Prevalence of Venous Thromboembolism and Anticoagulant Use in Patients with COVID-19 in Alberta, Canada

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ABSTRACT

Background: COVID-19 causes a hypercoagulable state and increases the risk of venous thromboembolism (VTE).

Objectives: The primary objective was to identify VTE prevalence among patients with COVID-19 in one Canadian province. Secondary objectives were to identify the prevalence of bleeding, describe anticoagulation prescribing practices, and identify factors contributing to VTE in these patients.

Methods: Adult patients admitted to Alberta hospitals between March and December 2020 with COVID-19 who had a length of stay of at least 72 hours were included in this retrospective study. VTE, bleeding events, and comorbidities were defined by *International Classification of Diseases and Related Health Problems, 10th Revision* codes. Cases of VTE and controls (no VTE) were matched on the basis of age older than 60 years, active cancer, and length of stay for the full cohort, as well as for a subgroup of patients with D-dimer data available, to assess for factors associated with VTE.

Results: A total of 2544 patients were included. Median age was 66 years, 1461 patients (57.4%) were male, median weight was 77.7 kg, and median D-dimer level on admission was 1.00 mg/L. The prevalence of VTE was 3.7% (n = 93) and that of major and clinically relevant non-major bleeding was 4.9% (n = 125). Of the total population, 1224 patients (48.1%) had standard prophylactic-dose anticoagulation, 460 (18.1%) received only higher-dose anticoagulation, 248 (9.7%) received both prophylactic- and higher-dose anticoagulation, and 612 (24.1%) had no anticoagulation data. Logistic regression showed that only the presence of D-dimer above 3 mg/L was associated with a significant odds ratio for VTE (7.04, 95% confidence interval 2.43–20.84).

Conclusions: VTE prevalence among patients with COVID-19 was higher than baseline prevalence in Alberta. Analysis of prescribing practices demonstrated that a large proportion of patients received higher-dose anticoagulation.

Keywords: COVID-19, venous thromboembolism, D-dimer

RÉSUMÉ

Contexte : La COVID-19 provoque un état d'hypercoagulabilité et augmente le risque de thromboembolie veineuse (TEV).

Objectifs : L'objectif principal de cette étude consistait à identifier la prévalence de la TEV chez les patients atteints de COVID-19 dans une province canadienne. Ses objectifs secondaires consistaient, quant à eux, à identifier la prévalence des saignements, décrire les pratiques relatives à la prescription d'anticoagulants et à identifier les facteurs contribuant à la TEV chez ces patients.

Méthodes : Cette étude rétrospective a été menée auprès de patients adultes atteints de COVID-19 admis dans les hôpitaux de l'Alberta entre mars et décembre 2020 avec une durée de séjour d'au moins 72 heures. La TEV, les événements hémorragiques et les comorbidités étaient définis par les codes de la *Classification internationale des maladies et des problèmes de santé connexes, 10e révision* (CIM-10). Les cas de TEV et les témoins (sans TEV) ont été appariés sur les bases suivantes afin d'évaluer les facteurs associés à la TEV : âge de plus de 60 ans, cancer actif et durée de séjour pour l'ensemble de la cohorte, ainsi que pour un sous-groupe de patients dont les données sur les D-dimères étaient disponibles.

Résultats : Au total, 2544 patients ont été inclus. L'âge médian était de 66 ans; 1461 patients (57,4 %) étaient des hommes; leur poids médian était de 77,7 kg et le taux médian de D-dimères à l'admission était de 1,00 mg/L. La prévalence de la TEV était de 3,7 % (n = 93) et celle des saignements majeurs et non majeurs cliniquement pertinents était de 4,9 % (n = 125). Sur la population totale, 1224 patients (48,1 %) ont reçu un anticoagulant à dose prophylactique standard; 460 (18,1 %) n'ont reçu qu'un anticoagulant à dose plus élevée; 248 (9,7 %) ont reçu à la fois un anticoagulant à dose prophylactique et à dose plus élevée; et 612 (24,1 %) ne disposaient pas de données relatives à la prescription d'anticoagulant. La régression logistique a montré que seule la présence de D-dimères au-dessus de 3 mg/L était associée à un rapport de cotes significatif pour la TEV (7,04, intervalle de confiance à 95 % 2,43-20,84).

