Antithrombotic Therapy in Patients with COVID-19

Summary Recommendations

Chronic Anticoagulant and Antiplatelet Therapy

• The COVID-19 Treatment Guidelines Panel (the Panel) recommends that patients with COVID-19 who are receiving anticoagulant or antiplatelet therapies for underlying conditions continue these medications unless significant bleeding develops or other contraindications are present (AIII).

Screening and Evaluation for Venous Thromboembolism

• There is insufficient evidence for the Panel to recommend either for or against routine screening for venous thromboembolism (VTE) in patients with COVID-19 without signs or symptoms, regardless of their coagulation markers.

• For hospitalized patients with COVID-19 who experience rapid deterioration of pulmonary, cardiac, or neurological function or sudden, localized loss of peripheral perfusion, the Panel recommends evaluating the patients for thromboembolic disease (AIII).

Anticoagulant Treatment for Thrombosis

• The Panel recommends that when diagnostic imaging is not possible, patients with COVID-19 who are highly suspected to have thromboembolic disease be managed with therapeutic anticoagulation (AIII).

• The Panel recommends that patients with COVID-19 who require extracorporeal membrane oxygenation or continuous renal replacement therapy or who have thrombosis related to catheters or extracorporeal filters be treated with antithrombotic therapy as per the standard institutional protocols for those without COVID-19 (AIII).

Antithrombotic Therapy for Nonhospitalized Patients Without Evidence of Venous Thromboembolism

• In nonhospitalized patients with COVID-19, the Panel recommends against the use of anticoagulants and antiplatelet therapy (i.e., aspirin, P2Y12 inhibitors) for the prevention of VTE or arterial thrombosis, except in a clinical trial (AIIa). This recommendation does not apply to patients with other indications for antithrombotic therapy.

• The Panel recommends against routinely continuing VTE prophylaxis after hospital discharge for patients with COVID-19 unless they have another indication or are participating in a clinical trial (AII). For patients discharged after COVID-19-related hospitalization who are at high risk of VTE and at low risk of bleeding, there is insufficient evidence for the Panel to recommend either for or against continuing anticoagulation unless another indication for VTE prophylaxis exists.

Antithrombotic Therapy for Hospitalized, Nonpregnant Adults Without Evidence of Venous Thromboembolism

• The Panel recommends against using anticoagulant or antiplatelet therapy to prevent arterial thrombosis outside of the usual standard of care for patients without COVID-19 (AIII).

• In hospitalized patients, low-molecular-weight heparin (LMWH) or unfractionated heparin (UFH) is preferred over oral anticoagulants, because these 2 types of heparin have shorter half-lives and the effect can be reversed quickly, they can be administered intravenously or subcutaneously, and they have fewer drug-drug interactions (AIII). When heparin is used, LMWH is preferred over UFH.

For adults who require low-flow oxygen and do not require intensive care unit (ICU)-level care:

• The Panel recommends the use of a therapeutic dose of heparin for patients with D-dimer levels above the upper limit of normal who require low-flow oxygen and who do not have an increased risk of bleeding (CIIa).

• Contraindications for the use of therapeutic anticoagulation in patients with COVID-19 are a platelet count <50 x 10⁹/L, hemoglobin <8 g/dL, the need for dual antiplatelet therapy, bleeding within the past 30 days that required an emergency department visit or hospitalization, a history of a bleeding disorder, or an inherited or active acquired bleeding disorder. This list is based on the exclusion criteria from clinical trials; patients with these conditions have an increased risk of bleeding.

• In patients without VTE who have begun a therapeutic dose of heparin, treatment should continue for 14 days or until they are transferred to the ICU or discharged from the hospital, whichever comes first.
### Summary Recommendations, continued

- The Panel recommends the use of a **prophylactic dose of heparin** for patients who are not receiving a therapeutic dose of heparin, unless a contraindication exists (AIIb).
- The Panel **recommends against** the use of a **therapeutic dose of oral anticoagulants** for VTE prophylaxis or the prevention of COVID-19 progression, except in a clinical trial (AIIa).
- There is insufficient evidence for the Panel to recommend either for or against the use of thrombolytic agents for the treatment of COVID-19.
- The Panel **recommends against** the use of antiplatelet therapy to prevent COVID-19 progression or death in noncritically ill patients (BIIa).

