REVIEW ARTICLE

blood advances

A practical approach to evaluating postoperative thrombocytopenia

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Identifying the cause(s) of postoperative thrombocytopenia is challenging. The postoperative period includes numerous interventions, including fluid administration and transfusion of blood products, medication use (including heparin), and increased risk of organ dysfunction and infection. Understanding normal thrombopoietin physiology and the associated expected postoperative platelet count changes is the crucial first step in evaluation. Timing of thrombocytopenia is the most important feature when differentiating causes of postoperative thrombocytopenia. Thrombocytopenia within 4 days of surgery is commonly caused by hemodilution and increased perioperative platelet consumption prior to thrombopoietin-induced platelet count recovery and transient platelet count overshoot. A much broader list of possible conditions that can cause late-onset thrombocytopenia (postoperative day 5 [POD5] or later) is generally divided into consumptive and destructive causes. The former includes common (eg, infection-associated disseminated intravascular coagulation) and rare (eg, postoperative thrombotic thrombocytopenic purpura) conditions, whereas the latter includes such entities as drug-induced immune thrombocytopenia or posttransfusion purpura. Heparin-induced thrombocytopenia is a unique entity associated with thrombosis that is typically related to intraoperative/perioperative heparin exposure, although it can develop following knee replacement surgery even in the absence of heparin exposure. Very late onset (POD10 or later) of thrombocytopenia can indicate bacterial or fungal infection. Lastly, thrombocytopenia after mechanical device implantation requires unique considerations. Understanding the timing and severity of postoperative thrombocytopenia provides a practical approach to a common and challenging consultation.

Introduction

Thrombocytopenia, frequently defined as a platelet count of $<150 \times 10^9$/L, occurs after major surgery in 30% to 60% of patients.[1,2] However, if thrombocytopenia is defined as any significant decline in platelet count (eg, 20% or 30%) compared with a preoperative baseline value, then virtually all patients undergoing major surgery experience "thrombocytopenia."

The differential diagnosis of postoperative thrombocytopenia is broad and includes pseudothrombocytopenia (eg, spurious platelet clumping, platelet satellitism, blood drawn from above an IV infusion site), hemodilution, increased platelet clearance due to consumption or destruction, sequestration (eg, hypersplenism), or decreased platelet production.[3] We aim to provide a practical approach to differentiating various pathological conditions from normal postoperative thrombocytopenia, with a focus on the timing of the platelet count decrease, its magnitude, and other associated features. We will also briefly review the distinct presentations of thrombocytopenia with artificial surface exposure such as after mechanical device implantation.

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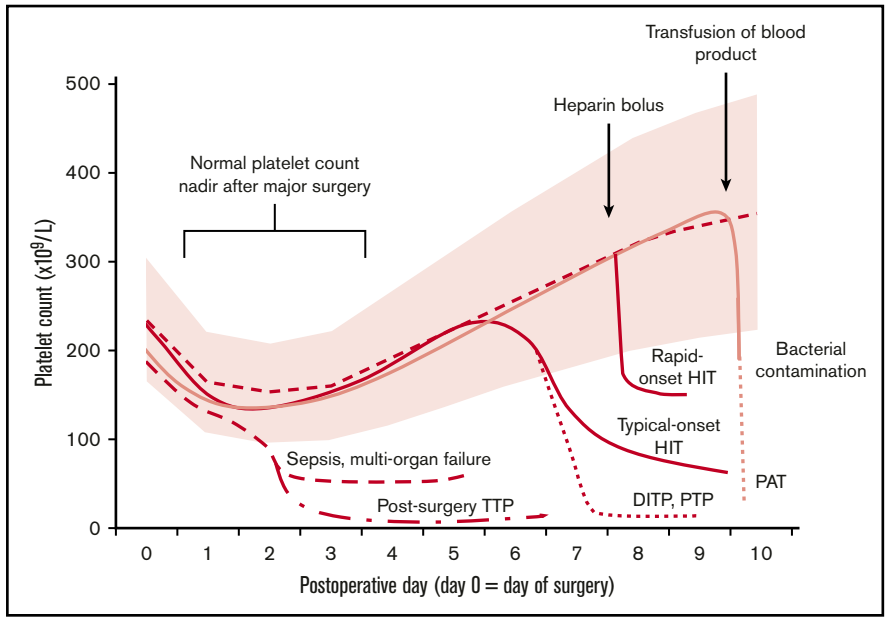

