

Pembrolizumab, PEMEtrexed and CARBOplatin (AUC 5) Therapy

INDICATIONS FOR USE:

INDICATION	ICD10	Regimen Code	Reimbursement Status
Pembrolizumab is indicated in combination with PEMEtrexed and CARBOplatin for the first-line treatment of metastatic non-squamous NSCLC in adults whose tumors have no EGFR or ALK positive mutations	C34	00568a	Pembrolizumab: ODMS 01/02/2021 PEMEtrexed: Hospital CARBOplatin: Hospital

TREATMENT:

The starting dose of the drugs detailed below may be adjusted downward by the prescribing clinician, using their independent medical judgement, to consider each patients individual clinical circumstances.

Treatment is administered every 21 days for up to 4 cycles in combination with CARBOplatin and then followed by maintenance therapy of pembrolizumab and PEMEtrexed every 21 days up or until disease progression or unacceptable toxicity develops.

Atypical responses (i.e., an initial transient increase in tumour size or small new lesions within the first few months followed by tumour shrinkage) have been observed. It is recommended to continue treatment for clinically stable patients with initial evidence of disease progression until disease progression is confirmed.

Facilities to treat anaphylaxis MUST be present when chemotherapy is administered.

Admin Order	Day	Drug	Dose	Route	Diluent & Rate	Cycle
1	1	Pembrolizumab ¹	200mg	IV infusion	100ml 0.9% NaCl over 30 mins using a low-protein binding 0.2 to 5 micrometre in-line or add-on filter.	Every 21 days
2	1	PEMEtrexed ²	500mg/m ²	IV infusion	100ml 0.9% NaCl over 10min	Every 21 days
3	1	CARBOplatin	AUC 5 ³ mg/ml/min	IV infusion	500ml glucose 5% over 30 mins	Every 21 days cycles 1-4
		Folic Acid or multivitamin containing 350-1000 micrograms folic acid	350-1000 micrograms ⁴	PO		
		Vitamin B ₁₂ (hydroxycobolamin)	1,000 micrograms ⁵	IM		

¹Pembrolizumab is diluted to a final concentration ranging from 1-10mg/ml.

²PEMEtrexed is physically incompatible with diluents containing calcium.

³Maximum dose 750mg.

⁴At least five doses of folic acid must be taken during the seven days preceding the first dose of PEMEtrexed, and dosing must continue during the full course of therapy and for 21 days after the last dose of PEMEtrexed.

⁵Must be given in the week preceding the first dose of PEMEtrexed and once every three cycles thereafter. Subsequent vitamin B₁₂ injections may be given on the same day as PEMEtrexed.

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The dose in mg of CARBOplatin to be administered is calculated as follows:

$$\text{Dose (mg)} = \text{target AUC (mg/ml x min)} \times \text{GFR ml/min} + 25$$

Reference [NCCP Regimen 00261 CARBOplatin Monotherapy](#) for information on calculation of CARBOplatin dose.

ELIGIBILITY:

- Indications as above
- Histologically or cytologically confirmed stage IV non-squamous NSCLC with no sensitizing EGFR mutations or ALK translocations
- ECOG Status 0-1
- Adequate haematological, hepatic and renal function

CAUTION:

Use with caution in patients with:

- History of serious autoimmune disease

EXCLUSIONS:

- Hypersensitivity to pembrolizumab, PEMEtrexed, CARBOplatin or any of the excipients
- Has received prior therapy with an anti-PD-1 or anti-PD-L1 antibody
- Active or unstable CNS metastases
- Creatinine clearance < 45ml/min
- Any medical condition that requires immunosuppressive doses of systemic corticosteroids or other immunosuppressive medication(s) (defined as >10mg prednisolone/daily (or steroid equivalent, excluding inhaled or topical steroids)
- History of interstitial lung disease or pneumonitis
- Any active clinically significant infection requiring therapy

PRESCRIPTIVE AUTHORITY:

The treatment plan must be initiated by a Consultant Medical Oncologist

TESTS:

Baseline tests:

- FBC, renal and liver profile
- Glucose
- Thyroid function tests
- Isotope GFR measurement (preferred) or GFR / Cr Clearance estimation
- Virology Screen: Hepatitis B (HBsAg, HbcoreAb) and Hepatitis C

Regular tests:

- FBC, renal and liver profile prior to each cycle

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- Glucose prior to each cycle
- Thyroid function tests every 3 to 6 weeks
- Ototoxicity and sensory neural damage should be clinically assessed prior to each cycle of platinum based chemotherapy

Disease monitoring:

Disease monitoring should be in line with the patient’s treatment plan and any other test/s as directed by the supervising Consultant.

