Physician Factors Associated with Inappropriate Vitamin B12 Prescribing in Ontario, Canada

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INTRODUCTION

Nearly two-thirds of Ontarians over the age of 65 are prescribed parenteral vitamin B12 without biochemical evidence of B12 deficiency in the year preceding their first prescription, costing an estimated \$46 million CAD.¹ To our knowledge, there is no published literature characterizing physician factors associated with inappropriate B12 prescribing. We assessed this using population-based databases.

METHODS

We undertook a retrospective cohort study using health system administrative databases available within ICES, in Ontario, Canada. Data sets were linked using unique, encoded identifiers and analyzed at ICES. All persons 65 years or older who received at least 1 intramuscular B12 prescription from January 1, 2011, to September 30, 2015, were included. Data were analyzed from July 26, 2018, to November 22, 2018. The primary outcome was inappropriate B12 supplementation, identified when persons with either a normal serum B12 level (≥ 221 pmol/L, consistent with the National Health and Nutritional Examination Survey upper limit of normal for marginal B12 deficiency)² or without a documented B12 level in the 12 months prior, received their first intramuscular B12 prescription. We performed univariate and multivariable analyses using multilevel logistic regressions (adjusting for clustering within prescribing physician groups) to identify physician factors associated with inappropriate prescribing of vitamin B12. Physician factors included age, sex, years in practice, prescription volume, specialty, and medical school location (Canadian versus International). Patient variables included in the multivariable analysis were age, gender, rurality, income status, and comorbidities (Table 1). The use of data for this project is authorised under Section 45 of Ontario's Personal Health Information Protection Act.

Dr. Yulia Lin and Dr. Matthew C Cheung contributed equally as co-senior authors to this study.

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RESULTS

A total of 12,978 physicians prescribed 405,469 intramuscular B12 prescriptions to 146,850 persons, of which 93,615 were deemed inappropriate (Table 1).¹ Physician factors (Table 2) associated with inappropriate B12 supplementation included higher volume of parenteral B12 prescribing (multivariable OR, 1.03 per 10 additional patients prescribed B12; 95% CI, 1.02–1.05), or having practiced for more years (OR, 1.15; 95% CI, 1.12–1.18). Female physicians were less likely (OR, 0.87; 95% CI, 0.81–0.93) to prescribe intramuscular B12 inappropriately compared with their male counterparts. When compared with primary care providers, internal medicine subspecialists were more likely to prescribe B12 inappropriately (OR 1.24; 95% CI 1.01–1.54), whereas geriatricians were less likely (OR, 0.35; 95% CI, 0.24–0.52). International medical graduates (OR, 0.83; 95% CI, 0.77–0.89) were less likely to prescribe parenteral B12 inappropriately when compared with Canadian medical graduates.

DISCUSSION

We identified numerous physician factors associated with inappropriate prescribing of B12. Physicians in practice for more years were more likely to prescribe inappropriately, consistent with previous Canadian studies, which may reflect the impact of pharmacologic training previously provided in medical school.³ Female physicians were more likely to prescribe B12 appropriately; this contributes to a growing literature demonstrating that women are more likely to adhere to clinical guidelines and may provide higher-quality care.⁴ It has been reported that geriatricians are more aware of the evidence supporting B12 supplementation, compared with general practitioners⁵; consistent with our observation, they were more likely than primary care providers to prescribe B12 appropriately. Finally, B12 deficiency is more common in low- and middle-income countries.² As such, increased physician familiarity with B12 prescribing in these countries could explain why international medical graduates prescribed B12 more appropriately than their Canadian counterparts.

Our limitations include not being able to understand why particular physician groups were associated with overprescribing vitamin B12, or why B12 was prescribed without evidence of deficiency. Other limitations include using an abridged lookback period, which might have

Table 1 Characteristics of Patients who Received Intramuscular B12, and of Physicians who Prescribed an Intramuscular B12 Injection from January 1, 2011, to September 30, 2015

Patient characteristics	No.	%
Age		
Mean (SD)	76.5 (8.1)	
Median (IQR)	76 (14.0)	
Range	65–110	
Age categorized		
65–69	36,866	25.1
70–74	28,196	19.2
75–79	28,014	19.1
80–84	26,055	17.7
85–89	18,384	12.5
90+	9335	6.4
Sex		
Female	86,813	59.1
Male	60,037	40.9
Location of residence		
Rural	12,692	8.6
Urban	124,359	84.7
Neighbourhood income quintile		
Q1 (lowest)	32,905	22.4
Q2	32,230	22.0
Q3	29,828	20.3
Q4	27,679	18.9
Q5 (highest)	23,573	16.1
Co-morbidities		
Crohn's disease, ulcerative colitis, and malabsorption	9309	6.3
Pernicious anemia	40,908	27.9
Dementia	14,844	10.1
Neuropathy	2471	1.7
ADG Co-morbidity score		
Low	24,135	16.4
Moderate	51,920	35.4
High	70,795	48.2
Physician characteristics	No.	%
Age		
Mean (SD)	51.0 (12.3)	
Median (IQR)	51 (18)	
Range	25–90	
Sex		
Female	4595	40.0
Male	6840	60.0
Type of practice		
Family physician (CCFP, FCFP)	9924	86.0
Emergency medicine (CCFP-EM, FRCPC)	218	1.9
Medicine specialist (FRCPC)	797	6.9
Surgical specialist (FRCSC)	189	1.6
Geriatrics	70	0.6
Other	348	3.0
Location of practice		
Rural	1120	9.8
Urban	10,321	90.2
Years of practice (years since graduation)		
≤ 5 years	669	5.9
5–15 years	2252	19.7
15–30 years	4363	38.2
30+ years	4147	36.3
Medical school location		
Canadian Medical Graduate (CMG)	7763	69.5
International Medical Graduate (IMG)	3411	30.5
Number of prescriptions given within the time period		
Mean (SD)	11.8 (20.8)	
Median (IQR)	5 (12)	
Range	1–500	