Figure 1. Normal physiology of changes to platelet counts after surgery and the expected deviations with different pathological conditions. DITP, drug-induced immune thrombocytopenia; HIT, heparin-induced thrombocytopenia; PAT, passive alloimmune thrombocytopenia; PTP, posttransfusion purpura; TTP, thrombotic thrombocytopenic purpura. Adapted from Hoffman et al (eds) with permission.[40]

Normal platelet count changes during the postoperative period

A platelet count decrease is normal and expected within 4 days of surgery, resulting from the combined effects of hemodilution along with accelerated platelet consumption related to surgical hemostasis (Figure 1). The majority of cardiac surgery patients have a nadir platelet count on postoperative days 2 to 3 (POD2 to POD3), with the platelet count returning to baseline by day 5.[4,5] In a prospective study of 581 cardiac surgery patients, 97% reached a platelet count nadir between day 1 and day 4.[1,6] Hemodilution-associated thrombocytopenia is proportional to the amount of crystalloid, colloid, and non–platelet-containing blood products given. Similar initial reductions in hemoglobin, hematocrit, and white blood cell count may also be seen.[3] Dilutional thrombocytopenia manifests within minutes to a few hours following surgery, with the platelet count continuing to decrease over the following 1 to 3 days due to a combination of fluid administration and ongoing platelet consumption. Furthermore, the thrombopoietin response to acute thrombocytopenia takes 3 to 4 days to increase platelet production by the bone marrow megakaryocytes (Figure 1).

Different types of surgery may affect the degree of thrombocytopenia and subsequent platelet count recovery, likely reflecting different amounts of hemodilution and platelet consumption, including consumption from cardiac pulmonary bypass (CPB) in certain surgeries.[1,7,8] For example, 56% of cardiac surgery patients had a platelet count $<150 \times 10^9$/L postoperatively, compared with 28% of hip surgery patients, reflecting the greater magnitude of platelet count decrease seen in cardiac vs orthopedic surgery patients (~50% vs ~30%).[1,2]

The thrombopoietin response to platelet dilution and consumption results in a physiological "overshoot" in the platelet count. Postoperative platelet counts peak at two- to threefold the patient's preoperative platelet count at approximately POD14, before gradually returning to the patient's baseline value over the following 14 days.[2,9] This overshoot occurs because of a delay between an increase in thrombopoietin that stimulates megakaryocytes and the release of new platelets from the bone marrow. Figure 1 highlights normal thrombopoietin physiology. Healthy volunteers administered a thrombopoietin agonist showed an increased platelet count beginning at least 3 days later, with peak platelet counts achieved on days 12 to 16.[9] Given the expected platelet count increase from the time of postoperative nadir (usually seen on POD2 and POD3 [range, POD1 to POD4]) to approximately day 14, any confirmed platelet count decline that occurs between days 4 and 14 requires investigation.

Spurious thrombocytopenia

"Pseudothrombocytopenia" refers to various explanations for spurious causes of thrombocytopenia. EDTA-related platelet clumping can occur, or less commonly platelets can bind to leukocytes, resulting in the morphological appearance of platelet rosetting around polymorphonuclear leukocytes (ie, satellitism). These phenomena result from naturally occurring immunoglobulin G (IgG) antibodies that recognize EDTA-specific epitopes on platelet glycoprotein IIb/IIIa (GPIIb/IIIa) and neutrophil FcγIII receptors, respectively. Platelet clumping/satellitism occurs ex vivo, as the causative antibodies react under low calcium concentrations caused by the chelating anticoagulant, EDTA, and can be time-dependent. Examination of a peripheral blood film and redrawing the sample into a tube containing sodium citrate usually helps distinguish spurious from true thrombocytopenia: it is important to remember that the platelet count drawn into citrate will be spuriously reduced (by ~10%) due to the dilutional or anticoagulant effect of the citrate anticoagulant solution into which the blood is drawn.[10]

