not for the TPS 1 to 49% population. The committee noted that inclusion criteria in KEYNOTE-010 required patients to have an Eastern Cooperative Oncology Group (ECOG) Performance Status of 0 or 1. The committee heard from the clinical experts that the overall population in KEYNOTE-010 was likely to be the same as those who have pembrolizumab in clinical practice. The committee concluded that the population in KEYNOTE-010 was generalisable to clinical practice in England.

4.5 The committee noted that the median overall survival gain from KEYNOTE-010 was 10.5 months for pembrolizumab compared with 8.6 months for docetaxel in the intention-to-treat population. This difference was statistically significant. The committee concluded that based on the trial data, pembrolizumab had an important extension-to-life benefit for people with locally advanced or metastatic NSCLC whose tumours express PD-L1 compared with docetaxel.

4.6 The committee discussed the indirect treatment comparison presented by the company, which compared the relative treatment effects of pembrolizumab with nintedanib plus docetaxel in the population with adenocarcinoma. Two studies formed the basis of the indirect treatment comparison: KEYNOTE-010 and LUME-LUNG-01. Both trials included docetaxel as a comparator. LUME-LUNG-01 included adults with advanced NSCLC whose disease had progressed on or after treatment with only 1 previous chemotherapy regimen, and stratified recruited patients by cancer histology, with both treatment arms including about 50% of patients with adenocarcinoma. The ERG highlighted that KEYNOTE-010 included adults with PD-L1-positive advanced NSCLC whose disease has progressed after chemotherapy and after targeted

therapy for EGFR- or ALK-positive tumours. But in LUME-LUNG-01, neither PD-L1 expression nor EGFR mutation status was assessed in the patients with advanced NSCLC. The committee noted that the results from the indirect treatment comparison were not directly used in the economic model. Only the hazard ratio for nintedanib plus docetaxel compared with docetaxel was applied to the docetaxel arm in the model for the adenocarcinoma subgroup. The committee concluded that the indirect treatment comparison was not robust, and that the trial populations of KEYNOTE-010 and LUME-LUNG-01 were too different. Therefore it was not appropriate for decision-making regarding the effectiveness of pembrolizumab compared with nintedanib in the population with adenocarcinoma.

Cost effectiveness

4.7 The committee discussed the cost-effectiveness evidence presented by the company and its critique by the ERG. It accepted the structure of the economic model developed by the company and considered it appropriate for decision-making. During consultation the company submitted a revised patient access scheme and updated evidence, which took into account 6 months of further follow-up data from the KEYNOTE-010 trial.

Treatment duration

4.8 The committee discussed the assumption in the company's model that at 2 years all patients whose disease had not progressed (the pre-progression state) would stop treatment. It understood that this assumption was based on the KEYNOTE-010 protocol, which stated that patients could continue pembrolizumab until disease progression or unacceptable toxicity, or for 2 years without interruption. The committee recalled that the company's submission stated that the optimal duration of treatment with pembrolizumab is unknown. It was aware of the clinical experts' comments that this is because the data are immature. The committee heard from the company that, based on the latest data cut-off