**For adults who require ICU-level care, including those receiving high-flow oxygen:**

- The Panel recommends using a **prophylactic dose of heparin** as VTE prophylaxis, unless a contraindication exists (AI).
- For patients who start on a therapeutic dose of heparin in a non-ICU setting due to COVID-19 and then transfer to the ICU, the Panel recommends switching from the therapeutic dose to a **prophylactic dose of heparin**, unless VTE is confirmed (BIII).
- The Panel **recommends against** the use of an **intermediate dose** (e.g., enoxaparin 1 mg/kg once daily) or a **therapeutic dose of anticoagulation** for VTE prophylaxis, except in a clinical trial (BI).
- There is insufficient evidence for the Panel to recommend either for or against the use of antiplatelet therapy in critically ill patients with COVID-19.

**Hospitalized Children**

- For hospitalized children with COVID-19, the indications for VTE prophylaxis should be the same as those for children without COVID-19 (BIII).
- Refer to **Therapeutic Management of Hospitalized Children With COVID-19** and **Therapeutic Management of Hospitalized Pediatric Patients With Multisystem Inflammatory Syndrome in Children (MIS-C) (With Discussion on Multisystem Inflammatory Syndrome in Adults [MIS-A])** for the Panel’s recommendations on the use of antithrombotic therapy in children.

**Pregnant and Lactating Patients**

- The Panel recommends that pregnant patients who are receiving anticoagulant or antiplatelet therapies for underlying conditions continue these medications after they receive a diagnosis of COVID-19 (AIII).
- The Panel recommends the use of a **prophylactic dose of anticoagulation** for pregnant patients who are hospitalized for manifestations of COVID-19, unless a contraindication exists (BIII).
- Because pregnant patients have not been included in most clinical trials evaluating therapeutic anticoagulation in the setting of COVID-19, there is insufficient evidence for the Panel to recommend either for or against the use of therapeutic anticoagulation in pregnant patients with COVID-19 who do not have evidence of VTE.
- As in nonpregnant patients, VTE prophylaxis after hospital discharge is not routinely recommended for pregnant patients (BIII). Decisions to continue VTE prophylaxis in the pregnant or postpartum patient after discharge should be individualized, with consideration of concomitant VTE risk factors.
- The use of anticoagulation therapy during labor and delivery requires specialized care and planning. The management of anticoagulation therapy in pregnant patients with COVID-19 should be similar to the management used for pregnant patients with other conditions (AIII).
- UFH, LMWH, and warfarin do not accumulate in breast milk and do not induce an anticoagulant effect in the newborn; therefore, they can be used by breastfeeding individuals who require VTE prophylaxis or treatment (AIII).

**Rating of Recommendations:** A = Strong; B = Moderate; C = Weak

**Rating of Evidence:** I = One or more randomized trials without major limitations; IIa = Other randomized trials or subgroup analyses of randomized trials; IIb = Nonrandomized trials or observational cohort studies; III = Expert opinion

### Association Between COVID-19 and Thromboembolism

COVID-19 has been associated with inflammation and a prothrombotic state, with increases in levels of fibrin, fibrin degradation products, fibrinogen, and D-dimer.\(^1\,^2\) In some studies, elevations in these
markers have been associated with worse clinical outcomes.\textsuperscript{3,4}

Studies have reported varying incidences of venous thromboembolism (VTE) in patients with COVID-19. A meta-analysis of studies of hospitalized patients with COVID-19 treated with VTE prophylaxis found an overall VTE prevalence of 14.1\% (95\% CI, 11.6–16.9).\textsuperscript{5} The VTE prevalence was higher in studies that used ultrasound screening (40.3\%; 95\% CI, 27.0–54.3) than in studies that did not (9.5\%; 95\% CI, 7.5–11.7). In randomized controlled trials conducted prior to the pandemic, the incidence of VTE in hospitalized patients without COVID-19 who received VTE prophylaxis ranged from 0.3\% to 1\% for symptomatic VTE and from 2.8\% to 5.6\% for VTE overall.\textsuperscript{6-8} In randomized trials, the VTE incidence among critically ill patients without COVID-19 who received a prophylactic dose of anticoagulants ranged from 5\% to 16\%, and a prospective cohort study of critically ill patients with sepsis reported a VTE incidence of 37\%.\textsuperscript{9-12}