DOSE MODIFICATIONS:

Pembrolizumab dose modifications:

- Dose reduction is not recommended for pembrolizumab
- Management of immune-related adverse reactions may require withholding of a dose or permanent discontinuation of pembrolizumab therapy and institution of systemic high-dose corticosteroid (See Table 5)
- Any dose modification should be discussed with a Consultant

PEMEtrexed and CARBOplatin dose modifications:

- Treatment may be delayed to allow sufficient time for recovery
- Treatment should be discontinued after 2 dose reductions if toxicity >grade 3 occurs
- Any dose modification should be discussed with a Consultant

Haematological:

Table 1: Recommended dose modification of PEMEtrexed and CARBOplatin in haematological toxicity

ANC (x10 ⁹ /L)		Platelets (x10 ⁹ /L)	Dose
≥1.5	or	≥100	100%
1-1.5	or	75-99	Consider delay until recovery
0.5-0.9	or	50-74	Delay until recovery
<0.5	or	<50	Delay treatment until recovery and consider reducing PEMEtrexed and CARBOplatin by 25% for subsequent cycles
<1.0 and fever >38°C			
Any	And	<50 with bleeding	Delay treatment until recovery and consider reducing PEMEtrexed and CARBOplatin by 50% for subsequent cycles
Consider discontinuing therapy if a patient qualifies for a third dose reduction or a cycle is delayed by more than 21 days.			
Dose reductions should be maintained for subsequent cycles.			

Renal and Hepatic Impairment:

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Table 2: Recommended dose modification in renal and hepatic impairment*

Drug	Renal Impairment		Hepatic Impairment			
Pembrolizumab	Mild/Moderate	No dose adjustment required	Mild		No dose adjustment required	
	Severe	Has not been studied	Moderate/Severe		Has not been studied	
CARBOplatin	See note below ^b		No dose reduction necessary			
PEMEtrexed	CrCl (ml/min)	Dose	Bilirubin		Aminotransferases	
	≥45	100%	>1.5 x ULN	and/or	> 3 x ULN (hepatic metastases absent)	Not recommended
				or	> 5 x ULN (presence of hepatic metastases)	
<45	Not recommended	Clinical decision				

*See Table 3 for management of pembrolizumab in treatment related hepatitis and Table 5 for management of PEMEtrexed and CARBOplatin in treatment-related hepatotoxicity

^bRenal dysfunction and CARBOplatin:

- Patients with creatinine clearance values of < 60ml/min are at greater risk of developing myelosuppression.
- If GFR between 20 to ≤ 30ml/min, CARBOplatin should be administered with extreme caution.
- In case of GFR ≤ 20ml/min CARBOplatin should not be administered at all.
- If Cockcroft & Gault or Wright formulas are used, the dose should be calculated as required per cycle based on a serum creatinine obtained within 48 hrs of drug administration.
- If isotope GFR is used, the dose should remain the same provided the serum creatinine is ≤110% of its value at the time of the isotope measurement. If the serum creatinine is higher than this, consideration should be given to remeasuring the GFR or to estimating it using Cockcroft & Gault or Wright formulae.

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Management of immune-related adverse events:

Table 3: Recommended treatment modifications for pembrolizumab

Immune-related adverse reactions	Severity (NCI-CTCAE v.4 grading)	Treatment modification
Pneumonitis	Grade 2	Withhold*
	Grade 3 or 4, or recurrent Grade 2	Permanently discontinue
Colitis	Grade 2 or 3	Withhold*
	Grade 4 or recurrent Grade 3	Permanently discontinue
Nephritis	Grade 2 with creatinine > 1.5 to ≤ 3 times upper limit of normal (ULN)	Withhold*
	Grade ≥ 3 with creatinine > 3 times ULN	Permanently discontinue
Endocrinopathies	Symptomatic hypophysitis	Withhold*
	Type 1 diabetes associated with Grade ≥ 3 hyperglycaemia (glucose > 250 mg/dL or > 13.9 mmol/L) or associated with ketoacidosis Hyperthyroidism Grade ≥ 3	For patients with Grade 3 or Grade 4 endocrinopathy that improved to Grade 2 or lower and is controlled with hormone replacement, if indicated, continuation of pembrolizumab may be considered after corticosteroid taper, if needed. Otherwise treatment should be discontinued.
Hypothyroidism	Hypothyroidism	Hypothyroidism may be managed with replacement therapy without treatment interruption.
Hepatitis	Grade 2 with aspartate aminotransferase (AST) or alanine aminotransferase (ALT) > 3 to 5 times ULN or total bilirubin > 1.5 to 3 times ULN	Withhold*
	Grade ≥ 3 with AST or ALT > 5 times ULN or total bilirubin > 3 times ULN	Permanently discontinue
	In case of liver metastasis with baseline Grade 2 elevation of AST or ALT, hepatitis with AST or ALT increases ≥ 50% and lasts ≥ 1 week	
Skin reactions	Grade 3 or suspected Stevens-Johnson syndrome (SJS) or toxic epidermal necrolysis (TEN)	Withhold*
	Grade 4 or confirmed SJS or TEN	Permanently discontinue
Other immune-related adverse reactions**	Based on severity and type of reaction (grade 2 or Grade 3)	Withhold*
	Grade 3 or 4 myocarditis	Permanently discontinue
	Grade 3 or 4 encephalitis	
	Grade 3 or 4 Guillain-Barre syndrome Grade 4 or recurrent Grade 3	
Infusion-related reactions	Grade 3 or 4	Permanently discontinue

* until adverse reactions recover to Grade 0-1. If treatment related toxicity does not resolve to Grade 0-1 within 12 weeks after last dose of pembrolizumab or if corticosteroid dosing cannot be reduced to ≤ 10mg prednisone or equivalent per day within 12 weeks, pembrolizumab should be permanently discontinued

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**Pembrolizumab should be permanently discontinued for Grade 4 or recurrent Grade 3 immune-related adverse reactions, unless otherwise specified in Table 3.

Management of adverse events:

Table 4: Recommended dose modification of PEMEtrexed and CARBOplatin for Adverse Events

Adverse reactions*	Recommended dose modification
Diarrhoea Grade ≥ 3	Withhold treatment until resolution to less than or equal to patient's pre-therapy value Resume at 75% of previous dose for PEMEtrexed and at 100% of previous dose for CARBOplatin
Mucositis Grade ≥3	Withhold treatment until resolution to less than or equal to patient's pre-therapy value Resume at 50% of previous dose for PEMEtrexed and at 100% of previous dose for CARBOplatin
Neurotoxicity Grade ≥3	Withhold treatment until resolution to less than or equal to patient's pre-therapy value Resume at resume at 75% of previous dose PEMEtrexed and CARBOplatin
Other Grade ≥3	Withhold treatment until resolution to less than or equal to patient's pre-therapy value Resume at resume at 75% of previous dose PEMEtrexed and CARBOplatin
Grade ≥3 toxicity after 2 dose reductions	Discontinue treatment

*CTCAE V4;

Treatment related hepatotoxicity

Table 5: Recommended dose modification for PEMEtrexed and CARBOplatin for treatment related hepatotoxicity

Bilirubin		ALT, AST	Dose Modification
> 3.0 x	or	> 5 x ULN	Withhold treatment until resolution to less than or equal to patient's pre-therapy value Resume at 75% of previous dose for both PEMEtrexed and CARBOplatin
>10 x ULN	or	>20 x ULN	Discontinue

SUPPORTIVE CARE:

EMETOGENIC POTENTIAL:

Pembrolizumab: Minimal (**Refer to local policy**)
 PEMEtrexed: Low (**Refer to local policy**)
 CARBOplatin: High (**Refer to local policy**)

PREMEDICATIONS:

- PEMEtrexed should be pre-medicated with corticosteroid the day prior to, on the day of, and the day after PEMEtrexed administration. The corticosteroid should be equivalent to 4 mg of dexamethasone administered orally twice a day.