(31 March 2016) and additional follow-up data (to 21 July 2016), no KEYNOTE-010 patients continued treatment after 2 years. In line with the protocol, patients discontinued treatment after 2 years of uninterrupted therapy (and no documented disease progression) or 35 doses, whichever occurred later. The committee noted that, despite being in the trial protocol, there is no 2-year stopping rule in the pembrolizumab summary of product characteristics. The clinical experts stated that in clinical practice, the decision to stop treatment would be made between the clinician and the patient, but the number of patients likely to have treatment after 2 years would be small. The clinical experts also stated that a small proportion of patients who stopped treatment would be followed up with the possibility of restarting treatment depending on the clinical circumstances. The committee considered the company's analyses which explored the effect of varying the proportion of patients having treatment after 2 years and before disease progression. The company had resubmitted evidence during consultation assuming that 25% of patients would continue treatment at 2 years in the base-case analysis and the committee noted that the incremental cost-effectiveness ratio (ICER) increased from £44,490 to £49,063 per quality-adjusted life year (QALY) gained as the proportion of patients having treatment after 2 years increased from 25% to 100%. The committee noted that, to model implementation of a 2-year stopping rule, it should be assumed that all people having pembrolizumab would stop treatment after 2 years if their disease has not progressed, and incorporating a 2-year stopping rule would reduce the company's base-case ICER by about £2,000 per QALY gained. The committee noted the uncertainty around the optimal treatment duration and was aware that consultation comments from NHS England stated that data on the optimal treatment duration of checkpoint inhibitors such as pembrolizumab will begin to be available within the next 2 years. NHS England commented during consultation that it was confident that a 2-year stopping rule would be acceptable to both patients and clinicians

and would be implementable. Also, the comments suggested that pembrolizumab could be reappraised by NICE in 2 years time to account for new evidence on optimal treatment duration. The committee concluded that implementation of a 2-year stopping rule and review of the published guidance at 2 years is appropriate.

Treatment switching

4.9 The committee heard that crossover was not permitted in KEYNOTE-010. However, the company reported that of the patients randomised to chemotherapy, 48% (50 people) crossed over and had treatment with other anti-PD-L1 treatments after treatment discontinuation. A 2-stage adjustment method was used by the company to account for treatment switching in the base-case analyses. The rank-preserving structural failure time (RPSFT) method, a pre-specified analysis, was presented as a scenario. The committee noted that the ICER for pembrolizumab compared with docetaxel using the RPSFT method was higher than that for the 2-stage method. The committee heard from the ERG that the RPSFT method does not have a test for a common treatment effect and it preferred the 2-stage adjustment method to account for the effects of crossover; it also noted that this method has been used in other appraisals of immunotherapies. The committee concluded that the 2-stage adjustment method was reasonable.

Time on treatment and additional weeks of therapy

4.10 The committee discussed time on treatment for people enrolled in KEYNOTE-010. The ERG highlighted that when using the individual patient level data provided by the company at clarification stage, the ERG analyses gave an estimated treatment duration of 217 days using the gamma model and 255 days with the Kaplan–Meier plus exponential model. The company also did analyses in which different parametric curves were fitted; it concluded that the generalised gamma model did not provide the best model or visual fit. The committee noted that it would

have preferred to see time on treatment taken directly from KEYNOTE-010 rather than the company's approach of using time to progression with a constant hazard adjustment to estimate time to treatment discontinuation. The committee was not clear about how many patients had scans to check for true disease progression and what proportion of these scans confirmed disease progression. The committee noted that additional weeks of therapy were sometimes needed (as stated in the KEYNOTE-010 protocol) to distinguish between true progression and pseudo-progression. Pseudo-progression is when tumours appear to enlarge but then respond to treatment. It heard from the clinical experts that additional outpatient visits and CT scans may be needed for approximately 10% of patients in clinical practice. In response to a query from committee, the company clarified that the hazard ratio for the relationship between disease progression and time on treatment (HR=1.039) included administration costs for people who remained on pembrolizumab (needing a confirmatory scan) and people whose disease had not yet progressed. The company did not specifically adjust for pseudo-progression in their estimates of treatment costs, but the committee heard from the company that if patients remained on treatment during pseudo-progression, the time on treatment data would reflect this. The ERG stated that, overall, the adjusted progression-free survival curve appeared very similar to the time on treatment curve. However, the committee noted that after a confirmatory scan some patients remained on treatment after disease progression. It was unclear if some patients, who did not need a scan to confirm true progression, continued therapy in the progressed state. The committee concluded that there was still some uncertainty about how many people continue treatment after disease progression and noted that these treatment and administration costs may not be appropriately captured in the company's analyses.