Guidelines about the use of antithrombotic therapy in patients with COVID-19 have been released by multiple organizations, including the American College of Chest Physicians,\textsuperscript{13} the American Society of Hematology,\textsuperscript{14} the Anticoagulation Forum,\textsuperscript{15} the International Society on Thrombosis and Haemostasis,\textsuperscript{16} the Italian Society for Haemostasis and Thrombosis,\textsuperscript{17} the National Institute for Health and Care Excellence (NICE),\textsuperscript{18} and the Royal College of Physicians.\textsuperscript{19}

The guidelines referenced above agree that hospitalized, nonpregnant patients with COVID-19 should receive, at a minimum, a prophylactic dose of anticoagulation to prevent VTE. The NICE guidelines state: “Consider a treatment dose of a low-molecular-weight heparin (LMWH) for young people and adults with COVID-19 who need low-flow oxygen and who do not have an increased bleeding risk.”

Results from clinical trials that assess the safety and efficacy of different anticoagulant doses and strategies have provided further information on antithrombotic strategies for patients with COVID-19.

**Chronic Anticoagulant or Antiplatelet Therapy**

The COVID-19 Treatment Guidelines Panel (the Panel) recommends that hospitalized patients with COVID-19 who are receiving anticoagulant or antiplatelet therapies for underlying medical conditions continue these medications unless significant bleeding develops or other contraindications are present (AIII). Outpatients with COVID-19 who are receiving warfarin and are in isolation and unable to have international normalized ratio monitoring may be candidates for switching to direct oral anticoagulant therapy. Patients with a mechanical heart valve, ventricular assist device, valvular atrial fibrillation, or antiphospholipid antibody syndrome or who are lactating should not discontinue treatment with warfarin (AIII).

**Screening and Evaluation for Venous Thromboembolism**

VTE guidelines for patients without COVID-19 have recommended against routine screening ultrasounds in critically ill patients because no study has shown that this strategy reduces the rate of subsequent symptomatic thromboembolic complications.\textsuperscript{20} Although the incidence of thromboembolic events, especially pulmonary emboli, can be high among hospitalized patients with COVID-19, no published data demonstrate the clinical utility of using lower extremity ultrasound as routine surveillance for deep vein thrombosis in this population.

There is insufficient evidence for the Panel to recommend either for or against routine screening for deep vein thrombosis in patients with COVID-19 who do not have signs or symptoms of VTE, regardless of the status of their coagulation markers. For hospitalized patients with COVID-19 who experience rapid deterioration of pulmonary, cardiac, or neurological function or sudden, localized loss of peripheral perfusion, the Panel recommends evaluating the patients for thromboembolic disease (AIII).
Managing Antithrombotic Therapy in Patients With COVID-19

The Panel recommends that when diagnostic imaging is not possible, patients with COVID-19 who are highly suspected to have thromboembolic disease be managed with therapeutic anticoagulation (AIII).

The Panel recommends that patients with COVID-19 who require extracorporeal membrane oxygenation (ECMO) or continuous renal replacement therapy or who have thrombosis related to catheters or extracorporeal filters be treated with antithrombotic therapy as per the standard institutional protocols for those without COVID-19 (AIII).

Selection of Anticoagulant or Antiplatelet Drugs

Whenever anticoagulant or antiplatelet therapy is used, potential drug-drug interactions with other concomitant drugs must be considered. The University of Liverpool has collated a list of drug interactions. In hospitalized, critically ill patients, LMWH or unfractionated heparin (UFH) is preferred over oral anticoagulants, because these 2 types of heparin have shorter half-lives and the effect can be reversed quickly, they can be administered intravenously or subcutaneously, and they have fewer drug-drug interactions (AIII).

Management of Nonhospitalized Patients

ACTIV-4b was a placebo-controlled, randomized trial that evaluated the efficacy of using aspirin or prophylactic doses (2.5 mg) or therapeutic doses (5 mg) of apixaban in outpatients with COVID-19 aged >40 years. After 657 outpatients were randomized, the trial was stopped in June 2021 due to a low event rate for the composite outcome of thromboembolic events, hospitalization, and mortality (1 patient each in the placebo, aspirin, and apixaban 2.5 mg arms and 2 patients in the apixaban 5 mg arm). The median time from randomization to study treatment was 3 days, and 22 participants were hospitalized for COVID-19 prior to initiation of the study drugs. It is not known whether patients with previous VTE events or inherited thrombophilias were included in this trial.