Specimen collection and handling can also cause spurious thrombocytopenia. A traumatic venipuncture with ex vivo thrombin-induced platelet clumping results in a single reduced platelet value. Other causes of spurious thrombocytopenia include sample collection above a running IV fluid administration site, incorrect sample handling such as high or low temperatures, or

Table 1. Classification of postoperative thrombocytopenia based upon timing of onset

Early (within 4 d of surgery)*	Late (POD5 or later)
Hemodilution: common	HIT: usually begin 5 to 10 d after intraoperative heparin (cardiac or vascular surgery) or 5 to 10 d after start of postoperative heparin thromboprophylaxis
DIC: common in patients who develop serious postoperative complications such as sepsis, cardiogenic shock, multiorgan dysfunction syndrome	DIC: sepsis and other causes of DIC can occur on POD5 or later; late thrombocytopenia sometimes indicates fungemia
TMA: rare, TTP, or aHUS occur in the early postoperative period	DITP: usually begins at least 5 d after start of perioperative medication, eg, vancomycin, cephalosporins, etc
PAT: rare; abrupt drop in platelet count secondary to platelet-reactive alloantibodies present in transfused blood products	PTP: rare; severe drop in platelet count occurring at least 5 d after perioperative administration of blood product that leads to formation of platelet-reactive alloantibodies
CAPS: rare, can be triggered by surgery	
Mechanical: CPB, intravascular catheters, implantable devices including ventricular assist devices	

aHUS, atypical hemolytic uremic syndrome; CAPS, catastrophic antiphospholipid syndrome; CPB, cardiopulmonary bypass.
*Persistent thrombocytopenia may be due to preexisting conditions such as bone marrow disorders, lymphoproliferative disorders, splenomegaly, hereditary thrombocytopenia, cardiac/valvular disorders, or chronic infections such as HIV or hepatitis C.

sample movements in vacuum tube transport systems. If any unexpected platelet count occurs, a repeat platelet count value on the same day is recommended to confirm or refute the decline, along with other tests to investigate a true thrombocytopenia (see "Investigations").

Pathologic causes of postoperative thrombocytopenia

Thrombocytopenia related to existing bone marrow disorders or splenomegaly may be present prior to surgery. Immediate postoperative thrombocytopenia will be more severe and the expected postoperative thrombocytosis may not be evident.

Unexpected postoperative thrombocytopenia is caused by platelet consumption or platelet destruction. Platelet consumption refers to those disorders in which physiological processes are pathologically accelerated, such as thrombin generation or platelet/von Willebrand factor interactions in disseminated intravascular coagulation (DIC) and thrombotic microangiopathies (TMAs), respectively. Platelet destruction refers to nonphysiological processes such as direct immune-mediated platelet clearance, as seen in immune thrombocytopenia (ITP), drug-induced ITP (DITP), or posttransfusion purpura (PTP), among others (Table 1). Heparin-induced thrombocytopenia (HIT) is a unique prothrombotic disorder in which antibody-mediated activation of platelets occurs with parallel marked activation of coagulation.

Timing of thrombocytopenia

The timing of thrombocytopenia is the most important feature when differentiating among the causes of postoperative thrombocytopenia. Table 1 summarizes the classification of acute thrombocytopenia in postoperative or posttrauma patients, based on early (within 4 days) vs late (POD5 or later) thrombocytopenia.