Extrapolation methods used for overall survival

4.11 The committee noted that, to estimate overall survival, the company used 52-week Kaplan–Meier data from KEYNOTE-010. After 52 weeks, for docetaxel, the company fitted an exponential model to the KEYNOTE-010 data after a 2-stage crossover adjustment. The company explored cut-off points of 42, 62, 72 and 82 weeks as well as 52 weeks. The committee acknowledged at the first appraisal meeting that there was marked sensitivity of the ICER to the choice of different cut-off points when using the original September data cut-off as well as the company and the ERG's approach to deriving the exponential curve. During consultation the company submitted additional evidence, which incorporated the more recent KEYNOTE-010 data from March 2016. The committee discussed the different cut-off points used when switching from trial survival data to the exponential survival modelling based on this additional evidence, and it noted that the sensitivity of the ICER to the different cut-off points was significantly reduced, and this supported the company's use of the exponential model. The company stated that their original extrapolated curves overlaid with the Kaplan–Meier data from March 2016 showed that the 42-week and 82-week cut-off points were implausible. The committee concluded that the 42-week and 82-week cut-off points could be excluded from consideration, but there was no evidence that the 52-week cut-off chosen by the company and ERG for their base-case analyses was the most appropriate for extrapolating the Kaplan–Meier data. The committee concluded that the 52-week, 62-week and 72-week cut-off points are all plausible, but noted that based on the March 2016 data submitted by the company during consultation, the ICER is no longer very sensitive to the choice of cut-off point to model overall survival.

Long-term treatment effect

4.12 The committee understood that the company's survival estimates depend on an ongoing reduction in the risk of death with pembrolizumab (time to

death was independent of previous time on treatment or disease progression), which continues after treatment has stopped and is maintained for a lifetime. The committee recalled that the original modelling projections, using the September 2015 KEYNOTE-010 data and the company's preferred assumptions, suggested that 10.3% and 1.2% of patients in the pembrolizumab arm would be alive at 5 years and 10 years, falling to 9.6% and 1.0% respectively when incorporating the March 2016 data submitted during consultation. Consultation comments from clinical experts noted that immunotherapies are expected to maintain their effect for a subgroup of people and that these values appear reasonable from clinical experience. But the committee considered that the assumption of a constant treatment effect over 20 years, irrespective of the time spent on treatment or disease progression was unlikely based on current clinical understanding of disease progression. The additional evidence submitted by the company during consultation included scenarios in which the hazard ratio for overall survival was set to 1.0 at 3, 5, and 10 years to model stopping of the continued treatment effect. The committee noted that, using the company's preferred assumptions of an extrapolation point of 52 weeks (see section 4.11) and 25% of patients continuing treatment after 2 years (see section 4.8), the ICER ranges from £61,954 per QALY gained with a 3-year treatment effect to £44,490 per QALY gained with a lifetime treatment effect.

4.13 The committee noted that the ERG presented data from Schadendorf (2015). This was a meta-analysis of studies in which patients received ipilimumab for treating unresectable or metastatic melanoma. The ERG based their preferred scenario that continued treatment effect stops at 3 years on the Schadendorf evidence, but it noted that these analyses are only designed to show the sensitivity of ICERs to different treatment effect durations. The committee noted in the March 2016 data submitted by the company at consultation all patients had stopped taking pembrolizumab and that the hazard ratios for both overall survival and progression-free

survival were essentially unchanged from the original September 2015 data, supporting the company's preferred assumption that there is a long-term treatment effect. The committee considered that although there is evidence to support a continued benefit of pembrolizumab after stopping treatment and in the progressed state, the size of this effect and its duration is unknown for NSCLC. The committee concluded that the ICERs were sensitive to a continued treatment effect after stopping treatment, and although it considered the company's preferred scenario of a lifetime treatment effect to be implausible, it had not been presented with any evidence on which it could agree a single clinically plausible scenario.