SD, standard deviation; IQR, interquartile range; CCFP, Certification in the College of Family Physicians; FCFP, Fellowship in the College of Family Physicians; FRCPC, Fellow of the Royal College of Physicians of Canada; FRCSC, Fellow of the Royal College of Surgeons of Canada; ADG, Johns Hopkins Aggregated Diagnosis Groups (The Johns Hopkins ACG® System)

Table 2 Physician Characteristics Associated with Inappropriate Vitamin B12 Prescribing

OR (95% CI)				
	Univariate analysis	p	Final multivariable ^b	p
Physician factors				
Age ^a	1.17 (1.14, 1.21)	< 0.001	—	—
Physician's prescription volume (past 365 days)* ^a	1.03 (1.01, 1.05)	< 0.001	1.03 (1.02, 1.05)	< 0.001
Years since graduation* ^a	1.17 (1.14, 1.20)	< 0.001	1.15 (1.12, 1.18)	< 0.001
Physician's sex (F vs M)*	0.79 (0.74, 0.84)	< 0.001	0.87 (0.81, 0.93)	< 0.001
Physician's specialty (REF: GP/FP)	1.00			
Emergency medicine	1.04 (0.79, 1.37)	0.79	1.08 (0.81, 1.42)	0.61
Medicine subspecialist*	1.25 (1.05, 1.48)	0.01	1.24 (1.01, 1.54)	0.04
Surgical specialist	1.16 (0.86, 1.58)	0.33	1.30 (0.71, 2.37)	0.39
Geriatrics*	0.48 (0.36, 0.66)	< 0.001	0.35 (0.24, 0.52)	< 0.001
Other	1.04 (0.82, 1.32)	0.75	1.07 (0.69, 1.66)	0.77
International vs Canadian graduate*	0.82 (0.77, 0.88)	< 0.001	0.83 (0.77, 0.89)	< 0.001

*Significant under 0.05 level in the final model and the univariate analysis

^aOdds ratios are presented in increments of 10. Every increase in 10 more patients or 10 more years are associated with the odds ratio presented

^bAdjusted odds ratios are presented after adjustment of patients' characteristics of age, sex, rurality, anemia, dementia, neuropathy, ADG groups, and income quintile

CI, confidence interval; GP/FP, general practice or family practice

misclassified persons undergoing treatment for chronic B12 deficiency as receiving inappropriate supplementation. However, we are reassured that our data were not meaningfully impacted by left censoring as a 24-month lookback revealed similar rates of inappropriate prescribing.⁶ Lastly, while using methylmalonic acid and homocysteine levels to corroborate vitamin B12 deficiency may have strengthened our study, we feel having done so would not have reflected real-world practice given their cost and limited availability²; furthermore, they are not included in ICES databases. Future quality improvement initiatives should target the identified physician groups, to reduce this burden of unnecessary care.

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William K. Silverstein, MD^{1,2}

Yulia Lin, MD, FRCPC^{1,3,4,5}

Christoffer Dharma, MSc⁶

Ruth Croxford, MSc⁶

Matthew C. Cheung, MD, SM, FRCPC^{1,3,6}

¹Department of Medicine, Faculty of Medicine,
University of Toronto,
Toronto, ON, Canada

²Department of Medicine, Sunnybrook Health
Sciences Centre,
Toronto, Ontario, Canada

³Division of Medical Oncology & Hematology,
Sunnybrook Health Sciences Centre,
Toronto, ON, Canada

⁴Department of Laboratory Medicine & Molecular
Diagnostics, Sunnybrook Health Sciences Centre,
Toronto, ON, Canada

⁵Department of Laboratory Medicine and
Pathobiology, University of Toronto,
Toronto, ON, Canada

⁶ICES,
Toronto, ON, Canada

Corresponding Author: William K. Silverstein, MD; Department of
Medicine, Sunnybrook Health Sciences Centre, Toronto, Ontario,
Canada (e-mail: William.Silverstein@mail.utoronto.ca).

Authors' Contribution WKS, YL, and MCC devised the study. CD
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CD, RC, and MCC. Manuscript was drafted by WKS. Manuscript was
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Conflict of Interest: WKS, CD, RC, and MCC had no competing
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