Platelet count decrease within 4 days of surgery

Immediate postoperative thrombocytopenia occurs because of hemodilution, consumption, and occasionally spurious results. Multiorgan failure occurs early in some postoperative patients; usually, these patients will meet criteria for DIC and/or shock. Clinical features of shock include hypotension or decreased urine output and laboratory features such as lactic acidemia, liver or kidney dysfunction, and bone marrow stress response (leukoerythroblastic picture with immature white blood cells and nucleated red blood cells). Early bacteremia and sepsis, or ongoing bleeding postoperatively, may also cause a more profound early postoperative thrombocytopenia.[11]

Patients with severe DIC, ongoing shock, and associated liver dysfunction are at high risk of developing microvascular thrombosis in peripheral limbs manifesting as symmetrical peripheral gangrene. Ischemic hepatocellular injury leads to lack of protein C and antithrombin production and results in dysregulated thrombin generation. The clinical picture includes lactic acidemia (reflecting circulatory shock), circulating nucleated red cells, severe thrombocytopenia, elevated fibrin D-dimer (reflecting increased fibrin formation/fibrinolysis in DIC), and preceding acute transaminitis (indicating "shock liver"). Critical limb ischemia/necrosis usually begins or progresses 2 to 5 days after the onset of shock and shock liver, which reflects the time required to achieve critical depletion of protein C and antithrombin.[12] In a patient who had recently received heparin, the clinical picture can suggest a (wrong) diagnosis of HIT.

Cardiac patients with implanted devices (eg, ventricular assist devices, intra-aortic balloon pumps) or indwelling catheters (eg, extracorporeal membrane oxygenation) may have additional reasons for early consumption and will be discussed in "Postoperative thrombocytopenia with artificial surface exposure."

Development of HIT prior to POD5 is due to presence of HIT antibodies resulting from recent prior heparin exposure. One scenario is a course of heparin given a few days before cardiac surgery; here, the characteristic onset of thrombocytopenia beginning 5 to 10 days after an immunizing exposure to heparin may coincide with the early postcardiac surgery period.[13] Another scenario is administration of intraoperative heparin followed by a marked intraoperative or early postoperative platelet count decline because of "rapid-onset HIT" after an immunizing exposure to heparin in the previous 100 days.[14]

DITP rarely occurs within POD1 to POD4. However, early DIPT is possible after a single dose of GPIIb/IIIa inhibitors (due to naturally occurring antibodies), or because of reexposure to a medication to which a patient is sensitized due to previous exposure. Unlike HIT, such latent antibodies can be present for years postexposure. For example, DITP after perioperative antibiotic prophylaxis can occur in patients who previously have been exposed to the same antibiotic in the remote past (Figure 2A).

Rare disorders that cause early postoperative thrombocytopenia

Some rare thrombocytopenic disorders, such as TMA entities like thrombotic thrombocytopenic purpura (TTP) or atypical hemolytic uremic syndrome (aHUS) can be triggered by surgery or trauma.[15,16] Features that should prompt consideration of postoperative TMA include a platelet count nadir that is below what is expected, plus the presence of fragmentation hemolysis (Figure 2B). Evidence of end-organ dysfunction with TTP or aHUS (eg, neurological or renal dysfunction) may also be present. Sometimes, patients with antiphospholipid antibody syndrome (APS), either known or previously undiagnosed, develop catastrophic APS (CAPS) following surgery or trauma.[17,18] Additional features of end-organ dysfunction (eg, renal or neurological dysfunction), or venous, arterial, or small-vessel thrombosis may be present. Severe thrombocytopenia with clinical evidence of microvascular thrombosis in several organs should prompt consideration of CAPS.

Platelet count decrease from POD5 to POD10

Immune causes of thrombocytopenia that reflect new antibody production usually take at least 5 days to manifest, explaining why disorders such as DITP, HIT, or PTP usually become manifest during the second postoperative week. A typical presentation includes 2 successive episodes of thrombocytopenia: the first (expected) early postoperative thrombocytopenia, followed by partial or complete platelet count recovery with a subsequent unexpected platelet count fall pointing to an immune-mediated disorder.[5,19]

DITP usually occurs after drug administration for 5 or more days, such as when medications are started in the postoperative period. Typically, severe thrombocytopenia with petechiae and purpura develop ~1 week after starting a new medication.[20] Drugs most likely to be implicated for postoperative DITP include antibiotics such as vancomycin, piperacillin, cephalosporins, and trimethoprim-sulfamethoxazole; anticonvulsants such as carbamazepine; anti-inflammatories such as naproxen and ibuprofen; as well as other medications such as amiodarone, ranitidine, and haloperidol.[3,21,22] A DITP is unlikely to be present unless thrombocytopenia is severe (platelet count $<20 \times 10^9$/L). Exceptions to the timing of DITP are from glycoprotein IIb/IIIa inhibitors, where thrombocytopenia usually occurs within hours of the first dose. Immune thrombocytopenia without prior drug exposure is less common but possible, particularly in a patient with known ITP.