Utility values used in the pre- and post-progression states

4.14 The committee concluded that the KEYNOTE-010 utility data were the most appropriate to inform decision-making and including a disutility for adverse events was appropriate.

End-of-life considerations

4.15 The committee considered the advice about life-extending treatments for people with a short life expectancy in NICE's final Cancer Drugs Fund technology appraisal process and methods. It noted the evidence presented by the company, which showed that people with NSCLC have a life expectancy of less than 24 months. The committee heard that the average number of months of life gained with pembrolizumab, as estimated by the company's economic model, is between 21.2 and 22.8 months, compared with 10.4 months with docetaxel. It agreed that there is significant uncertainty in the overall survival gain and that this degree of benefit is likely to be optimistic. However, the committee considered it reasonable to assume that the benefit is likely to exceed 3 months. The committee therefore concluded that pembrolizumab met the end-of-life criteria and that it can be considered a life-extending, end-of-life treatment.

Most plausible ICER

4.16 The committee discussed the most plausible ICER for pembrolizumab compared with docetaxel. It noted comments from the clinical experts that the appropriate population is the overall population expressing PD-L1 (see section 4.4). Also, the committee considered that the indirect comparison in the adenocarcinoma subgroup was too unreliable for decision-making and so it focused on the pembrolizumab and docetaxel comparison in the overall population (see section 4.6). The committee agreed that the KEYNOTE-010 data were more appropriate, compared with the KEYNOTE-01 data (see section 4.4). The committee was aware of its earlier conclusion that no patient would continue treatment after 2 years with implementation of a 2-year stopping rule, and that this would reduce the ICER by about £2,000 per QALY gained (see section 4.8) and discussed the remaining area of uncertainty; the long-term treatment effect. It recalled that the ICERs are sensitive to a continued treatment effect after stopping treatment, with a range when using the company's preferred assumptions of £61,954 to £44,490 per QALY gained (see section 4.12), but concluded that within the uncertainties and with implementation of a 2-year stopping rule, the majority of plausible ICERs are below the range usually considered to be a cost-effective use of NHS resources.

4.17 The committee discussed the uncertainty about the long-term treatment effect. It was aware of several ongoing clinical trials which could reduce this uncertainty and if pembrolizumab is recommended for routine commissioning, relevant data would be collected by the Systemic Anti-Cancer Therapy Data Set. The committee concluded that uncertainty about the long-term treatment effect would reduce as data become available on the optimal duration of treatment of PD-L1 inhibitors in the next 2 years.

4.18 The committee discussed whether, overall, pembrolizumab is a cost-effective use of NHS resources, taking into account the most plausible ICER and the uncertainty that has been identified. It was also aware that there would be a wider benefit to the NHS because the simple discount agreed in the patient access scheme would apply across all indications. It concluded that pembrolizumab should be recommended for routine use with a 2-year stopping rule, but the guidance should be reviewed 2 years after publication to take in account more mature evidence.

4.19 The committee heard from the clinical and patient experts that pembrolizumab was innovative in its potential to make a significant and substantial effect on health-related benefits. It understood that pembrolizumab is generally well tolerated compared with docetaxel, is easy to administer and shows an improvement in overall survival benefit compared with other drugs. The committee concluded that pembrolizumab addresses an unmet need in a debilitating condition for which few treatment options are available, but there were no other benefits not captured in the QALY.

