Hello, and welcome to the March 2020 edition of *Vascular Disease Management*. I have chosen to comment on an article by Reshma Reddy Golamari, MD, and colleagues, entitled “Catheter-directed thrombolysis in submassive pulmonary embolism: safety and efficacy.”

I have chosen to comment on this article because pulmonary embolism (PE) accounts for the death of over 100,000 hospitalized patients per year in the United States. Interventional and surgical treatment has been shown to improve overall survival with less long-term morbidity, and these advances have resulted in the proliferation of dedicated pulmonary embolus response teams throughout this country. Interventional therapy has been demonstrated, in certain subsets, to lessen the likelihood of subsequent development of chronic thromboembolic pulmonary hypertension (CTEPH), which has been reported to occur in up to 4% of patients and portends a poor prognosis. While PE response teams primarily began at major tertiary hospitals, smaller centers are now also reporting improved outcomes with team-directed therapy in acute PE. In this article, Golamari reported favorable outcomes in the interventional therapy of 10 patients presenting with submassive PE at a small community hospital. His team utilized catheter-directed thrombolytic administration coupled with ultrasound to facilitate rapid thrombus dissolution with favorable outcomes.

The severity of PE is classified as massive where there is acute hemodynamic compromise, submassive with right ventricular dysfunction (demonstrable by echocardiography, computed tomography angiography, or elevated cardiac biomarkers), or low risk (without evidence of right ventricular dysfunction or compromise). These classifications are associated with acute mortality rates of 58%, 15%, and less than 2%, respectively.

Patients with documented PE should be fully anticoagulated immediately, then undergo urgent echocardiographic evaluation to assess right ventricular function and size. Serum biomarkers, troponin, and brain-natriuretic peptide should be obtained. Clinical assessment of hemodynamic status and risk of intervention include a thorough history of bleeding risk; recent cerebrovascular accident or transient ischemic attack; recent neurosurgery; recent intracranial trauma; absolute anticoagulation risk; recent cardiopulmonary resuscitation; recent abdominal, ophthalmic, or obstetric surgery; recent trauma; history of intracranial tumor or vascular abnormality; and uncontrolled hypertension. Risks include recent gastrointestinal bleed; history of severe contrast allergy; severe thrombocytopenia, known right-left cardiac or pulmonary shunt; suspected intracardiac thrombus; suspected infected venous thrombus; chronic kidney disease; active pregnancy; severe liver disease; and active sepsis.

Low-risk patients are typically treated with anticoagulation alone, but data have clearly shown that there is a role for intervention in massive and submassive embolization. Historically, acute massive PE was treated with anticoagulation and either systemic lytic therapy or surgical embolectomy with extracorporeal support when necessary. More recently, interventional techniques such as catheter-directed thrombolysis augmented by ultrasound with the EKOS device (BTG), catheter-based thrombus fragmentation, rheolytic thrombectomy (AngioJet), suction embolectomy (Penumbra Indigo System) and directed mechanical thrombus removal (Inari FlowTriever system) have emerged as additional therapeutic options.

Thrombolytic agents are contraindicated in patients with active pathological bleeding or patients who are at high risk of bleeding with thrombolytics. Catheter-directed thrombolysis with coupled ultrasound may facilitate quicker thrombolysis and allow lower dose thrombolytic therapy and shorter infusion times, but there remains a risk of pathological bleeding. Catheter fragmentation devices macerate but do not remove thrombus, resulting in risk of embolization. Rheolytic devices may cause complications.
such as bradycardia, hypoxia, and vasospasm that are thought to be secondary to the release of adenosine from platelet disruption. There are reports that these adverse effects can be overcome by aminophylline infusion and prophylactic temporary pacing. The Inari FlowTriever and Penumbra Indigo System can be utilized in patients with absolute contraindication to thrombolytic drugs, as these devices mechanically remove or suction thrombus, respectively.

Following interventional therapy, patients should be fully anticoagulated for 3 to 6 months. Data from the EINSTEIN CHOICE trial suggest that anticoagulation for up to 1 year with rivaroxaban can decrease recurrent thromboembolic events with relatively low risk of major bleeding.

Great strides have been made in the interventional therapy of massive and submassive PE and have resulted in decreased mortality and decreased development of chronic thromboembolic pulmonary hypertension. PE response teams are a crucial part of this new paradigm, but better prevention of PE in high-risk subsets is also needed.