Thrombocytopenia may occur after blood product transfusion. PTP is an alloimmune reaction that causes severe thrombocytopenia ~1 week after a blood product transfusion.[3] Passive alloimmune thrombocytopenia (PAT) has a similar etiology to transfusion-associated acute lung injury where platelet-reactive alloantibodies present within a blood product cause thrombocytopenia abruptly after administrating the blood product, such as packed red blood cells or frozen plasma. Thrombocytopenia is generally severe when alloantibodies reactive against human platelet alloantigen 1a (HPA-1a) are implicated, but can be less severe if the alloantibodies against the HPA-5a/b system are responsible (Figure 2C).[23] Bacterial contamination of a blood product and associated sepsis can also cause thrombocytopenia soon after transfusion.

If heparin was administered intraoperatively or postoperatively, then HIT should be considered, especially in the absence of bleeding and infection. Most patients with HIT are postsurgical, likely reflecting the immunizing effects of combining heparin with release of platelet factor 4 (PF4) from perioperative platelet activation. Sometimes, the preceding immunizing heparin exposure is trivial (eg, heparin "flushes") or obscure (eg, heparin administration during an interventional radiology procedure). Patients with HIT have a characteristic platelet count drop that typically begins 5 to 10 days after the preceding immunizing heparin exposure, with a >50% decrease from highest postoperative platelet count value that immediately precedes the platelet count decline.[7] Patients with HIT may have associated venous and arterial thromboembolism (ratio of venous to arterial thrombosis of 4:1) and less commonly necrotizing skin reactions at heparin injection sites and anaphylactoid reactions within 30 minutes of receiving IV bolus heparin.[2,24] Adrenal hemorrhage or infarction is possible and presumed to be secondary to adrenal vein thrombosis. The 4Ts score is a helpful framework to identify patients at risk of HIT. If the pretest probability is high enough, defined as a 4Ts score ≥4 points, then instituting therapeutic anticoagulation with a nonheparin anticoagulant while awaiting laboratory evaluation of HIT is recommended.[25,26] Patients with HIT have evidence of overt DIC (with decreased fibrinogen or increased international normalized ratio [INR]) in ~10% to 15% of cases.[19]

The platelet count fall of HIT can begin or worsen despite stopping heparin. Known as "delayed-onset HIT," this condition is now classified as 1 of the "autoimmune HIT" disorders, which are characterized by the presence of pathologic HIT antibodies that can activate platelets even in the absence of heparin.[27,28] It can take several weeks for platelet count recovery in such patients ("persisting or refractory HIT"). HIT can also occur after surgery in the absence of perioperative heparin exposure. This has been reported in ~12 patients after knee replacement surgery and could reflect immunization triggered by release of PF4/polyanion complexes released abruptly after tourniquet removal.[29] Patients with such "spontaneous HIT syndrome" post–knee replacement also have HIT antibodies with heparin-independent platelet-activating properties, thus classifying this condition as an autoimmune HIT disorder. Recommended treatment of this syndrome includes a nonheparin anticoagulant and adjunctive therapy with IV immunoglobin, which abruptly inhibits HIT antibody-induced platelet activation thereby deescalating HIT-associated hypercoagulability.[30]

Late causes of thrombocytopenia (>10 days) after surgery

Thrombocytopenia after POD10 includes late infection, late administration of medications or blood products, or posttransfusion graft-versus-host disease. The later the onset, the more likely a fungal infection should be considered. Posttransfusion graft-versus-host disease is rare, and usually presents 3 weeks or later postoperatively. Sometimes patients are recognized as having thrombocytopenia ~1 month postsurgery; this may simply reflect