Summary of appraisal committee's key conclusions

TAXXX	Appraisal title: Pembrolizumab for treating PD-L1-positive non-small-cell lung cancer after chemotherapy	Section
Key conclusion		
Pembrolizumab is recommended as an option for treating locally advanced or metastatic PD-L1-positive non-small-cell lung cancer in adults who have had at least one chemotherapy (and targeted treatment if they have an epidermal growth factor receptor [EGFR]- or anaplastic lymphoma kinase [ALK]-positive tumour), only if: • pembrolizumab is stopped at 2 years of uninterrupted treatment and no documented disease progression, and • the company provides pembrolizumab with the discount agreed in the patient access scheme revised in the context of this appraisal.		1.1,
The committee concluded that pembrolizumab had an important extension-to-life benefit for people with locally advanced or metastatic NSCLC whose tumours express PD-L1 based on the KEYNOTE-010 trial data.		4.5
The committee noted the uncertainty around the optimal treatment duration and was aware that consultation comments from NHS England stated that data on the optimal treatment duration of checkpoint inhibitors such as pembrolizumab will begin to be available within the next 2 years. NHS England commented during consultation that it was confident that a 2-year stopping rule would be acceptable to both patients and clinicians and would be implementable.		4.8

It recalled that the ICERs are sensitive to a continued treatment effect after stopping treatment, with a range when using the company's preferred assumptions of £61,954 to £44,490 per QALY gained (see section 4.12), but concluded that within the uncertainties and with implementation of a 2-year stopping rule, the majority of plausible ICERs are below the range usually considered to be a cost-effective use of NHS resources. The committee discussed whether, overall, pembrolizumab is a cost-effective use of NHS resources, taking into account the most plausible ICER and the uncertainty that has been identified. It was also aware and that there would be a wider benefit to the NHS because the simple discount agreed in the patient access scheme would apply across all indications. It concluded that pembrolizumab should be recommended for routine use with a 2-year stopping rule, but the guidance should be reviewed 2 years after publication to take in account more mature evidence.		4.16 4.18
Current practice		
Clinical need of patients, including the availability of alternative treatments	People with locally advanced or metastatic NSCLC have a poor prognosis. It is a debilitating condition with many distressing symptoms. Improving quality of life and even small extensions in duration of life are of considerable importance to this patient group. Platinum therapy is given as a first treatment for NSCLC in people whose disease is not EGFR-TK-positive, followed by docetaxel or docetaxel plus nintedanib (depending on tumour histology).	4.1, 4.3

The technology		
Proposed benefits of the technology How innovative is the technology in its potential to make a significant and substantial impact on health-related benefits?	People with NSCLC have limited treatment options and existing treatments such as docetaxel can cause severe adverse effects. Premedication is not needed before pembrolizumab and it is generally well tolerated. Based on clinical trial data, pembrolizumab provides a statistically significant median overall survival gain compared with docetaxel and an important extension-to-life benefit for people with locally advanced or metastatic NSCLC whose tumours express PD-L1.	4.1, 4.5
What is the position of the treatment in the pathway of care for the condition?	The committee noted that the marketing authorisation for pembrolizumab states that people should have treatment based on their tumour's expression of PD-L1 (that is, with a tumour proportion score [TPS] ≥1%), confirmed by a validated test. The committee understood that platinum therapy is given as a first treatment for NSCLC in people whose tumours are not EGFR-TK-positive, followed by docetaxel or docetaxel plus nintedanib (depending on tumour histology). For people with EGFR-TK-positive tumours, treatment starts with a tyrosine kinase inhibitor, followed by a platinum therapy option. For people with ALK-positive tumours, platinum combination	4.2 4.3

	therapy followed by an ALK inhibitor are the standard treatment choices. The committee heard from the clinical experts that pembrolizumab would be an alternative to docetaxel or to docetaxel plus nintedanib (depending on tumour histology) in people who have had targeted treatment for EGFR-TK- or ALK-positive tumours. The committee concluded that pembrolizumab was appropriately positioned in the clinical pathway as a treatment option for people who have had 2 or 3 therapies and as an alternative to docetaxel or to docetaxel plus nintedanib.	
Adverse reactions	A small proportion of people have immune-related adverse effects such as rash and colitis.	4.1
Evidence for clinical effectiveness		
Availability, nature and quality of evidence	The clinical evidence for treating NSCLC came from 3 studies (KEYNOTE-01, KEYNOTE-010 and LUME-LUNG-01). The committee considered that the KEYNOTE-010 evidence was the most applicable to the decision problem because the KEYNOTE-010 population consisted only of people with PD-L1 positive NSCLC, whereas KEYNOTE-01 is a non-randomised cohort study of pembrolizumab which	4.4 4.4,