Conclusions : La prévalence de la TEV chez les patients atteints de COVID-19 était plus élevée que la prévalence de référence en Alberta. L'analyse des pratiques de prescription a montré qu'une grande proportion de patients recevait un anticoagulant à plus forte dose.

Mots-clés : COVID-19, thromboembolie veineuse, D-dimères

INTRODUCTION

COVID-19 frequently causes a hypercoagulable state in hospitalized patients, likely as a result of multiple mechanisms, including the systemic inflammatory response, immobilization leading to venous stasis, and direct endothelial damage from viral injury.[1] Significant coagulopathy is present in many patients with COVID-19, including elevated D-dimer and fibrinogen.[2-6] The level of D-dimer appears to be correlated with disease severity.[4,7-9] Multiple studies have demonstrated a higher rate of venous thromboembolism (VTE) among patients hospitalized with COVID-19 than seen in typical acute care and critical care populations; however, there is some variability in incidence rates across these studies.[10] Several meta-analyses of patients hospitalized with COVID-19 have shown a rate of VTE ranging from 20% to 30%, which is nearly twice the rate of VTE among hospitalized medical patients who do not have COVID-19.[11-19] The risk of VTE increases in patients who are critically ill, which is evidenced by their need for admission to an intensive care unit (ICU) and/or mechanical ventilation, as well as in those with prior VTE, active cancer, or obesity.[9]

On the basis of this literature, it is clear that all patients hospitalized with COVID-19 should receive thromboprophylaxis in the absence of contraindications. However, there is some concern that with the elevated risk of VTE in this patient population, the standard prophylactic doses of anticoagulation may be insufficient.[20] In fact, practices related to anticoagulant regimens have changed over the course of the pandemic. During the period when this study was conducted, most Canadian and international organizations continued to recommend standard-dose thromboprophylaxis, although several organizations recommended intermediate or therapeutic doses for patients with COVID-19 in the absence of diagnosed or suspected VTE.[21,22]

The primary objective was to identify VTE prevalence among patients admitted to hospital with COVID-19 in Alberta (Alberta Health Services). Secondary objectives were to identify the prevalence of bleeding, to describe anticoagulation prescribing practices, and to identify factors contributing to VTE in these patients.

METHODS

Study Design and Data Sources

This cross-sectional and nested case–control study was conducted in Alberta, Canada, from March 1 to December 31, 2020. Ethics approval was obtained from the Health Research Ethics Board – Health Panel (Pro00104825). Eligible patients were identified retrospectively by the Data Integration, Management, and Reporting service, which then extracted and linked the data. The Communicable Disease Outbreak Management data set was used to identify the date when each patient recovered from COVID-19. Data were collected from the provincial Discharge Abstract Database regarding prevalence of VTE, bleeding, and comorbidities using codes from the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (ICD-10; see Appendix 1, available from https://www.cjhp-online.ca/index.php/cjhp/issue/view/211). Prescribing practices for anticoagulation were collected using Anatomical Therapeutic Chemical codes (Appendix 2, available from https://www.cjhp-online.ca/index.php/cjhp/issue/view/211) in the Drug Optimization, Sustainability, and Evaluation dashboard (the provincial data set for in-hospital medications). Sunrise Clinical Manager, the electronic charting software used in the Calgary zone, was the only database that could provide height and weight data; as a result, these variables were inaccessible for most of the patients in our study. Laboratory data were obtained from the LAB database but were available only for patients admitted to Alberta hospitals other than those that use Epic software, another electronic charting platform to which we did not have access.

Patient Population

Adult patients hospitalized for 72 hours or longer who tested positive for COVID-19 were included in this study. Positivity for COVID-19 was defined as a positive test result while the patient was in hospital or admission to hospital after testing positive but before the recovery date. To allow for a broad picture of this patient population, no other exclusion criteria were applied.

Outcome Measures

The primary outcome was the prevalence of VTE, including deep vein thrombosis (DVT), pulmonary embolism, and other venous clots, among hospitalized patients with COVID-19. VTE was defined on the basis of ICD-10 codes for the index hospitalization, in any diagnosis code field (Appendix 1).