Two trials evaluated the use of LMWH and its impact on hospitalization and mortality in outpatients with COVID-19. ETHIC was a multicenter, open-label randomized controlled trial of unvaccinated outpatients with COVID-19. Adults with at least 1 risk factor for severe disease were randomized to receive enoxaparin 40 mg subcutaneously (SUBQ) once daily (if they weighed <100 kg) or enoxaparin 40 mg SUBQ twice daily (if they weighed >100 kg) for 21 days or standard of care. The study was terminated early due to a low event rate and slow accrual. There was no difference between the arms in the number of patients who met the composite endpoint of all-cause mortality and all-cause hospitalization (12 of 105 patients [11%] in the enoxaparin arm vs. 12 of 114 patients [11%] in the standard of care arm). Four of the 12 patients in the enoxaparin arm who were admitted to the hospital required acute medical care or intensive care unit (ICU) admission (3 required mechanical ventilation or ECMO). There were no hospitalizations in the standard of care arm. Bleeding events occurred in 2 patients who received enoxaparin and in 1 patient who received standard of care.

The OVID trial was a multicenter, open-label randomized controlled trial of 472 adults with COVID-19 aged >50 years who were randomized to receive enoxaparin 40 mg SUBQ once daily for 14 days or standard of care. The study was terminated after recruiting 50% of the planned number of participants due to a low probability of showing superiority of enoxaparin. There was no difference between the arms in the number of patients who met the composite endpoint of all-cause hospitalization and mortality (8 of 234 patients [3%] in the enoxaparin arm vs. 8 of 238 patients [3%] in the standard of care arm). No major bleeding events occurred during the study.

In nonhospitalized patients with COVID-19, the Panel recommends against the use of anticoagulants and antiplatelet therapy (i.e., aspirin, P2Y12 inhibitors) for the prevention of VTE or arterial thrombosis,
except in a clinical trial (AIIa). This recommendation does not apply to patients with other indications for antithrombotic therapy.

**Management of Hospitalized Patients**

Several studies have evaluated the risks and benefits of prophylactic or therapeutic doses of anticoagulants in patients with COVID-19. Observational studies and clinical trials have examined the effects of anticoagulation on mortality, progression of COVID-19, thrombosis, and bleeding. Some of these studies are outlined below (visit [ClinicalTrials.gov](https://clinicaltrials.gov) for a current list of trials). Observational studies are included here only when evidence from clinical trials is not available.

**Prophylactic Dose of Anticoagulation Versus No Anticoagulation—Observational Cohort**

An observational study of 4,297 veterans hospitalized with COVID-19 evaluated the benefit of prophylactic anticoagulation. A prophylactic dose of anticoagulation was administered to 3,627 patients with COVID-19 within 24 hours of hospital admission. An inverse probability of treatment weighted analysis showed a cumulative 30-day mortality of 14% among veterans who received prophylactic anticoagulation and 19% among patients who were not treated with anticoagulation (HR 0.73; 95% CI, 0.66–0.81). Participants treated with the prophylactic dose did not have a significant difference in the risk of bleeding that required transfusion when compared with participants who were not treated (HR 0.87; 95% CI, 0.71–1.05). Overall, the study demonstrated that patients with COVID-19 may benefit from a prophylactic dose of anticoagulation.24

**Therapeutic Versus Prophylactic Doses of Heparin in Hospitalized Patients Who Do Not Require Intensive Care Unit-Level Care**

Several randomized controlled trials have evaluated the role of therapeutic doses of heparin in reducing the risk of VTE events or mortality in patients hospitalized for COVID-19.