	retrospectively identified PD-L1 status and used the docetaxel arm of KEYNOTE-010 as a comparator; this can lead to a greater risk of bias. The committee concluded that pembrolizumab had an important extension-to-life benefit for people with locally advanced or metastatic NSCLC whose tumours express PD L1 based on the trial data. The committee concluded that the indirect treatment comparison of pembrolizumab compared with nintedanib plus docetaxel was not robust and was limited because of the differences between the trial populations. Therefore it was not appropriate for decision-making on the effectiveness of pembrolizumab in the population with adenocarcinoma histology.	4.6
Relevance to general clinical practice in the NHS	The committee heard from the clinical experts that the overall population in KEYNOTE-010 was likely to be the same as those who have pembrolizumab in clinical practice. The committee concluded that the population in KEYNOTE-010 was generalisable to clinical practice in England.	4.4
Uncertainties generated by the evidence	The committee noted the uncertainty around the optimal duration of treatment. It noted NHS England was confident that a 2-year stopping rule would be acceptable to both patients and clinicians and would be	4.8

	implementable. It concluded that implementation of a 2-year stopping rule and review of the published guidance at 2 years is appropriate.	
	The committee heard from the ERG that the RPSFT method to account for treatment switching does not have a test for a common treatment effect and it preferred the 2-stage adjustment method to account for the effects of crossover; it also noted that this method has been used in other appraisals of immunotherapies. The committee concluded that the 2-stage adjustment method was reasonable.	4.9
	The committee concluded that there was still some uncertainty about how many people continue treatment after disease progression and noted that these treatment and administration costs would not be included in the company analyses.	4.10
	The committee concluded that there was no evidence that the 52-week cut-off was the most appropriate for extrapolating the Kaplan–Meier data but noted that based on the March 2016 data submitted by the company during consultation, the ICER is no longer very sensitive to the choice of cut-off point to model overall survival.	4.11

	The committee considered that although it is likely there would be some continued benefit of pembrolizumab after stopping treatment and in the progressed state, the size of this effect and its duration is unknown for NSCLC. The committee concluded that the ICERs were sensitive to a continued treatment effect after stopping treatment, and although it considered the company's preferred scenario of a lifetime treatment effect to be implausible, it had not been presented with any evidence on which it could agree a single clinically plausible scenario.	4.13
Are there any clinically relevant subgroups for which there is evidence of differential effectiveness?	The company presented an indirect treatment comparison to compare the relative treatment effects of pembrolizumab with nintedanib plus docetaxel in the population with adenocarcinoma. Two studies formed the basis of the indirect treatment comparison: KEYNOTE-010 and LUME-LUNG-01. The committee concluded that the indirect treatment comparison was not robust, and that the trial populations of KEYNOTE-010 and LUME-LUNG-01 were too different. Therefore it was not appropriate for decision-making on the effectiveness of pembrolizumab in the population with adenocarcinoma histology.	4.6
Estimate of the size of the clinical	In the overall population in KEYNOTE-010 the median overall survival gain was 10.5 months	4.5

effectiveness including strength of supporting evidence	for pembrolizumab compared with 8.6 months for docetaxel. The committee concluded that pembrolizumab had an important extension-to-life benefit compared with docetaxel.	
Evidence for cost effectiveness		
Availability and nature of evidence	The committee accepted the structure of the economic model developed by the company and considered it appropriate for decision-making. During consultation the company submitted a revised patient access scheme and updated evidence, which takes into account 6 months of further follow-up data from the KEYNOTE-010 trial. The company used efficacy data for pembrolizumab and docetaxel from KEYNOTE-010.	4.7, 4.10
Uncertainties around and plausibility of assumptions and inputs in the economic model	The committee was not clear about how many patients had scans to check for true disease progression and what proportion of these scans confirmed disease progression. The committee noted that additional weeks of therapy were sometimes needed (as stated in the KEYNOTE-010 protocol) to distinguish between true progression and pseudo-progression. The committee concluded that there was still some uncertainty about how many people continue treatment after disease progression and noted that these treatment	4.10