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- Intramuscular injection of vitamin B₁₂ (hydroxycobolamin) (1,000 micrograms) in the week preceding the first dose of PEMEtrexed and once every three cycles thereafter. Subsequent vitamin B₁₂ injections may be given on the same day as PEMEtrexed.
- At least five doses of folic acid must be given during the seven days preceding the first dose of PEMEtrexed, and dosing must continue during the full course of therapy and for 21 days after the last dose of PEMEtrexed.

OTHER SUPPORTIVE CARE: None usually required

ADVERSE EFFECTS / REGIMEN SPECIFIC COMPLICATIONS

The adverse effects listed are not exhaustive. Please refer to the relevant Summary of Product Characteristics for full details.

Pembrolizumab

- In view of the serious and potentially life-threatening side effects of pembrolizumab, it is mandatory that patients be carefully assessed prior to commencing on treatment. Efficacy and safety data from patients ≥ 75 years are limited. For patients ≥ 75 years, pembrolizumab combination therapy should be used with caution after careful consideration of the potential benefit/risk on an individual basis. Patients have to be monitored regularly for hepatic, pulmonary, gastrointestinal toxicity and for endocrinopathies while on treatment.
- **Immune-related adverse reactions:** Most immune-related adverse reactions occurring during treatment with pembrolizumab were reversible and managed with interruptions of pembrolizumab, administration of corticosteroids and/or supportive care. Immune-related adverse reactions have also occurred after the last dose of pembrolizumab. Immune-related adverse reactions affecting more than one body system can occur simultaneously. For suspected immune-related adverse reactions, adequate evaluation to confirm aetiology or exclude other causes should be ensured. Based on the severity of the adverse reaction, pembrolizumab should be withheld and corticosteroids administered. Upon improvement to Grade ≤ 1 , corticosteroid taper should be initiated and continued over at least 1 month. Based on limited data from clinical studies in patients whose immune-related adverse reactions could not be controlled with corticosteroid use, administration of other systemic immunosuppressants can be considered. Pembrolizumab may be restarted within 12 weeks after last dose of pembrolizumab if the adverse reaction remains at Grade ≤ 1 and corticosteroid dose has been reduced to ≤ 10 mg prednisone or equivalent per day. Pembrolizumab must be permanently discontinued for any Grade 3 immune-related adverse reaction that recurs and for any Grade 4 immune-related adverse reaction toxicity, except for endocrinopathies that are controlled with replacement hormones.
- **Immune-related pneumonitis:** Patients should be monitored for signs and symptoms of pneumonitis. Suspected pneumonitis should be confirmed with radiographic imaging and other causes excluded. Corticosteroids should be administered for Grade ≥ 2 events (initial dose of 1-2 mg/kg/day prednisone or equivalent followed by a taper); pembrolizumab should be withheld for Grade 2 pneumonitis, and permanently discontinued for Grade 3, Grade 4 or recurrent Grade 2 pneumonitis.
- **Immune-related colitis:** Colitis has been reported in patients receiving pembrolizumab. Patients should be monitored for signs and symptoms of colitis, and other causes excluded. Corticosteroids should be administered for Grade ≥ 2 events (initial dose of 1-2 mg/kg/day prednisone or equivalent followed by a taper); pembrolizumab should be withheld for Grade 2 or Grade 3 colitis, and

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permanently discontinued for Grade 4 colitis. The potential risk of gastrointestinal perforation should be taken into consideration.

- **Immune-related hepatitis:** Hepatitis has been reported in patients receiving pembrolizumab. Patients should be monitored for changes in liver function (at the start of treatment, periodically during treatment and as indicated based on clinical evaluation) and symptoms of hepatitis, and other causes excluded. Corticosteroids should be administered (initial dose of 0.5-1 mg/kg/day (for Grade 2 events) and 1-2 mg/kg/day (for Grade \geq 3 events) prednisone or equivalent followed by a taper) and, based on severity of liver enzyme elevations, pembrolizumab should be withheld or discontinued.
- **Immune-related nephritis:** Nephritis has been reported in patients receiving pembrolizumab. Patients should be monitored for changes in renal function, and other causes of renal dysfunction excluded. Corticosteroids should be administered for Grade \geq 2 events (initial dose of 1-2 mg/kg/day prednisone or equivalent followed by a taper) and, based on severity of creatinine elevations, pembrolizumab should be withheld for Grade 2, and permanently discontinued for Grade 3 or Grade 4 nephritis.
- **Immune-related endocrinopathies:** Severe endocrinopathies, including hypophysitis, type 1 diabetes mellitus, diabetic ketoacidosis, hypothyroidism, and hyperthyroidism have been observed with pembrolizumab treatment. Long-term hormone replacement therapy may be necessary in cases of immune-related endocrinopathies.