Secondary outcomes were the prevalence of bleeding among hospitalized patients with COVID-19, as defined by ICD-10 codes (Appendix 1), description of anticoagulants used in hospital for this population, comparison of anticoagulant dose between patients with and without VTE, and identification of risk factors for VTE by matching patients with and without VTE. Anticoagulation dose was classified as the standard prophylactic dose, only a higher dose, both prophylactic and higher doses, or no documentation of anticoagulant found (Appendix 3, https://www.cjhp-online.ca/index.php/cjhp/issue/view/211). Given lack of access to weight data for the entire population, it was assumed that tinzaparin up to 4500 units was the standard prophylactic dose, and any greater dose in patients without weight data was considered to be a higher dose. Where weight data were available, the Alberta Health Services anticoagulant weight-banding guidelines for tinzaparin

and enoxaparin were used to classify the dose as prophylactic or higher (Appendix 3).

Data Analysis

Data were collected by the Data Integration, Management, and Reporting service and were provided to the researchers in an Excel spreadsheet (Microsoft Corporation). Statistical analyses were performed using Excel and R. Normality of continuous variables was tested using the Shapiro–Wilk test. Normally distributed continuous variables were tested for significance of difference between groups using the χ^2 test, and non-normally distributed variables were tested with the Kruskal–Wallis test. Categorical variables were tested for significance of difference using 1-way analysis of variance or, if the number of outcomes was low (< 10), the Fisher exact test.

A nested case–control analysis and logistic regression were performed to assess for risk factors associated with development of VTE during the hospital stay using the full cohort, as well as the cohort limited to patients for whom D-dimer data were available. An exploratory logistic regression was first performed to identify factors that might have contributed to VTE that could be used for matching. The cases were patients in whom VTE developed, and the controls were those with no VTE. Given the association found between D-dimer and VTE in the exploratory regression, the exposure of interest for the D-dimer subgroup was D-dimer above 3 mg/L at any point during the hospital admission (where normal D-dimer level is below 0.5 mg/L). For both analyses, each case of VTE was matched 1:2 with non-VTE controls on the basis of factors shown by the exploratory regression to be associated with VTE. The matching and conditional logistic regressions were run 1000 times in the D-dimer subgroup to increase the robustness of the findings. Odds ratios and 95% confidence intervals (CIs) were determined for the outcome of VTE.

RESULTS

Of the 3679 patients admitted to hospital in Alberta with COVID-19 during the study period, 2544 (69.1%) were included in the study, with most exclusions being related to length of stay less than 72 hours (56.7%) and repeat hospitalizations (28.9%) (Figure 1). In addition, 92 patients were excluded because they were transferred to another hospital and discharge data were therefore not available. At the time of admission, median age was 66 years, 57.4% of the patients were male, 34.9% had diabetes mellitus, 3.8% had active cancer, and 8.0% had atrial fibrillation (Table 1). Median admission estimated glomerular filtration rate was 81 mL/min/1.73m^2, median weight was 77.7 kg, and median admission D-dimer was 1.00 mg/L. Almost 20% of patients were admitted to the ICU, and 21.2% of patients died during the hospital stay.

Overall, 93 patients (3.7%) had a VTE, of which the majority were pulmonary embolisms (76.3%) (Table 2). Bleeding occurred in 125 patients (4.9%), and these events consisted primarily of gastrointestinal bleeds (74.4%) (Table 2).

Of the total population, 1224 patients (48.1%) were given standard prophylactic-dose anticoagulation during the admission, 460 patients (18.1%) received only higher-dose anticoagulation, 248 patients (9.7%) received both prophylactic and higher-dose anticoagulation, and for 612 patients (24.1%), no anticoagulation data were found (Figure 2). Among the higher doses administered, the most common were tinzaparin 8000 units, tinzaparin 10 000 units, or a direct oral anticoagulant (Appendix 4, available from https://www.cjhp-online.ca/index.php/cjhp/issue/view/211). Anticoagulant prescribing practices were compared between patients with and without VTE (Figure 2). Among the 2451 patients without VTE, 1220 (49.8%) received a prophylactic dose during the admission, 427 (17.4%) received only higher-dose anticoagulation, 204 (8.3%) had both prophylactic and higher doses, and no anticoagulant was found for 600 (24.5%) patients. Among those with VTE, 4 (4.3%) remained on a prophylactic dose throughout their admission, 33 (35.5%) received only higher-dose anticoagulation, 44 (47.3%) received both prophylactic and higher-dose anticoagulation, and for 12 (12.9%) patients, no anticoagulant data were found. Of the 4 patients who had VTE but remained on a prophylactic dose (1 with DVT, 3 with pulmonary embolism), 1 had low hemoglobin and a bleeding event, and 1 died in the ICU. For the other 2 patients, there was no clear reason for remaining on prophylactic anticoagulation.