	and administration costs would not be included in the company analyses. The committee considered that the KEYNOTE-010 evidence was the most applicable to the decision problem because the KEYNOTE-010 population consisted only of people with PD-L1 positive NSCLC, whereas KEYNOTE-01 is a non-randomised cohort study of pembrolizumab which retrospectively identified PD-L1 status and used the docetaxel arm of KEYNOTE-010 as a comparator; this can lead to a greater risk of bias. The committee concluded that the 52-week, 62-week and 72-week cut-off points for extrapolating the Kaplan–Meier data are all plausible, but noted that based on the March 2016 data submitted by the company during consultation, the ICER is no longer very sensitive to the choice of cut-off point to model overall survival. The committee concluded that the ICERs were sensitive to a continued treatment effect after stopping treatment, and although it considered the company's preferred scenario of a lifetime treatment effect to be implausible, it had not been presented with any evidence on which it could agree a single clinically plausible scenario.	4.4 4.11 4.13

	The committee discussed the uncertainty about the long-term treatment effect. It was aware of several ongoing clinical trials which could reduce this uncertainty and if pembrolizumab is recommended for routine commissioning, relevant data would be collected by the Systemic Anti-Cancer Therapy Data Set. The committee concluded that uncertainty about the long-term treatment effect would reduce as data become available on the optimal duration of treatment of PD-L1 inhibitors in the next 2 years.	4.17
Incorporation of health-related quality-of-life benefits and utility values Have any potential significant and substantial health-related benefits been identified that were not included in the economic model, and how have they been considered?	The committee concluded that the KEYNOTE-010 utility data were the most appropriate to inform decision-making and including a disutility for adverse events was appropriate. The committee concluded that pembrolizumab addresses an unmet need in a debilitating condition, for which few treatment options are available, but there were no other health benefits not captured in the QALY.	4.16 **Error! Reference source not found.**
Are there specific groups of people for whom the	No evidence has been submitted that there is a group of people for whom the technology is particularly cost effective.	–

technology is particularly cost effective?		
What are the key drivers of cost effectiveness?	The key drivers of cost-effectiveness were: • Treatment duration: the committee noted that the ICER increased from £44,490 to £49,063 per QALY gained as the proportion of patients having treatment after 2 years increased from 25% to 100% • Long-term treatment effect: The committee noted that, using the company's preferred assumptions of an extrapolation point of 52 weeks (see section 4.11) and 25% of patients continuing treatment after 2 years (see section 4.8), the ICER ranges from £61,954 per QALY gained with a 3-year treatment effect to £44,490 per QALY gained with a lifetime treatment effect. The committee concluded that the ICERs were sensitive to a continued treatment effect after stopping treatment, and although it considered the company's preferred scenario of a lifetime treatment effect to be implausible, it had not been presented with any evidence on which it could agree a single clinically plausible scenario.	4.8 4.12 4.13
Most likely cost-effectiveness	The committee discussed the most plausible ICER for pembrolizumab compared with docetaxel. It noted comments from the clinical experts that the appropriate population is the	4.16

estimate (given as an ICER)	overall population expressing PD-L1 (see section 4.4). Also, the committee considered that the indirect comparison in the adenocarcinoma subgroup was too unreliable for decision-making and so it focused on the pembrolizumab and docetaxel comparison in the overall population (see section 4.6). The committee agreed that the KEYNOTE-010 data were more appropriate, compared with the KEYNOTE-01 data (see section 4.4). The committee was aware of its earlier conclusion that no patient would continue treatment after 2 years with implementation of a 2-year stopping rule, and that this would reduce the ICER by about £2,000 per QALY gained (see section 4.8) and discussed the remaining area of uncertainty; the long-term treatment effect. It recalled that the ICERs are sensitive to a continued treatment effect after stopping treatment, with a range when using the company's preferred assumptions of £61,954 to £44,490 per QALY gained (see section 4.12), but concluded that within the uncertainties and with implementation of a 2-year stopping rule, the majority of plausible ICERs are below the range usually considered to be a cost-effective use of NHS resources.	
Additional factors taken into account		