Three open-label randomized controlled trials (the large ATTACC/ACTIV-4a/REMAP-CAP multiplatform trial and the smaller RAPID and HEP-COVID trials) compared therapeutic doses of heparin to prophylactic or intermediate doses of the anticoagulant in selected hospitalized patients who did not require intensive care. Clinical data for these trials are summarized in Table 7a. The inclusion and exclusion criteria for these studies varied, but most included a need for supplemental oxygen and no risk of a major bleeding event. In the larger multiplatform trial, therapeutic doses of heparin increased the number of organ support-free days but did not significantly affect mortality or length of hospitalization when compared with prophylactic doses of heparin.25

The RAPID trial enrolled patients with elevated D-dimer levels and hypoxemia. The patients were randomized to receive therapeutic or prophylactic doses of heparin. There was no statistically significant difference between the arms for the primary endpoint, which was a composite of ICU admission, noninvasive or mechanical ventilation, or death by Day 28. However, the therapeutic dose of heparin reduced the risk of all-cause death, a secondary outcome.26

The HEP-COVID trial enrolled patients who required supplemental oxygen and had a D-dimer value >4 times the upper limit of normal (ULN) or a sepsis-induced coagulopathy score of ≥4. There were significantly fewer occurrences of the primary endpoint of VTE, arterial thromboembolism, or all-cause death within 32 days of randomization in the therapeutic LMWH arm than in the prophylactic LMWH arm, but there was no difference between arms for the outcome of death within 32 days.27

Given the results of the ATTACC/ACTIV-4a/REMAP-CAP, RAPID, and HEP-COVID trials, for hospitalized, nonpregnant adults with COVID-19 who do not require ICU-level care and have no evidence of VTE:
The Panel recommends the use of a therapeutic dose of heparin for patients with D-dimer levels above the ULN who require low-flow oxygen and who do not have an increased risk of bleeding (CIIa).

- Based on clinical trial exclusion criteria, contraindications for the use of therapeutic anticoagulation in patients with COVID-19 are a platelet count <50 x 10^9/L, hemoglobin <8 g/dL, the need for dual antiplatelet therapy, bleeding within the past 30 days that required an emergency department visit or hospitalization, a history of a bleeding disorder, or an inherited or active acquired bleeding disorder.

- LMWH is preferred over UFH because of its ease of administration and because LMWH was the predominant form of heparin used in the clinical trials for COVID-19.

- In patients without VTE who have begun a therapeutic dose of heparin, treatment should continue for 14 days or until they are transferred to the ICU or discharged from the hospital, whichever comes first.

- Patients with predicted hospitalizations of <72 hours were excluded from the multiplatform ATTACC/ACTIV-4a/REMAP-CAP trial. Whether the benefits of using therapeutic doses of anticoagulation for short hospital stays outweigh the risks is currently unknown.

- The Panel recommends the use of a prophylactic dose of heparin for patients who do not meet the criteria for receiving therapeutic heparin or are not receiving a therapeutic dose of heparin for other reasons, unless a contraindication exists (AIIb).

- The Panel recommends against the use of a therapeutic dose of oral anticoagulants for VTE prophylaxis or the prevention of COVID-19 progression, except in a clinical trial (AIIa).

- There is insufficient evidence for the Panel to recommend either for or against the use of thrombolytic agents for the treatment of COVID-19.

**Prophylactic Versus Intermediate or Therapeutic Doses of Heparin in Hospitalized Patients Who Require Intensive Care Unit-Level Care**

Several randomized controlled trials have evaluated the role of therapeutic doses of heparin in reducing VTE events or mortality in patients in the ICU setting. Clinical data for these trials are summarized in Table 7a.

For the composite endpoint of adjudicated VTE, arterial thrombosis, ECMO, or all-cause mortality, the INSPIRATION trial found no difference between patients in the ICU who were treated with an intermediate dose of anticoagulation (enoxaparin 1 mg/kg daily) and those who received a prophylactic dose (45.7% vs. 44.1%; OR 1.06; 95% CI, 0.76–1.48). Major bleeding occurred in 2.5% of patients in the intermediate-dose anticoagulation arm and in 1.4% of patients who received the prophylactic dose. Overall, there was no significant benefit of receiving an intermediate dose of anticoagulation for patients with COVID-19 who were in the ICU.28

A multiplatform randomized control trial (ATTACC/ACTIV-4a/REMAP-CAP) compared the effectiveness of a therapeutic dose of heparin or LMWH with usual care in reducing the number of organ support-free days among critically ill patients with COVID-19.25 All 3 trials were stopped for futility. Heparin doses in the usual care arm varied. The median number of organ support-free days was 3 days (IQR -1 to 16) for patients who received a therapeutic dose of anticoagulation and 4 days (IQR -1 to 16) for patients who received usual care. The likelihood of survival to hospital discharge did not differ between the arms (63% for the therapeutic arm vs. 65% for the usual care arm; aOR 0.84; 95% CrI, 0.64–1.11). Major bleeding occurred in 4% of patients who received therapeutic anticoagulation and in 2% of patients who received usual care. Therapeutic doses of heparin showed no significant benefit for patients with COVID-19 who were admitted to the ICU.
Given the results of these trials, for hospitalized, nonpregnant adults with COVID-19 who require ICU level-care and who do not have documented or suspected VTE:

- The Panel recommends using a **prophylactic dose of heparin** as VTE prophylaxis, unless a contraindication exists (AII).