Anticoagulation prescribing practices were also determined for the subgroup of patients for whom weight data were

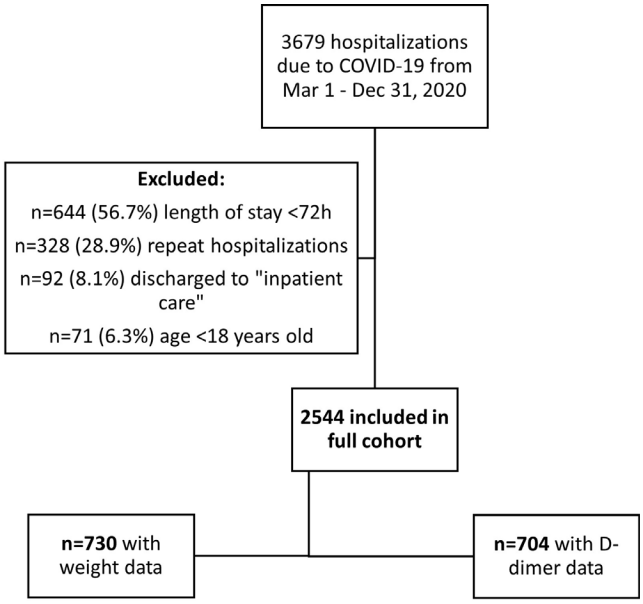

FIGURE 1. Flow chart of patient inclusion.

available (n = 730) (Figure 3). In this subgroup, 468 (64.1%) patients were receiving prophylactic-dose anticoagulation, 101 (13.8%) were receiving a higher dose, 89 (12.2%) were receiving both prophylactic- and higher-dose anticoagulation, and 72 (9.9%) had no anticoagulant documented.

Table 1 compares comorbidities, laboratory values, and hospitalization factors between patients with and without VTE. The median level of D-dimer on admission was significantly higher in the VTE group than the group without VTE (2.14 mg/L versus 0.99 mg/L). Patients with VTE had longer lengths of stay and higher risks of being admitted to the ICU, of needing mechanical ventilation or extracorporeal membrane oxygenation, and of dying than those without VTE. Additionally, patients with VTE had a higher prevalence of bleeding (15.1% versus 4.5%).

Nested case–control analysis of the D-dimer cohort (n = 704) involved 34 patients who had a VTE and 670 who did not have a VTE. Based on the exploratory logistic regression, cases and controls were matched using age older than 60 years, active cancer, and length of stay. The odds ratio for D-dimer level above 3 mg/L was 7.04 (95% CI 2.43–20.84) for the outcome of VTE.

A nested case–control analysis of the total cohort (n = 2544) was performed with variables for which complete data were available. After matching on age older than 60 years, presence of active cancer, and length of stay, none

TABLE 1. Baseline Characteristics and Comparison between Patients with and without VTE

