

DRUG NAME: Nivolumab

SYNONYM(S):

COMMON TRADE NAME(S): OPDIVO®

CLASSIFICATION: immunotherapy

Special pediatric considerations are noted when applicable, otherwise adult provisions apply.

MECHANISM OF ACTION:

Nivolumab is a fully human IgG4 monoclonal antibody known as a programmed cell death 1 (PD-1) immune checkpoint inhibitor. The PD-1 pathway is an immune system checkpoint that may be exploited by tumour cells to escape active T-cell surveillance. By blocking the binding of the PD-1 receptor to the PD-1 and PD-2 ligands, nivolumab reactivates tumour-specific cytotoxic T-lymphocytes in the tumour microenvironment and restimulates anti-tumour immunity.^{1,2}

PHARMACOKINETICS:

Distribution	tissue penetration or distribution is not known	
	cross blood brain barrier?	no information found
	volume of distribution ³	8L
	plasma protein binding	no information found
Metabolism	not defined; expected to be degraded into small peptides and amino acids via catabolic pathways similar to endogenous IgG	
	active metabolite(s)	no information found
	inactive metabolite(s)	no information found
Excretion	linear pharmacokinetics in the dose range of 0.1-20 mg/kg	
	urine	no information found
	feces	no information found
	terminal half life	26.7 days
	clearance	8.66 mL/h

Adapted from standard reference¹ unless specified otherwise.

USES:

Primary uses:

- *Melanoma
- *Lung cancer, non-small cell
- *Renal cell cancer
- *Head and neck cancer
- *Lymphoma, Hodgkin's
- *Liver cancer
- *Health Canada approved indication

Other uses:

SPECIAL PRECAUTIONS:

Caution:

- product contains 2.3 mg/mL **sodium** (0.1 mmol/mL); consider sodium content as needed for patients on a controlled sodium diet¹
- avoid systemic **corticosteroids** or **immunosuppressants** prior to starting nivolumab due to potential interference with the efficacy of nivolumab; corticosteroids or immunosuppressants may be used during treatment with nivolumab in the management of immune-mediated adverse reactions¹

Carcinogenicity: no information found

Mutagenicity: no information found

Fertility: In animal studies, no histopathologic changes were detected during routine examination of male and female reproductive organs; however most tested animals were not sexually mature.¹

Pregnancy: Nivolumab has not been studied in pregnant women. Endogenous IgG4 is known to cross the placental barrier, particularly during the third trimester; therefore, as a human IgG4 antibody, nivolumab is expected to be transmitted from mother to fetus. Based on its mechanism of action, fetal exposure to nivolumab may increase the risk of developing immune-mediated disorders or altering the normal immune response. In animal reproductive studies, maternal nivolumab administration was associated with increases in third trimester fetal loss and increased neonatal mortality. Women of reproductive potential should use effective contraception while on nivolumab and for at least 5 months after treatment has been discontinued.^{1,3,4}

Breastfeeding is not recommended due to potential secretion of nivolumab into breast milk. Human IgG is known to be secreted into breast milk; therefore as a human IgG4 antibody, nivolumab is expected to do likewise.^{1,3}

SIDE EFFECTS:

The table includes adverse events that presented during drug treatment but may not necessarily have a causal relationship with the drug. Because clinical trials are conducted under very specific conditions, the adverse event rates observed may not reflect the rates observed in clinical practice. Adverse events are generally included if they were reported in more than 1% of patients in the product monograph or pivotal trials, and/or determined to be clinically important.⁵

ORGAN SITE	SIDE EFFECT
Clinically important side effects are in bold, italics	
blood and lymphatic system/ febrile neutropenia	anemia (28-37%, severe 2-3%) ^{1,3}
	leukopenia (11%, severe 1%)
	lymphopenia (29-48%, severe 6-16%) ^{1,3}
	neutropenia (15%, severe 1%)
	thrombocytopenia (11-14%, severe 1%) ^{1,3}
endocrine (see paragraph following Side Effects table)	hyperthyroidism (1-3%, severe 1%) ^{1,3}
	hypophysitis (<1%)
	hypopituitarism (2%)
	hypothyroidism (4-6%)
eye	uveitis (<1%)
gastrointestinal (see paragraph following Side Effects table)	emetogenic potential: low ⁶
	abdominal pain (4-16%, severe 2%) ^{1,3}
	colitis (17-21%, severe 2%) ^{1,3}
	constipation (4-24%) ^{1,3}