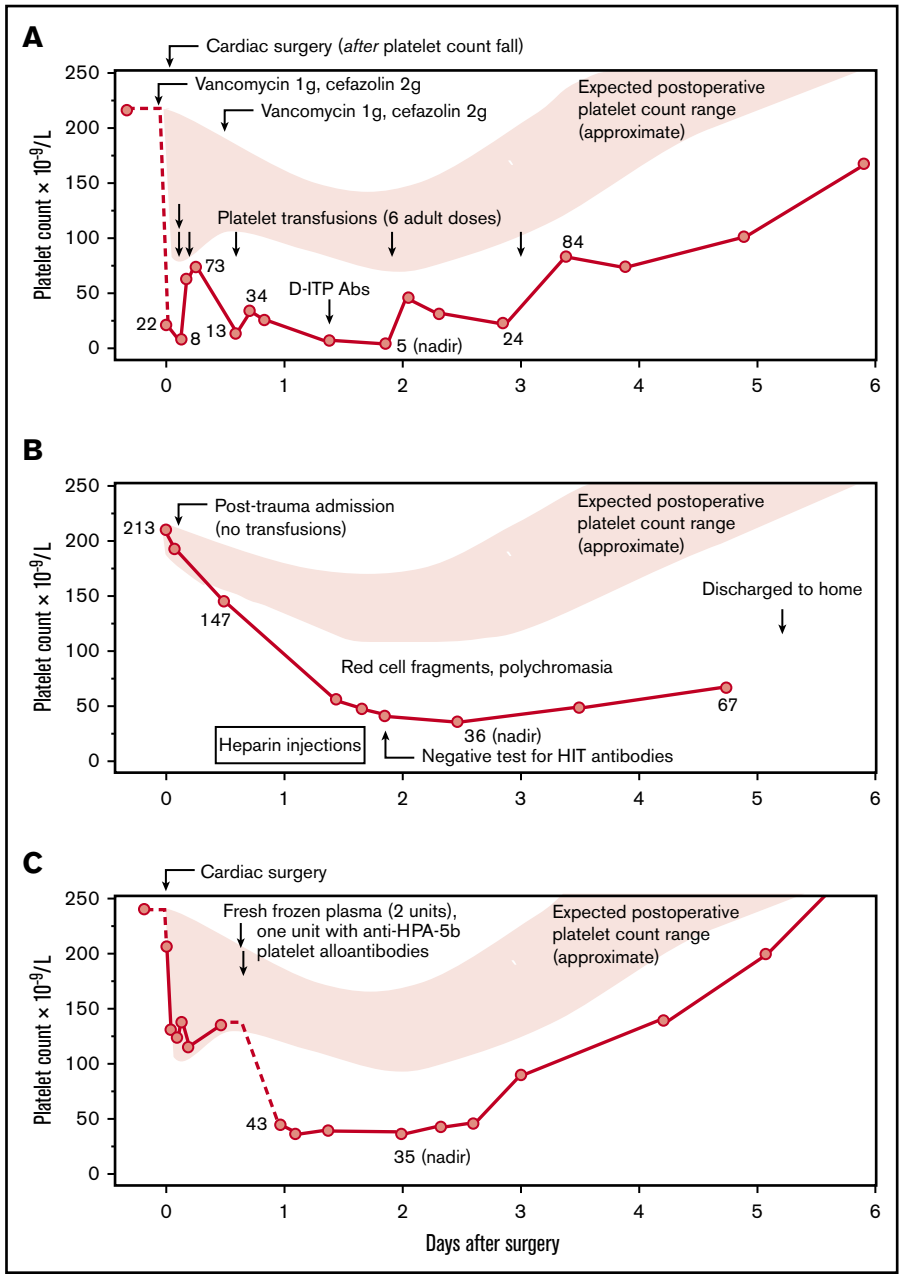

Figure 2. Three patients with severe early postoperative thrombocytopenia. For all 3 patients, early platelet count declines that seemed greater than expected for the clinical situation suggested occurrence of a complicating disorder. The shaded area indicates the approximate expected range of postoperative platelet counts. (A) DITP (D-ITP) of rapid onset (vancomycin). An 81-year-old woman with a recent normal platelet count underwent preoperative insertion of a radial artery catheter immediately prior to elective mitral valve replacement surgery. A hematoma unexpectedly developed at the catheter insertion site, prompting ordering of a complete blood count prior to starting CPB. The platelet count returned at 22 × 10^9/L but cardiac surgery proceeded uneventfully, although the immediate postoperative platelet count fell further to 8 × 10^9/L. Three platelet transfusions raised the platelet count to 73 × 10^9/L, with subsequent decline to 5 × 10^9/L (nadir). Hematology diagnosed DITP of rapid onset secondary to administration of preoperative antibiotic prophylaxis (both vancomycin and cefazolin were given). The patient had undergone previous remote surgery with antibiotic prophylaxis as a potential explanation of prior immune sensitization. The patient made an uneventful recovery. A blood sample tested positive for vancomycin-dependent antibodies (Abs; DITP Abs). (B) Postoperative TMA (initial presentation of congenital TTP). A 33-year-old woman was admitted posttrauma for surgery of a facial fracture. She developed unexpected progressively severe postoperative thrombocytopenia, which prompted testing for HIT Abs, which returned negative. The patient was discharged to home, without further investigations, and made a full recovery with a normal platelet count at 1-month follow-up. Three years later, the patient developed severe thrombocytopenia and morphological evidence of red cell fragments and polychromasia (per hematology technologist report of the peripheral