Factor	Available Data[a]	Study Group; No. (%) of Patients[b] All Patients (n = 2544)	No VTE (n = 2451)	VTE (n = 93)	p Value
Age (years) (median and IQR)		66 (51–79)	66 (51–79)	66 (56–74)	0.72
Sex, male		1461 (57.4)	1404 (57.3)	57 (61.3)	0.51
Weight (kg) (median and IQR)	n = 730	77.7 (65.5–92.8)	77 (65.1–92.7)	85.5 (77.3–94.3)	< 0.001
BMI (median and IQR)	n = 414	27.8 (23.8–32.7)	27.8 (23.8–32.7)	27.8 (25.5–32.4)	0.66
Concurrent conditions					
Chronic respiratory disease		278 (10.9)	268 (10.9)	10 (10.8)	> 0.99
Heart failure		197 (7.7)	187 (7.6)	10 (10.8)	0.36
Hypertension		432 (17.0)	418 (17.1)	14 (15.1)	0.72
Hyperlipidemia		29 (1.1)	29 (1.2)	0 (0.0)	0.62
Diabetes mellitus		889 (34.9)	859 (35.0)	30 (32.3)	0.66
Renal disease		147 (5.8)	143 (5.8)	4 (4.3)	0.82
Active cancer		97 (3.8)	90 (3.7)	7 (7.5)	0.09
Atrial fibrillation		204 (8.0)	197 (8.0)	7 (7.5)	> 0.99
Laboratory results on admission					
eGFR (mL/min/1.73 m^2) (median and IQR)	n = 1560	81 (53–100)	80 (53–100)	87 (57.5–100)	0.38
Hemoglobin (g/L) (median and IQR)	n = 2003	128 (113–140)	128 (113–140)	127 (115–142)	0.71
Platelets (× 10^9/L) (median and IQR)	n = 2003	211 (160–273)	210 (159.3–272.3)	221 (162–278)	0.37
D-dimer (mg/L) (median and IQR)	n = 704	1.00 (0.58–1.96)	0.99 (0.57–1.90)	2.14 (0.83–6.16)	0.002
Maximum D-dimer (mg/L) (median and IQR)	n = 704	1.17 (0.64–2.29)	1.12 (0.62–2.15)	4.88 (1.70–10.00)	< 0.001
Fibrinogen (g/L) (mean ± SD)	n = 299	5.55 ± 1.92	5.56 ± 1.87	5.49 ± 2.45	0.86
LDH (U/L) (median and IQR)	n = 796	311.5 (227.75– 423.25)	291 (213–391)	358 (272.5–441.0)	0.017
Length of stay (days) (median and IQR)		9 (6–16)	9 (5.5–15)	19 (10–35)	<0.001
ICU admission		483 (19.0)	434 (17.7)	49 (52.7)	<0.001
Mechanical ventilation		308 (12.1)	267 (10.9)	41 (44.1)	<0.001
APACHE score (median and IQR)	n = 363	17 (13–23)	17 (13–22)	21 (15–24)	0.06
ECMO		7 (0.3)	5 (0.2)	2 (2.2)	0.025
Bleed		125 (4.9)	111 (4.5)	14 (15.1)	<0.001
Died before discharge		540 (21.2)	508 (20.7)	32 (34.4)	0.002

APACHE = Acute Physiology and Chronic Health Evaluation, BMI = body mass index, ECMO = extracorporeal membrane oxygenation, eGFR = estimated glomerular filtration rate, LDH = lactate dehydrogenase, ICU = intensive care unit, IQR = interquartile range, SD = standard deviation.
[a]If cell is blank, data were available for total cohort.
[b]Except where indicated otherwise.

of these variables were significantly associated with VTE (Table 3).

DISCUSSION

In this study, the prevalence of VTE was 3.7% among hospitalized patients with COVID-19. Although this is lower than what has been cited by some other studies, it is higher than the typical Alberta prevalence of VTE among all hospitalized patients, which was 2.3% in June 2021 and previously about 2.0%, before the COVID-19 pandemic (according to internal organizational data obtained from the AHS VTE DVT PE dashboard). This is consistent with COVID-19 itself causing a hypercoagulable state. There are several possible reasons for the VTE prevalence in this study to be lower than the rates in other studies. Critically ill patients are more likely to have VTE than more stable hospitalized patients.[11] Less than 20% of patients in this study required admission to the ICU, so it can be surmised that most patients were relatively stable. In addition, several studies with a higher rate of VTE included the use of systematic screening for DVT, which may identify asymptomatic DVTs that are not clinically significant.[14] Lastly, in Alberta, accreditation standards and provincial protocols support evidence-based thromboprophylaxis, whereby

TABLE 2. VTE and Bleeding Events in Total Population

Event Type or Location	No. of Patients (n = 2544)
VTE	93 (3.7%)
DVT	20
PE	71[a]
Other VTE[b]	6
Bleeding, by location[c]	125 (4.9%)
GI tract	93
Urinary tract	17
CNS	14
Uterine/vaginal	3
Other	24
Total no. of bleeds	151

CNS = central nervous system, DVT = deep vein thrombosis, GI = gastrointestinal, PE = pulmonary embolism, VTE = venous thromboembolism.
[a]Of the 71 people who experienced a PE, 4 also experienced a DVT.
[b]Other VTE consisted of 3 cases of portal vein thrombosis and 3 cases of embolism and thrombosis of other specified veins.
[c]The total number of bleeds is greater than the number of people who experienced bleeds because some people had more than 1 bleeding event.