Patient access schemes (PPRS)	The company has agreed a patient access scheme with the Department of Health. This scheme provides a discount to the list price of pembrolizumab applied at the point of purchase or invoice. The level of the discount is commercial in confidence. The Department of Health considered that this patient access scheme would not constitute an excessive administrative burden on the NHS.	2
End-of-life considerations	The committee heard that people with NSCLC have a life expectancy of less than 24 months. The committee heard that the average number of months of life gained with pembrolizumab, as estimated by the company's economic model, is between 21.2 and 22.8 months, compared with 10.4 months with docetaxel. It agreed that there is significant uncertainty in the overall survival gain, and that this degree of benefit is likely to be optimistic. However it was reasonable to assume that the benefit is likely to exceed 3 months. The committee therefore concluded that pembrolizumab met the end-of-life criteria and that it can be considered a life-extending, end-of-life treatment.	4.15
Equalities considerations and social value judgements	No equalities issues were raised during this appraisal.	–

5 Implementation

5.1 Section 7(6) of the National Institute for Health and Care Excellence (Constitution and Functions) and the Health and Social Care Information Centre (Functions) Regulations 2013 requires clinical commissioning groups, NHS England and, with respect to their public health functions, local authorities to comply with the recommendations in this appraisal within 3 months of its date of publication. Because pembrolizumab was made available in the NHS through the early access to medicines scheme, NHS England has indicated that this guidance will be implemented 30 days after final publication.

5.2 The Welsh Assembly Minister for Health and Social Services has issued directions to the NHS in Wales on implementing NICE technology appraisal guidance. When a NICE technology appraisal recommends the use of a drug or treatment, or other technology, the NHS in Wales must usually provide funding and resources for it within 3 months of the guidance being published.

5.3 When NICE recommends a treatment 'as an option', the NHS must make sure it is available within the period set out in the paragraphs above. This means that, if a patient has locally advanced or metastatic non-small-cell lung cancer expressing PD-L1, and the doctor responsible for their care thinks that pembrolizumab is the right treatment, it should be available for use, in line with NICE's recommendations.

5.4 The Department of Health and Merck Sharp & Dohme have agreed that pembrolizumab will be available to the NHS with a patient access scheme which makes it available with a discount. The size of the discount is commercial in confidence. It is the responsibility of the company to communicate details of the discount to the relevant NHS organisations.

Any enquiries from NHS organisations about the patient access scheme should be directed to [NICE to add details at time of publication]

6 Review of guidance

6.1 A review of the guidance on this technology will be started 2 years after publication of the guidance.

Professor Gary McVeigh
Chair, appraisal committee
November 2016

7 Appraisal committee members and NICE project team

Appraisal committee members

The 4 technology appraisal committees are standing advisory committees of NICE. This topic was considered by committee D.

Committee members are asked to declare any interests in the technology to be appraised. If it is considered there is a conflict of interest, the member is excluded from participating further in that appraisal.

The minutes of each appraisal committee meeting, which include the names of the members who attended and their declarations of interests, are posted on the NICE website.

NICE project team

Each technology appraisal is assigned to a team consisting of 1 or more health technology analysts (who act as technical leads for the appraisal), a technical adviser and a project manager.

Stuart Wood and Thomas Strong
Technical Leads

Fay McCracken

Technical Adviser

Kate Moore

Project Manager

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