Hypophysitis has been reported in patients receiving pembrolizumab. Patients should be monitored for signs and symptoms of hypophysitis (including hypopituitarism and secondary adrenal insufficiency) and other causes excluded. Corticosteroids to treat secondary adrenal insufficiency and other hormone replacement should be administered as clinically indicated, and pembrolizumab should be withheld for symptomatic hypophysitis until the event is controlled with hormone replacement. Continuation of pembrolizumab may be considered, after corticosteroid taper, if needed. Pituitary function and hormone levels should be monitored to ensure appropriate hormone replacement.

Type 1 diabetes mellitus, including diabetic ketoacidosis, has been reported in patients receiving pembrolizumab. Patients should be monitored for hyperglycaemia or other signs and symptoms of diabetes. Insulin should be administered for type 1 diabetes, and pembrolizumab should be withheld in cases of Grade 3 hyperglycaemia until metabolic control is achieved. Thyroid disorders, including hypothyroidism, hyperthyroidism and thyroiditis, have been reported in patients receiving pembrolizumab and can occur at any time during treatment; therefore, patients should be monitored for changes in thyroid function (at the start of treatment, periodically during treatment and as indicated based on clinical evaluation) and clinical signs and symptoms of thyroid disorders. Hypothyroidism may be managed with replacement therapy without treatment interruption and without corticosteroids. Hyperthyroidism may be managed symptomatically. Pembrolizumab should be withheld for Grade \geq 3 until recovery to Grade \leq 1 hyperthyroidism. For patients with Grade 3 or Grade 4 hyperthyroidism that improved to Grade 2 or lower, continuation of pembrolizumab may be considered, after corticosteroid taper, if needed. Thyroid function and hormone levels should be monitored to ensure appropriate hormone replacement.

- **Immune-related skin adverse reactions:** Immune-related severe skin reactions have been reported in patients receiving pembrolizumab. Patients should be monitored for suspected severe skin reactions and other causes should be excluded. Based on the severity of the adverse reaction, pembrolizumab should be withheld or permanently discontinued, and corticosteroids should be administered. Cases of Stevens-Johnson syndrome (SJS) and toxic epidermal necrolysis (TEN), some with fatal outcome, have been reported in patients receiving pembrolizumab). For signs or symptoms of SJS or TEN,

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pembrolizumab should be withheld and the patient should be referred to a specialised unit for assessment and treatment. If SJS or TEN is confirmed, pembrolizumab should be permanently discontinued. Caution should be used when considering the use of pembrolizumab in a patient who has previously experienced a severe or life-threatening skin adverse reaction on prior treatment with other immune stimulatory anticancer agents.

- **Other immune-related adverse reactions:** The following additional clinically significant, immune-related adverse reactions have been reported in patients receiving pembrolizumab: uveitis, arthritis, myositis, pancreatitis, Guillain-Barré syndrome, myasthenic syndrome, haemolytic anaemia, sarcoidosis and encephalitis. Based on the severity of the adverse reaction, pembrolizumab should be withheld and corticosteroids administered. Pembrolizumab may be restarted within 12 weeks after last dose of pembrolizumab if the adverse reaction remains at Grade ≤ 1 and corticosteroid dose has been reduced to ≤ 10 mg prednisone or equivalent per day.
- **Pembrolizumab must be permanently discontinued for any Grade 3 immune related adverse reaction that recurs and for any Grade 4 immune related adverse reaction toxicity.**
- **Infusion-related reactions:** Severe infusion-related reactions have been reported in patients receiving pembrolizumab. For severe infusion reactions, infusion should be stopped and pembrolizumab permanently discontinued. Patients with mild or moderate infusion reaction may continue to receive pembrolizumab with close monitoring; premedication with antipyretic and antihistamine may be considered.