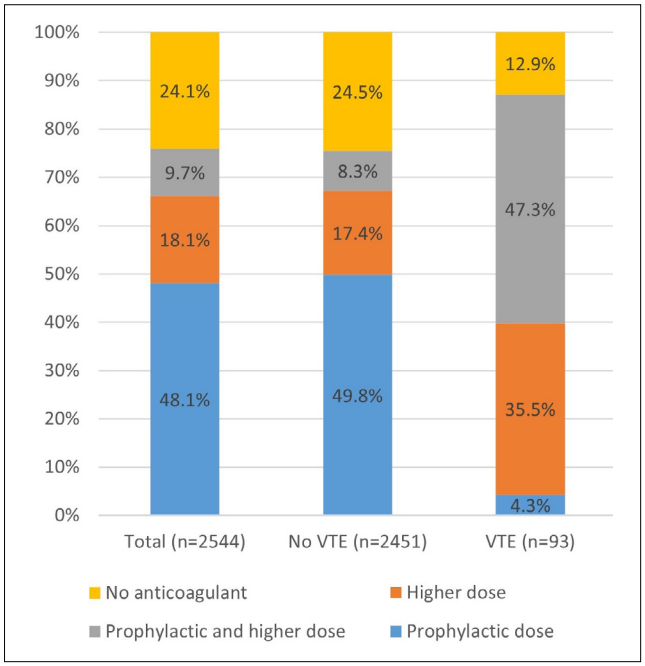

FIGURE 2. Anticoagulation prescribing practices for the total population and for patients with and without venous thromboembolism.

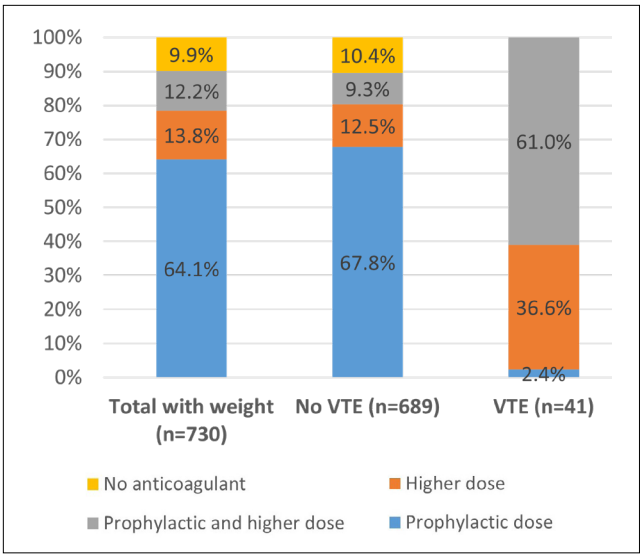

FIGURE 3. Anticoagulation prescribing practices for the subgroup of patients with weight data available (n = 730).

TABLE 3. Nested Case–Control Analysis of Total Cohort (n = 2544)[a] for Prediction of Venous Thromboembolism

Characteristic	Odds Ratio (95% CI)
Sex, male	1.34 (0.77–2.34)
Chronic respiratory disease	0.78 (0.35–1.72)
Heart failure	1.87 (0.74–4.70)
Hypertension	0.70 (0.32–1.49)
Diabetes	0.63 (0.36–1.11)
Renal disease	0.42 (0.12–1.50)
Atrial fibrillation	1.04 (0.34–3.12)

CI = confidence interval.
[a]Cases and controls were matched on the basis of age > 60 years, active cancer, and length of hospital stay.

most hospitalized medical patients would receive prophylactic anticoagulation, which has likely resulted in lower VTE prevalence compared with studies from other countries that have lower usage of thromboprophylaxis.[11] From the logistic regression analysis, a D-dimer level greater than 3 mg/L during hospitalization was identified as a significant predictor of VTE, which is consistent with what has been observed in other studies.[14,23]

The prevalence of clinically significant bleeding in this study (4.9%) was slightly higher than what has been seen in other studies. For example, a meta-analysis of studies of hospitalized patients with COVID-19 found a 3.9% incidence of major bleeding.[18] The bleeding prevalence in the present study may be higher because the ICD-10 codes that were used (Appendix 1) capture both major and clinically relevant non-major bleeding. The bleeding rate was higher among patients with VTE than those without VTE, likely because of the increased proportion of patients in the VTE group who were receiving higher-dose anticoagulation. Similar results were obtained in a propensity score–matched study of about 1000 patients, in which the researchers found that the incidence of major bleeding was higher among patients who received therapeutic anticoagulation.[24] Additionally, about half of the patients with VTE in our study were in the ICU, and thus were critically ill and at increased risk of bleeding, as evidenced by the bleeding prevalence of 9.3% (45/483) among patients in the ICU compared with 3.9% (80/2061) among those not in the ICU.