- For patients who start on a therapeutic dose of heparin in a non-ICU setting due to COVID-19 and then transfer to the ICU, the Panel recommends switching from the therapeutic dose to a **prophylactic dose of heparin**, unless VTE is confirmed (BIII).

- The Panel **recommends against** the use of an **intermediate dose** (e.g., enoxaparin 1 mg/kg daily) or a **therapeutic dose of anticoagulation** for VTE prophylaxis, except in a clinical trial (BII).

### Rivaroxaban Versus Usual Care in Hospitalized Patients With Elevated D-Dimer Levels

The ACTION trial randomized adults hospitalized with COVID-19 and elevated D-dimer levels (defined as above the laboratory ULN) to receive rivaroxaban 20 mg once daily for 30 days or usual care. No statistical difference was found between the arms for the composite endpoint of time to death, hospitalization duration, and oxygen use duration (hierarchical analysis; win ratio 0.86; 95% CI, 0.59–1.22) or for the individual components. The probability of clinically relevant, nonmajor bleeding was greater in the rivaroxaban arm (5% in the rivaroxaban arm vs. 1% in the usual care arm; relative risk 5.23; 95% CI, 1.54–17.77), but for major bleeding events, the difference in probability between the arms was not significant (3% in the rivaroxaban arm vs. 1% in the usual care arm; relative risk 2.45; 95% CI, 0.78–7.73).

Given the lack of benefit and the increased risk of bleeding events, the Panel **recommends against** the use of a **therapeutic dose of oral anticoagulants** for VTE prophylaxis or the prevention of COVID-19 progression, except in a clinical trial (BIIa).

### Antiplatelet Therapy Versus Usual Care in Hospitalized Patients

Multiple retrospective cohort studies have suggested that the use of aspirin reduced in-hospital mortality in patients who were treated prior to hospital admission or within 24 hours of admission. These studies have been summarized in meta-analyses. These epidemiologic studies used propensity scoring or adjusted for potential confounders, but indication bias cannot be fully removed from these studies. Thus, randomized controlled trials are needed to further define the role of aspirin and other antiplatelet therapies as adjunctive treatments in the management of COVID-19.

The RECOVERY trial randomized hospitalized adults with COVID-19 to receive usual care plus aspirin 150 mg per day (n = 7,351) or usual care only (n = 7,541). At enrollment, 38% of the patients required noninvasive ventilation or mechanical ventilation. Mortality at 28 days was 17% in both arms (rate ratio 0.96; 95% CI, 0.89–1.04). Among patients who were not receiving mechanical ventilation at baseline, there was no difference between the arms in the proportion of patients who progressed to requiring mechanical ventilation or death (21% in the aspirin arm vs. 22% in the usual care arm; rate ratio 0.96; 95% CI, 0.90–1.03). Among those treated with aspirin, the incidence of thrombotic events was lower (4.6% vs. 5.3%; absolute difference 0.6%; SE 0.4%), and the incidence of major bleeding events was higher (1.6% vs. 1.0%; absolute difference 0.6%; SE 0.2%). Overall, in this large trial of hospitalized patients with COVID-19, the use of aspirin was associated with an increase in the incidence of major bleeding events and did not reduce the risk of death.

The ACTIV-4a trial compared the use of P2Y12 inhibitor therapy plus a therapeutic dose of heparin to a therapeutic dose of heparin alone in hospitalized patients with COVID-19. In this study, enrollment of noncritically ill patients was stopped early due to futility; the combination therapy did not improve the number of organ support-free days. The limitations of this study include the open-label design, the use of different P2Y12 inhibitors, and the trial size.
Based on the findings of the ACTIV-4a and RECOVERY trials, the Panel **recommends against** the use of antiplatelet therapy to prevent COVID-19 progression or mortality in noncritically ill patients (**BIIa**).