blood smear). She was diagnosed as having congenital TTP, based upon history of recurrent thrombocytopenia and studies indicating absence ADAMTS13, lack of anti-ADAMTS13 autoantibodies, and corroborating genetic evaluation. (C) Passive alloimmune thrombocytopenia secondary to transfusion of fresh-frozen plasma containing anti–HPA-5b alloantibodies. A 52-year-old man underwent coronary artery bypass grafting using CPB. His initial postoperative course was unremarkable. However, he developed an unexpected platelet count fall to 43 × 10^9/L, without evidence of sepsis, shock, or any other postoperative complications. As the platelet count fall occurred after he received 2 U of fresh-frozen plasma, the patient was investigated for

the nadir value as the platelets gradually fall from the day 14 postoperative peak.[31]

Severity of thrombocytopenia

As discussed earlier, the severity of the platelet count decrease is an important clue that helps differentiate among the various causes of thrombocytopenia, particularly when the platelet count is $<20 \times 10^9$/L (Table 2). Causes of profound thrombocytopenia include septic shock; multiorgan failure; concomitant ITP, DITP, PTP, and PAT from blood transfusions; and TTP. TTP often causes a lower platelet count $<20 \times 10^9$/L, when compared with other TMAs such as aHUS where it is often $>50 \times 10^9$/L (Table 2). Unlike DITP and PTP, where platelet count nadir values are usually $<20 \times 10^9$/L, HIT typically causes a moderate degree of thrombocytopenia, and 80% to 90% of patients have a platelet count nadir between 20×10^9/L and 150×10^9/L (median platelet count nadir, $\sim 60 \times 10^9$/L).[32] HIT may be unrecognized in postoperative patients because a >50% platelet count fall in the setting of postoperative thrombocytosis may not result in absolute thrombocytopenia (ie, a platelet count $<150 \times 10^9$/L) but can still be a sign of HIT. The platelet count nadir in HIT can be $<20 \times 10^9$/L when there is overt, decompensated DIC.

