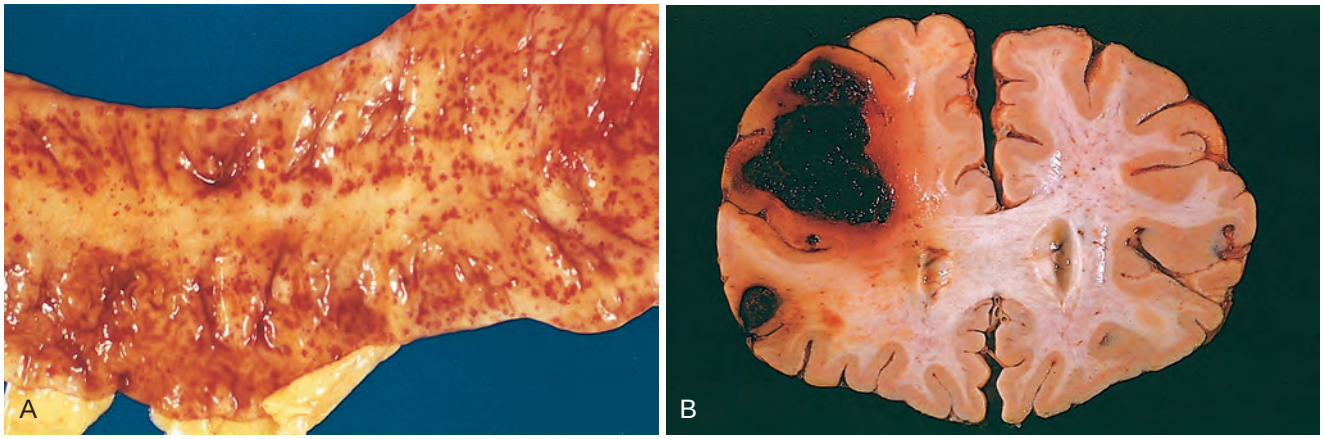

Figure 4-11 **A,** Punctate petechial hemorrhages of the colonic mucosa, a consequence of thrombocytopenia. **B,** Fatal intracerebral bleed.

(≥3 mm) than petechiae. It is believed that the capillaries of the mucosa and skin are particularly prone to rupture following minor trauma and that under normal circumstances platelets seal these defects virtually immediately. Mucosal bleeding associated with defects in primary hemostasis may also take the form of epistaxis (nosebleeds), gastrointestinal bleeding, or excessive menstruation (menorrhagia). A feared complication of very low platelet counts (*thrombocytopenia*) is intracerebral hemorrhage, which may be fatal.

- *Defects of secondary hemostasis (coagulation factor defects)* often present with bleeds into soft tissues (e.g., muscle) or joints. Bleeding into joints (*hemarthrosis*) following minor trauma is particularly characteristic of hemophilia (Chapter 14). It is unknown why severe defects in secondary hemostasis present with this peculiar pattern of bleeding; as with severe platelet defects, intracranial hemorrhage, sometimes fatal, may also occur.
- *Generalized defects involving small vessels* often present with "palpable purpura" and ecchymoses. *Ecchymoses* (sometimes simply called bruises) are hemorrhages of 1 to 2 cm in size. In both purpura and ecchymoses, the volume of extravasated blood is sufficient to create a palpable mass of blood known as a *hematoma*. Purpura and ecchymoses are particularly characteristic of systemic disorders that disrupt small blood vessels (e.g., vasculitis, Chapter 11) or that lead to blood vessel fragility (e.g., amyloidosis, Chapter 6; scurvy, Chapter 9).

The clinical significance of hemorrhage depends on the volume of the bleed, the rate at which it occurs, and its location. Rapid loss of up to 20% of the blood volume may have little impact in healthy adults; greater losses, however, can cause *hemorrhagic (hypovolemic) shock* (discussed later). Bleeding that is trivial in the subcutaneous tissues can cause death if located in the brain (Fig. 4-11*B*); because the skull is unyielding, intracranial hemorrhage may increase intracranial pressure to a level that compromises the blood supply or causes herniation of the brainstem (Chapter 28). Finally, chronic or recurrent external blood loss (e.g., peptic ulcer or menstrual bleeding) causes iron loss and can lead to an iron deficiency anemia. In contrast, when red cells are retained (e.g., hemorrhage into body cavities or tissues), iron is recovered and recycled for use in the synthesis of hemoglobin.

Thrombosis

The primary abnormalities that lead to thrombosis are (1) endothelial injury, (2) stasis or turbulent blood flow, and (3) hypercoagulability of the blood (the so-called Virchow triad) (Fig. 4-12). Thrombosis is one of the scourges of modern man, because it underlies the most serious and common forms of cardiovascular disease. Here, the focus is on its causes and consequences; its role in cardiovascular disorders is discussed in detail in Chapters 11 and 12.

Endothelial Injury

Endothelial injury leading to platelet activation almost inevitably underlies thrombus formation in the heart and the arterial circulation, where the high rates of blood flow impede clot formation. Notably, cardiac and arterial clots are typically rich in platelets, and it is believed that platelet adherence and activation is a necessary prerequisite for thrombus formation under high shear stress, such as exists

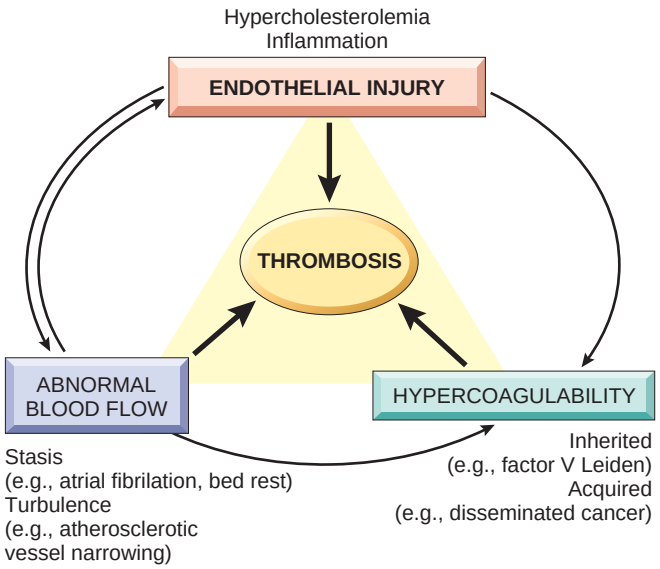

Figure 4-12 The Virchow triad in thrombosis. Endothelial integrity is the most important factor. Injury to endothelial cells can alter local blood flow and affect coagulability. Abnormal blood flow (stasis or turbulence), in turn, can cause endothelial injury. These factors may promote thrombosis independently or in combination.