The REMAP-CAP study team randomized critically ill patients with COVID-19 to receive aspirin (n = 565), a P2Y12 inhibitor (n = 455), or no antiplatelet therapy (n = 529). Treatment continued for 14 days or until hospital discharge, whichever came first. The aspirin and P2Y12 inhibitor arms were pooled for analysis because the criteria for equivalence were met. The trial was stopped early due to futility, as the median number of organ support-free days did not differ between the pooled antiplatelet and control arms (7 days; IQR 1–16 days; 95.7% posterior probability of futility). There was no statistically significant difference between the number of patients who survived to hospital discharge (723 of 1,011 patients [71.5%] in the pooled antiplatelet arm vs. 354 of 521 patients [67.9%] in the control arm; median-adjusted OR 1.27; 95% CrI, 0.99–1.62). The pooled antiplatelet arm had improved survival by 90 days (median aHR 1.22; 95% CrI, 1.06–1.40). The use of antiplatelet therapy was associated with an increased incidence of major bleeding (2.1% in the pooled antiplatelet arm vs. 0.4% in the control arm; aOR 2.97; 95% CrI, 1.23–8.28; adjusted absolute risk difference of 0.8%; 95% CrI, 0.1% to 2.7%).

In the RECOVERY trial, the use of aspirin therapy was not associated with a reduction in mortality in the subgroups of patients who required noninvasive ventilation or mechanical ventilation at baseline. In the REMAP-CAP trial, administering antiplatelet therapy to critically ill patients with COVID-19 improved 90-day survival but did not increase the number of organ support-free days. In both studies, the use of antiplatelet therapy was associated with an increased risk of bleeding. As such, there is insufficient evidence for the Panel to recommend either for or against the use of antiplatelet therapy in critically ill patients with COVID-19. Eligible patients should be encouraged to participate in clinical trials that are evaluating the use of antiplatelet therapy.

The clinical data for the trials discussed above are summarized in **Table 7b**.

**Thrombolytic Therapy**

Clinical trials are evaluating the effects of thrombolysis on mortality and the progression of COVID-19. There is insufficient evidence for the Panel to recommend either for or against the use of thrombolytic agents for VTE prophylaxis in hospitalized patients with COVID-19 outside of a clinical trial.

**Hospitalized Children**

A recent meta-analysis of publications on COVID-19 in children did not discuss VTE. Indications for VTE prophylaxis in hospitalized children with COVID-19 should be the same as those for hospitalized children without COVID-19 (**BIII**). For the Panel’s recommendations on the use of antithrombotic therapy in children, see Therapeutic Management of Hospitalized Children With COVID-19 and Therapeutic Management of Hospitalized Pediatric Patients With Multisystem Inflammatory Syndrome in Children (MIS-C) (With Discussion on Multisystem Inflammatory Syndrome in Adults [MIS-A]).

**Patients Discharged From the Hospital**

For patients with a high risk of VTE who do not have COVID-19, post-discharge prophylaxis has been shown to be beneficial. The Food and Drug Administration approved the use of rivaroxaban 10 mg once daily for 31 to 39 days in these patients. Inclusion criteria for the trials that studied post-discharge VTE prophylaxis included:

- A VTE risk score of ≥4 on the modified International Medical Prevention Registry on Venous Thromboembolism (IMPROVE) tool;
- A VTE risk score ≥2 on the modified IMPROVE tool and a D-dimer level >2 times ULN.
The MICHELLE trial randomized 320 patients with COVID-19 and an IMPROVE score of ≥4 or 2 to 3 with a D-dimer level >500 ng/mL to receive rivaroxaban 10 mg orally once daily or no anticoagulation for 35 days. The primary outcome was a composite of symptomatic VTE, fatal pulmonary embolism, symptomatic arterial thromboembolism, cardiovascular death, or asymptomatic VTE detected on screening imaging at Day 35. Five patients (3%) who were treated with rivaroxaban and 15 patients (9%) who did not receive anticoagulation experienced a thrombotic event (relative risk 0.33; 95% CI, 0.13–0.9). One patient who received rivaroxaban and 10 patients who did not receive anticoagulation experienced symptomatic events. No major bleeding events occurred, and 2 patients had clinically relevant, nonmajor bleeding in each arm. The open-label design and the inclusion of asymptomatic events that were detected on screening ultrasounds and computed tomography scans may have biased the results. Additionally, two-thirds of the screened patients did not meet the eligibility criteria for the trial, which limits the generalizability of the results.