ORGAN SITE	SIDE EFFECT
Clinically important side effects are in bold, italics	
	diarrhea (8-21%, severe 1-3%) ^{1,3}
	nausea (11-29%, severe 2%) ^{1,3}
	stomatitis (3%)
	vomiting (5-19%, severe 1%) ^{1,3}
general disorders and administration site conditions	extravasation hazard: none ⁷
	non-cardiac chest pain (13%) ³
	edema (3-17%, severe 1-2%) ^{1,3}
	fatigue (26-50%, severe 7%) ^{1,3}
	pyrexia (3-17%) ^{1,3}
immune system (see paragraph following Side Effects table)	dermatologic (1%)
	endocrinopathy (1-8%) ^{1,8}
	gastrointestinal (18-21%) ⁸
	hepatitis (1%) ^{4,8}
	infusion related reaction (2-4%); see paragraph following Side Effects table
	nephritis, renal failure (1-2%) ^{1,8}
	pulmonary (1-4%) ^{1,8}
infections and infestations	bronchitis (9%) ³
	pneumonia (10%, severe 5%) ³
	upper respiratory tract infection (2-11%) ^{1,3,9}
investigations (see paragraph following Side Effects table)	alkaline phosphatase increase (14-26%, severe 1-3%) ^{1,3}
	ALT increase (12-25%, severe 2-3%) ^{1,3}
	AST increase (16-27%, severe 1-4%) ^{1,3}
	total bilirubin increase (3-13%, severe 3%) ^{1,3}
	creatinine increase (10-22%, severe 1%) ^{1,3}
	weight loss(13%)
metabolism and nutrition	appetite, decreased (5-35%, severe 3%) ^{1,3}
	hypercalcemia (12%, severe 1%)
	hyperglycemia (2%, severe 1%); see paragraph following Side Effects table
	hyperkalemia (23%, severe 2%)
	hypocalcemia (20%)
	hypokalemia (15%, severe 1%)
	hypomagnesmia (21%, severe 1%)
	hyponatremia (35%, 7%)
musculoskeletal and connective tissue	arthralgia (6-13%)
	musculoskeletal pain (6-36%, severe 1-6%) ^{1,3}
	weakness (19%, severe 2%)
nervous system	headache (1-4%)
	peripheral neuropathy (3-9%)
renal and urinary	renal failure (2%, severe 1%); see paragraph following Side Effects table
respiratory, thoracic and mediastinal	cough (3-32%, severe 2%) ^{1,3}
	dyspnea (2-38%, severe 9%) ^{1,3}
	pneumonitis, or interstitial lung disease (2-6%) ^{1,3} ; sometimes fatal ⁴ ; see paragraph following Side Effects table

ORGAN SITE	SIDE EFFECT
Clinically important side effects are in bold, italics	
skin and subcutaneous tissue	alopecia (3%)
	dry skin (4%)
	erythema (6%)
	pruritus (7-17%, severe <1%)
	rash (11-21%, severe 1%) ^{1,3}
	urticaria (1%)
	vitiligo (11%)

Adapted from standard reference¹ unless specified otherwise.

Immune-mediated adverse events are a spectrum of side effects that arise from general immunologic enhancement caused by nivolumab. Adverse events can occur any time during treatment or months after discontinuation of therapy. Early identification of adverse events and prompt intervention is crucial for the safe use of nivolumab. Although symptoms may be nonspecific, if not recognized and treated early, they can be severe or fatal.

Endocrinopathies, diarrhea/colitis, liver enzyme test elevations, nephritis, pneumonitis, and rash should be considered immune-mediated until another etiology can be confirmed. Strongly advise patients to report any symptoms promptly and to avoid self-treatment without medical advice. Based on the severity of the reaction, symptom management may include temporarily withholding nivolumab and/or administration of corticosteroids, with or without additional immunosuppressive medication. Permanent discontinuation of nivolumab should be considered for life threatening or recurrent serious adverse events. When prolonged corticosteroid treatment is necessary for management of side effects, corticosteroids should be tapered over at least one month following resolution of symptoms to grade 1 or less, as rapid tapering may lead to relapse or worsening of the symptoms. Antibiotic prophylaxis may be necessary to prevent opportunistic infections (e.g., oral trimethoprim/sulfamethoxazole for the prevention of *Pneumocystis jiroveci* pneumonia). Referral to appropriate medical specialty may be indicated for the management of complications related to treatment. Restarting nivolumab may be considered depending on the grade of the initial immune mediated adverse event, but only following completion of the corticosteroid taper.^{1,10} For further information on management of immune-mediated adverse reactions, see BC Cancer Protocol SCIMMUNE [Management of Immune-Mediated Adverse Reactions to Checkpoint Inhibitors Immunotherapy](#).