Specific to anticoagulation prescribing practices, almost 50% of patients received only a prophylactic dose, about 18% of patients received only higher-dose anticoagulation, and about 10% received a higher dose along with a prophylactic dose at some point during admission. Possible reasons for the overall proportion of patients receiving higher-dose anticoagulation include 8.0% of the population having atrial fibrillation, which may warrant long-term anticoagulation. In addition, there are other indications for anticoagulation that we did not capture in our study, including presence of a prosthetic heart valve and prior VTE. It is likely that for a certain percentage of patients receiving higher-dose anticoagulation, the elevated doses were prescribed solely on the basis of severity of their COVID-19, as well as standard weight-based prophylaxis for those for whom we did not have access to a documented weight. This is evidenced by the 193 patients who received a "higher dose" of tinzaparin 8000 units and the 116 patients who received tinzaparin 10 000 units, which may represent weight-adjusted prophylaxis for patients with body weight 100–150 kg. However, given that the median weight of patients in this study was 78 kg, the observed rate of higher-dose anticoagulation likely reflects a combination of weight-based prophylactic, intermediate, and therapeutic dosing (Appendix 4).

At the time of this study, prophylactic dosing of anticoagulation was recommended by Alberta Health Services. Since then, several randomized controlled trials have investigated empiric higher dosing of anticoagulation in patients hospitalized with COVID-19. An open-label randomized controlled trial comparing intermediate with standard-dose thromboprophylaxis in 562 ICU patients with COVID-19 found that intermediate dosing had no benefit.[25] Similar results were obtained in an open-label, adaptive, randomized trial in which investigators found no benefit, and likely harm, of therapeutic anticoagulation in about 1000 patients with severe COVID-19.[26] A study involving both stable and unstable patients with COVID-19 found no benefit of therapeutic anticoagulation (primarily rivaroxaban) relative to prophylactic anticoagulation, and increased rates of bleeding.[27] In a study of patients with moderate COVID-19, with or without elevated D-dimer, therapeutic-dose anticoagulation in the absence of VTE was associated with fewer days requiring organ support and an increased but not statistically significant rate of major bleeding.[28] Given the benefit of therapeutic-dose anticoagulation for patients with moderate COVID-19 in this large trial,[28] Alberta now considers therapeutic anticoagulation for 14 days or until discharge for patients who are at low risk of bleeding.[11]

This study had several limitations. First, because of legislation concerning COVID-19, a chart review was not possible, which limited the analysis to administrative data linkages. Consequently, we were unable to capture some data elements (e.g., those needed to calculate a Padua Prediction Score, specifically complete weight and laboratory data). Because body weight was not available for most patients, our ability to accurately describe anticoagulation dosing was limited. Tinzaparin doses above 4500 units in patients without weight data were classified as "higher-dose" anticoagulation, which likely resulted in an overestimation of the number of patients in this group. To help mitigate this potential problem, anticoagulation prescribing practices were also assessed in the subgroup for whom weights were available, where the main differences were a higher proportion of patients receiving prophylactic dosing, as expected, and a lower proportion not receiving any anticoagulation. This subgroup may be a more accurate representation of anticoagulation prescribing practices for patients with COVID-19. We found that 25% of patients had no anticoagulation data, a higher proportion than expected. This group of patients may have been receiving nonpharmacological VTE prophylaxis, which we were unable to capture. In addition, there may be gaps in the medication data because of our reliance on administrative data, and some portion of this group was likely not truly on anticoagulation. Additionally, the dates of VTE events and of anticoagulant orders were not available, so we were unable to establish a timeline for those switched to weight-based prophylaxis or conversion to full-dose anticoagulation because of a documented or suspected VTE.

CONCLUSION

This study revealed an increased prevalence of VTE among hospitalized patients with COVID-19 relative to the baseline local VTE prevalence, with elevated D-dimer found to be a predictor of VTE. Prescribing practices for anticoagulation demonstrated that a large proportion of patients were receiving higher-dose anticoagulation. Studies published since initial preparation of this article (and summarized in the Discussion, above) have now shown a modest degree of benefit from therapeutic-dose anticoagulation in patients with moderate COVID-19 and a low risk of bleeding.

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