The Panel recommends against routinely continuing VTE prophylaxis for patients with COVID-19 after hospital discharge, except in a clinical trial (AIII). For patients who are at high risk of VTE and low risk of bleeding, there is insufficient evidence for the Panel to recommend either for or against continuing anticoagulation after discharge, unless another indication for VTE prophylaxis exists. Decisions to use post-discharge VTE prophylaxis in patients with COVID-19 should include consideration of the individual patient’s risk factors for VTE, bleeding risks, and feasibility. Eligible patients should be encouraged to participate in clinical trials that are evaluating the use of VTE prophylaxis.

Pregnant and Lactating Patients

Because pregnancy is a hypercoagulable state, the risk of thromboembolism is greater in pregnant individuals than in nonpregnant individuals. It is not yet known whether COVID-19 increases this risk. In several cohort studies of pregnant women with COVID-19 in the United States and Europe, VTE was not reported as a complication even among women with severe disease, although the receipt of prophylactic or therapeutic anticoagulation varied across the studies. The American College of Obstetricians and Gynecologists (ACOG) advises that, although there are no data for or against the use of thromboprophylaxis in the setting of COVID-19 during pregnancy, VTE prophylaxis can reasonably be considered for pregnant individuals hospitalized with COVID-19, particularly for those who have severe disease. If there are no contraindications, the Society for Maternal-Fetal Medicine recommends the use of prophylactic heparin or LMWH in pregnant patients who are critically ill or receiving mechanical ventilation. Several professional societies, including the American Society of Hematology and ACOG, have guidelines that specifically address the management of VTE in the context of pregnancy. If delivery is imminent, or if there are other risks for bleeding, the risk of bleeding may outweigh the potential benefit of using VTE prophylaxis in pregnant individuals.

Outside of pregnancy, D-dimer levels have been used to stratify VTE risk. However, physiologic increases in D-dimer levels may occur during pregnancy, making elevated D-dimer values an unreliable predictor that should not be used to evaluate VTE risk during pregnancy in the setting of COVID-19.

In general, the preferred anticoagulants for use during pregnancy are heparin compounds. Because of its reliability and ease of administration, LMWH is recommended rather than UFH for the prevention and treatment of VTE in pregnancy. Direct-acting anticoagulants are not routinely recommended for use during pregnancy because of a lack of safety data for pregnant individuals. The use of warfarin to prevent or treat VTE should be avoided in pregnant individuals regardless of their COVID-19 status, especially during the first trimester, due to the concern for teratogenicity.

Specific recommendations for pregnant or lactating individuals with COVID-19 include:

- The Panel recommends that pregnant patients who are receiving anticoagulant or antiplatelet
therapies for underlying conditions continue these medications after they receive a diagnosis of COVID-19 (AIII).

- The Panel recommends the use of a **prophylactic dose of anticoagulation** for pregnant patients who are hospitalized for manifestations of COVID-19, unless a contraindication exists (BIII).
- Because pregnant patients have not been included in most clinical trials evaluating therapeutic anticoagulation in the setting of COVID-19, there is insufficient evidence for the Panel to recommend either for or against the use of therapeutic anticoagulation in pregnant patients with COVID-19 who do not have evidence of VTE.
- As in nonpregnant patients, VTE prophylaxis after hospital discharge is not routinely recommended for pregnant patients (BIII). Decisions to continue VTE prophylaxis in the pregnant or postpartum patient after discharge should be individualized, with consideration of concomitant VTE risk factors.
- The use of anticoagulation therapy during labor and delivery requires specialized care and planning. It should be managed in pregnant patients with COVID-19 in a similar way as in pregnant patients with other conditions (AIII).
- UFH, LMWH, and warfarin do not accumulate in breast milk and do not induce an anticoagulant effect in the newborn; therefore, they can be used by breastfeeding individuals who require VTE prophylaxis or treatment (AIII).

References

10. PROTECT Investigators for the Canadian Critical Care Trials Group, Australian and New Zealand Intensive Care...


25. ATTACC Investigators, ACTIV-4a Investigators, REMAP-CAP Investigators, et al. Therapeutic