Reported immune-mediated **endocrinopathies** have included **hypothyroidism, hyperthyroidism, hypopituitarism, hypophysitis, diabetes mellitus, diabetic ketoacidosis, and adrenal insufficiency**. The median time to onset is 12 weeks (range: 5-34 weeks).¹ Patients may present with fatigue, weight change, headache, mood or behavior changes, forgetfulness, decreased sex drive, voice deepening, or constipation. Perform blood glucose levels and thyroid function tests at baseline and periodically during therapy. For symptomatic endocrinopathy, withhold nivolumab, initiate appropriate hormone therapy and if symptoms are severe, appropriate steroid therapy. Upon improvement, nivolumab may be resumed following completion of corticosteroid taper.^{1,3,4,8}

Gastrointestinal adverse immune reactions such as **diarrhea** and/or **colitis** are commonly reported, and in some cases have been fatal. The median time to onset is 1 to 5 months (range: 2 days to 19 months).³ Rule out other etiologies such as infectious or disease-related etiologies. For grade 2 and 3 diarrhea and/or colitis, withhold nivolumab and initiate appropriate corticosteroid therapy. Nivolumab may be restarted following completion of corticosteroid taper. In the case of grade 4 symptoms, permanently discontinue nivolumab and initiate corticosteroid regimen.^{1,3,4,8}

Immune-mediated **hepatitis** manifests as **elevated transaminases**. The median time to onset is 14 weeks (range: 2 weeks to 8 months).^{1,3} Observe patients for signs and symptoms of hepatotoxicity. Monitor liver function tests including AST, ALT, alkaline phosphatase, and total bilirubin at baseline and during therapy. Infectious or disease related etiologies should be ruled out following reports of elevated enzymes. For grade 2 elevations in AST/ALT or total bilirubin, withhold nivolumab until lab values return to grade 1 or baseline and the prescribed corticosteroid regimen, including taper, is complete. Permanently discontinue nivolumab for grade 3 or 4 elevations in AST/ALT or total bilirubin.^{1,3}

Significant immune-mediated **pneumonitis** or **interstitial lung disease**, including fatal cases, have occurred during and after nivolumab treatment. The median time to onset is 12 weeks (range: 9-22 weeks).¹ Patients may present with new or worsening cough, chest pain, and/or shortness of breath. For grade 2 pneumonitis, withhold nivolumab, and initiate corticosteroid therapy. Upon improvement, nivolumab may be resumed following corticosteroid taper. Permanently discontinue nivolumab if there is no improvement or a worsening of symptoms following corticosteroid treatment or if the patient presents with a grade 3 or 4 pneumonitis.^{1,3,8}

Immune-mediated **renal** adverse events include **increased creatinine**, or **nephritis**, and **renal failure**. The median time to onset can range from 1 week to 12 months after starting nivolumab.³ Monitor patients for edema, hematuria, and decreased urine output and monitor serum creatinine periodically during treatment as indicated. With grade 2 creatinine elevation, withhold nivolumab and initiate corticosteroids, followed by a steroid taper after resolution of symptoms. If toxicity worsens/does not improve or the patient presents with grade 3 or 4 elevations of serum creatinine, permanently discontinue nivolumab.^{1,8}

Other less common but clinically significant immune-mediated toxicities have been reported, even after discontinuation of the drug. These toxicities include **Guillain-Barré syndrome**, **autoimmune neuropathy**, **demyelination**, **encephalitis**, **pancreatitis**, **vasculitis**, **myasthenic syndrome**, and **uveitis**. For suspected immune-mediated adverse events, confirm etiology and exclude other causes. Based on the severity of the reaction, withhold nivolumab and administer corticosteroids. Nivolumab may be restarted after a corticosteroid taper. Permanently discontinue nivolumab for any severe immune adverse reaction that recurs or is life threatening.^{1,3,4}

Severe **infusion reactions** have been rarely reported. Patients with mild or moderate infusion reactions may receive nivolumab with close monitoring and premedication in accordance with local infusion reaction prophylaxis guidelines. For management of hypersensitivity reactions, see BC Cancer Protocol SCDRUGRX [Management of Hypersensitivity Reactions to Chemotherapeutic Agents](#). Permanently discontinue nivolumab following a grade 3 or 4 infusion reaction.¹

INTERACTIONS: none known¹

SUPPLY AND STORAGE:

Injection: Bristol-Myers Squibb Canada supplies nivolumab as 40 mg and 100 mg ready-to-use, single use (preservative-free) vials in a concentration of 10 mg/mL. Refrigerate. Protect from light. Do not shake. Product contains 2.3 mg/mL sodium (0.1 mmol/mL).¹

For basic information on the current brand used at BC Cancer, see [Chemotherapy Preparation and Stability Chart](#) in Appendix.