PEMEtrexed

- **Myelosuppression:** Usually the dose limiting toxicity with PEMEtrexed. PEMEtrexed should not be given to patients until absolute neutrophil count (ANC) returns to $1.5 \times 10^9/L$ and platelet count returns to $100 \times 10^9 /L$. Dose reductions for subsequent cycles are based on nadir ANC, platelet count and maximum non-haematologic toxicity seen from the previous cycle.
- **Skin reactions:** Pre-treatment with dexamethasone (or equivalent) can reduce the incidence and severity of skin reactions.
- **Cardiotoxicity:** Serious cardiovascular events including MI and cerebrovascular events have been uncommonly reported usually when PEMEtrexed is given in combination with another cytotoxic agent. Most of the patients in whom these events have been observed had pre-existing cardiovascular risk factors.

CARBOplatin

- **Hypersensitivity:** Reactions to CARBOplatin may develop in patients who have been previously exposed to platinum therapy. However allergic reactions have been observed upon initial exposure to CARBOplatin.
- **Neurotoxicity and ototoxicity:** Ototoxicity and sensory neural damage should be assessed by history prior to each cycle.

DRUG INTERACTIONS:

- The use of systemic corticosteroids or immunosuppressants before starting pembrolizumab should be avoided because of their potential interference with the pharmacodynamics activity and efficacy of pembrolizumab. However, systemic corticosteroids or other immunosuppressants can be used after starting pembrolizumab to treat immune-related adverse reactions.
- Current drug interaction databases should be consulted for more information In patients with normal

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renal function (CrCl > 80 ml/min), high doses of non-steroidal anti-inflammatory drugs (NSAIDs, such as ibuprofen > 1600 mg/day) and aspirin at higher dose (> 1.3 g daily) may decrease PEMEtrexed elimination and, consequently, increase the occurrence of PEMEtrexed adverse events.

- The concomitant administration of PEMEtrexed with NSAIDs or aspirin at higher dose should be avoided for 2 days before, on the day of, and 2 days following PEMEtrexed administration on patients with mild to moderate renal insufficiency (CrCl from 45 to 79 ml/min).
- In patients with mild to moderate renal insufficiency eligible for PEMEtrexed therapy, NSAIDs with long elimination half-lives should be interrupted for at least 5 days prior to, on the day of, and at least 2 days following PEMEtrexed administration.
- Nephrotoxic drugs (e.g. loop diuretics and aminoglycosides) may decrease the clearance of PEMEtrexed.
- Avoid concurrent use of CARBOplatin with nephrotoxic drugs (e.g. aminoglycosides, furosemide, NSAIDs) due to additive nephrotoxicity. If necessary monitor renal function closely.
- Avoid concurrent use of CARBOplatin with ototoxic drugs (e.g. aminoglycosides, furosemide, NSAIDs). When necessary perform regular audiometric testing.
- Current drug interaction databases should be consulted for more information.

COMPANY SUPPORT RESOURCES/Useful Links:

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Patient Guide

<https://www.hpra.ie/img/uploaded/swedocuments/196f9071-00a4-4498-9dcb-e29ef7b35e55.pdf>

Patient Alert Card

<https://www.hpra.ie/img/uploaded/swedocuments/c0984994-f8e8-4b10-95dd-7be12ff6c6f9.pdf>

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Version	Date	Amendment	Approved By
1	22/11/2019		Dr Dearbhaile Collins
2	02/03/2020	Inclusion of information regarding CARBOplatin dose calculation	Dr Dearbhaile Collins
3	01/02/2021	Updated reimbursement status	Dr Dearbhaile Collins

NCCP Regimen: Pembrolizumab, PEMEtrexed and CARBOplatin (AUC 5) Therapy	Published: 22/11/2019 Review: 19/12/2027	Version number: 4
Tumour Group: Lung NCCP Regimen Code: 00568	ISMO Contributor: Dr Dearbhaile Collins, Prof. Maccon Keane	Page 10 of 11
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4	04/07/2022	Amended standard wording for CARBOplatin dosing. Updated management of immune-related adverse events (Table 3).	Prof. Maccon Keane
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Comments and feedback welcome at oncologydrugs@cancercontrol.ie.

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