The pace of platelet count fall may also help to differentiate causes of postoperative thrombocytopenia. Immune-mediated causes of thrombocytopenia, such as HIT, may have a more rapid platelet count fall compared with non–immune-mediated causes of thrombocytopenia, such as infection or DIC.[10]

Investigations

When approaching a patient with unexpected postoperative thrombocytopenia, it is important to repeat a complete blood count the same day to confirm the abnormality. Timely screening for serious conditions such as DIC and TMAs includes a peripheral blood smear, INR, partial thromboplastin time, fibrinogen, and a fibrin-specific marker (eg, D-dimer). When evaluating for a suspected TMA, testing for markers of hemolysis includes reticulocyte count, bilirubin, haptoglobin, and lactate dehydrogenase (LDH). In addition to LDH, additional markers such as aspartate aminotransferase, alanine aminotransferase, and creatine phosphokinase may be ordered to interpret whether the elevated LDH is in isolation (eg, hemolysis) or related to another cause (eg, transaminitis). In the right clinical context, an elevated alanine aminotransferase may be related to concomitant shock liver or creatine phosphokinase may be related to postoperative myocardial infarction or ischemic limb injury. If the laboratory profile points to presence of DIC or TMA, it is important to repeat these tests at least once daily as both DIC and TMAs are dynamic illnesses.

Depending on the clinical context, selected additional studies may include blood cultures, HIT testing (eg, rapid automated assays such as the latex immunoturbidimetric assay or IgG-specific chemiluminescence assay, PF4/polyanion enzyme-immunoassay, serotonin-release assay, or other platelet activation assay), antinuclear antibody or antiphospholipid antibody testing, a direct antiglobulin test (to evaluate concomitant immune-mediated hemolysis), ADAMTS13 activity and inhibitor assay and complement genetic testing (if TTP or aHUS is suspected), HIV testing, hepatitis C antibody levels, abdominal ultrasound to assess for spleen size, or a bone marrow aspirate and biopsy.[33,34]

Table 2. Severity of thrombocytopenia

Severity of thrombocytopenia, $\times 10^9$/L	Associated disorders
Mild to moderate, 75-150	Hemodilution, HIT, DIC, TMA
Moderate to severe, ~20-75	HIT, DIC, TMA
Very severe, usually <20	DITP, PTP, DIC (severe), PAT, TTP*

*TTP is a TMA disorder notable for its usual severe degree of thrombocytopenia.

Postoperative thrombocytopenia with artificial surface exposure

Some postoperative patients require a device that results in exposure of blood to artificial surfaces, including an intra-aortic balloon pump, ventricular assist device, or extracorporeal membrane oxygenation. Early postoperative thrombocytopenia in patients with mechanical circulatory support is exacerbated by increased platelet consumption of critical illness, as well as increased platelet consumption on the devices. Furthermore, thrombocytopenia can persist with platelet count recovery often paralleling device discontinuation as critical illness resolves.[35] Heparin anticoagulation is usually required for temporary mechanical circulatory devices or a bridge to warfarin therapy. When heparin is continued at therapeutic doses for a week or more, the risk of HIT can be as high as 10%.[36,37] However, nonpathogenic anti-PF4/heparin antibodies form commonly, so HIT should be suspected only when thrombocytopenia suggestive of HIT occurs and platelet-activating antibodies are demonstrated in a serotonin release assay or other sensitive platelet activation assay.[36,38] Patients managed with mechanical circulatory support have a high risk for bleeding due to large surgeries, postoperative thrombocytopenia and device-related platelet dysfunction and coagulopathy from hyperfibrinolysis, DIC, hepatic dysfunction, anticoagulation, or acquired von Willebrand syndrome secondary to depletion of high-molecular-weight multimers from a high shear state.[39]

Summary

Understanding normal thrombopoietin physiology is the crucial first step to evaluating the different causes of thrombocytopenia, with timing and magnitude of thrombocytopenia manifesting during the postoperative period as the most important features during evaluation. Although there are many potential causes of postoperative thrombocytopenia, the timing and severity of the platelet decline provide useful guidance for the clinician in formulating the differential diagnosis and planning appropriate investigations and treatment.

Figure 2. (continued) passive alloimmune thrombocytopenia. Direct radioimmunoprecipitation of patient platelets showed IgG Abs bound to platelet GPIa/IIa. Serum obtained from the female plasma donor was subsequently shown to contain anti–HPA-5b IgG alloantibodies; the patient typed as HPA-5a/5b, and the plasma donor typed as expected as homozygous HPA-5a. Modified from Warkentin et al.[23]

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