SOLUTION PREPARATION AND COMPATIBILITY:

For basic information on the current brand used at BC Cancer, see [Chemotherapy Preparation and Stability Chart](#) in Appendix.

Additional information:

- can be administered undiluted or diluted with NS or D5W¹
- maximum infusion volumes may apply to some fixed dose regimens and are intended to prevent exceeding compendial endotoxin limits¹¹⁻¹³ of 5.0 EU/kg; however, endotoxin exposure limits will not be exceeded at BC Cancer when preparing nivolumab in infusion bags of 50-100 mL following weight-based dosing for standard BC Cancer protocols (final bag concentration between 1-10 mg/mL)

Compatibility: consult detailed reference

PARENTERAL ADMINISTRATION:

BC Cancer administration guideline noted in **bold, italics**

Subcutaneous	no information found
Intramuscular	no information found
Direct intravenous ¹⁴	do NOT use
<i>Intermittent infusion</i> ¹⁵⁻²⁴	• <i>over 30-60 minutes</i> ; administer with a low protein binding in-line filter (0.2-1.2 micron) ¹
Continuous infusion	no information found
Intraperitoneal	no information found
Intrapleural	no information found
Intrathecal	no information found
Intra-arterial	no information found
Intravesical	no information found

DOSAGE GUIDELINES:

Refer to protocol by which patient is being treated. Numerous dosing schedules exist and depend on disease, response, and concomitant therapy.

Adults:

BC Cancer usual dose noted in **bold, italics**

<i>Intravenous:</i>	Cycle Length:	
	<i>2 weeks</i> ^{15,17,19,21,23}	<i>3 mg/kg IV for one dose on day 1</i> (total dose per cycle 3 mg/kg)
	3 weeks ^{25,26}	1 mg/kg IV for one dose on day 1 (total dose per cycle 1 mg/kg)
	<i>2 weeks</i> ^{15,17,19,21,23,27}	<i>240 mg IV for one dose on day 1</i> (total dose per cycle 240 mg)
	<i>4 weeks</i> ^{15,18,20,22,24,28}	<i>480 mg IV for one dose on day 1</i> (total dose per cycle 480 mg)
	<i>4 weeks</i> ^{18,20,22,24,27,28}	<i>6 mg/kg IV for one dose on day 1</i> (total dose per cycle 6 mg/kg)
<i>Concurrent radiation:</i>	no information found	
<i>Dosage in myelosuppression:</i>	modify according to protocol by which patient is being treated	
<i>Dosage in renal failure:</i>	<ul style="list-style-type: none"> • mild to moderate impairment: no dose adjustment required¹ • severe renal dysfunction: no information found 	

BC Cancer usual dose noted in ***bold, italics***

	Cycle Length:	
<i>Dosage in hepatic failure:</i>		<ul style="list-style-type: none"> • total bilirubin 1-1.5 X ULN or AST >ULN: no dose adjustment required^{1,14} • total bilirubin >1.5 X ULN and any AST: no information found
<i>Dosage in dialysis:</i>		no information found
<u>Children:</u>		no information found

REFERENCES:

1. Bristol-Myers Squibb Canada. OPDIVO® product monograph. Montreal, Quebec; 24 September 2015.
2. Rounds A, Kolesar J. Nivolumab for second-line treatment of metastatic squamous non-small-cell lung cancer. *Am J Health Syst Pharm* 2015;72(21):1851-1855.
3. Lexi-Drugs® (database on the Internet). Nivolumab. Lexi-Comp Inc., 8 January 2016. Available at: <http://online.lexi.com>. Accessed 12 January 2016.
4. AHFS Drug Information® (database on the Internet). Nivolumab. Lexi-Comp Inc., 13 October 2015. Available at: <http://online.lexi.com>. Accessed 12 January 2016.
5. Kerry Savage MD. BC Cancer Agency Melanoma Tumour Group. Personal communication. 21 March 2016.
6. BC Cancer Agency. (SCNAUSEA) Guidelines for Prevention and Treatment of Chemotherapy-induced Nausea and Vomiting in Adults. Vancouver, British Columbia: BC Cancer Agency; 1 Mar 2012.
7. BC Cancer Agency Provincial Systemic Therapy Program. Provincial Systemic Therapy Program Policy III-20: Prevention and Management of Extravasation of Chemotherapy. Vancouver, British Columbia: BC Cancer Agency; 1 November 2014.
8. Bristol-Myers Squibb Company. OPDIVO® Immune-Mediated Adverse Reactions Management Guide. Princeton, NJ, USA; March 2015.
9. Bristol-Myers Squibb Company. OPDIVO® full prescribing information. Princeton, NJ, USA; March 2015.
10. Postow M, Wolchok J. Toxicities associated with checkpoint inhibitor immunotherapy. In: 2015 UpToDate®; Ross, Michael E. (Ed); Waltham, Massachusetts: UpToDate®; Available at www.uptodate.com; updated 6Jan2016; accessed 26Jan2016.
11. Bristol-Myers Squibb Canada. Personal communication: Rational of maximum volume with fixed-dose nivolumab administration. undated; received 4Oct2018.
12. The United States Pharmacopeia (USP). General Chapter 85: Bacterial Endotoxins Test. Rockville, Maryland: The United States Pharmacopeial Convention, Inc.; 2012. p. 1-5.
13. Bristol-Myers Squibb Canada. OPDIVO® product monograph. Montreal, Quebec; 16 July 2018.
14. Bristol-Myers Squibb Pharmaceutical Limited. OPDIVO® summary of product characteristics. Uxbridge, Middlesex, UK; 22 June 2015.
15. Bristol-Myers Squibb Canada. OPDIVO® product monograph. Montreal, Quebec; 24 May 2018.
16. Waterhouse D, Horn L, Reynolds C, et al. Safety profile of nivolumab administered as 30-min infusion: analysis of data from CheckMate 153. *Cancer Chemother Pharmacol* 2018;81(4):679-686.
17. BC Cancer Agency Genitourinary Tumour Group. (UGUAVNIV) BCCA Protocol Summary for Treatment of Metastatic or Advanced Renal Cell Carcinoma Using Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
18. BC Cancer Agency Genitourinary Tumour Group. (UGUAVNIV4) BCCA Protocol Summary for Treatment of Metastatic or Advanced Renal Cell Carcinoma Using 4-Weekly Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
19. BC Cancer Agency Head and Neck Tumour Group. (UHNANIV) BCCA Protocol Summary for Palliative Therapy for Unresectable, Platinum-refractory, Recurrent or Metastatic Squamous Cell Cancer of the Head and Neck Using Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
20. BC Cancer Agency Head and Neck Tumour Group. (UHNANIV4) BCCA Protocol Summary for Palliative Therapy for Unresectable, Platinum-refractory, Recurrent or Metastatic Squamous Cell Cancer of the Head and Neck Using 4-Weekly Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
21. BC Cancer Agency Lung Tumour Group. (ULUAVNIV) BCCA Protocol Summary for Treatment of Advanced NonSmall Cell Lung Cancer Using Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
22. BC Cancer Agency Lung Tumour Group. (ULUAVNIV4) BCCA Protocol Summary for Treatment of Advanced NonSmall Cell Lung Cancer Using 4-weekly Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
23. BC Cancer Agency Skin and Melanoma Tumour Group. (USMAVNIV) BCCA Protocol Summary for the Treatment of Unresectable or Metastatic Melanoma Using Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.
24. BC Cancer Agency Skin and Melanoma Tumour Group. (USMAVNIV4) BCCA Protocol Summary for the Treatment of Unresectable or Metastatic Melanoma Using 4-Weekly Nivolumab. Vancouver, British Columbia: BC Cancer Agency; 1 August 2018.

25. Larkin J, Chiarion-Sileni V, Gonzalez R, et al. Combined nivolumab and ipilimumab or monotherapy in untreated melanoma. *N Engl J Med* 2015;373(1):23-34.
26. Postow MA, Chesney J, Pavlick AC, et al. Nivolumab and ipilimumab versus ipilimumab in untreated melanoma. *N Engl J Med* 2015;372(21):2006-2017.
27. Zhao X, Suryawanshi S, Hruska M, et al. Assessment of nivolumab (Nivo) benefit-risk profile from a 240-mg flat dose versus a 3-mg/kg dosing regimen in patients (Pts) with solid tumors. *Ann Oncol* 2016;27(Supplement 6 (abstract 1098P)):vi359-vi378.
28. Zhao X, Ivaturi V, Gopalakrishnan M, et al. Abstract CT101: A model-based exposure-response (E-R) assessment of a nivolumab (NIVO) 4-weekly (Q4W) dosing schedule across multiple tumor types. *Cancer Research* 2017;77(13 Supplement).