

Ultrasound-Guided Paracentesis in Cirrhosis: Bleeding Risk, Coagulopathy, and Routine Pre-Procedure Transfusion

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Abstract

Paracentesis is the most frequently performed invasive procedure in patients with cirrhosis, and because these patients commonly present with a prolonged international normalized ratio and thrombocytopenia, many clinicians still transfuse fresh frozen plasma or platelets before the procedure in the belief that this prevents bleeding. This practice rests on an older view of liver disease as a simple bleeding disorder, a view that modern understanding of rebalanced hemostasis has largely overturned. This review examined whether routine pre-procedure transfusion is justified when paracentesis is performed under ultrasound guidance, and what should replace it. A structured narrative synthesis was undertaken of observational studies, randomized trials, systematic reviews, and practice guidance on adults with chronic liver disease, supplemented by health-systems literature to address implementation, and the certainty of the main conclusions was graded qualitatively.

The evidence shows that major bleeding after paracentesis is uncommon, affecting well under one percent of procedures in most settings, and that it remains uncommon even in patients whose coagulation results would traditionally have been considered prohibitive. Conventional coagulation tests do not identify the patients who bleed, because cirrhosis lowers procoagulant and anticoagulant factors together and the international normalized ratio measures only one side of that balance. Prophylactic plasma and platelets have no demonstrated benefit, seldom correct the laboratory values they target, and expose patients to circulatory overload, lung injury, rising portal pressure, and delay in a procedure whose timeliness itself influences survival. Risk is better captured by the clinical context, particularly acute kidney injury, advanced liver failure, and acute-on-chronic liver failure, while viscoelastic testing offers a more physiological guide that reduces blood product use without increasing bleeding. The intervention most consistently associated with safer practice is procedural rather than hematological: ultrasound guidance, scanning of the needle tract for abdominal wall vessels, and well-trained operators substantially reduce bleeding complications. Translating this evidence into practice depends on the wider health system, including access to ultrasound and reliable laboratories, secure supplies of blood products and albumin, workforce training, and routine audit, considerations that weigh most heavily in resource-limited settings. Routine measurement and correction of coagulation tests before ultrasound-guided paracentesis in cirrhosis is therefore not supported, and clinical effort is better directed toward prompt, image-guided procedures, careful recognition of genuinely high-risk patients, and the system-level conditions that allow transfusion-sparing care to become standard practice.

Keywords: Paracentesis; Cirrhosis; ascites; coagulopathy; INR; thrombocytopenia; fresh frozen plasma; platelet transfusion; ultrasound guidance; rebalanced hemostasis.

Introduction

Ascites is the most common decompensating event in cirrhosis, and abdominal paracentesis is central to its management. Diagnostic paracentesis is recommended for every patient with new-onset ascites and for any hospitalized patient with cirrhosis and ascites, to exclude spontaneous bacterial peritonitis. Therapeutic large-volume paracentesis (LVP), usually with albumin replacement, is first-line treatment for tense and refractory ascites (Aithal et al., 2021; Biggins et al., 2021; European Association for the Study of the Liver, 2018; Runyon, 2009). Repeated LVP was established as an effective and safe alternative to diuretics for tense ascites in randomized trials in the late 1980s (Gines et al., 1987; Runyon, 1986), and the onset of ascites marks a turning

point in prognosis: among patients hospitalized for ascites, survival has been reported at about 85% at one year and 56.5% at five years, falling sharply once ascites becomes refractory (de Franchis et al., 2022; Planas et al., 2006). Many patients therefore undergo the procedure repeatedly, sometimes weekly, over months or years, and repeated admissions are common; coordinated care pathways for chronic disease aim to reduce exactly this kind of readmission burden (Akinlolu et al., 2023).

Timeliness matters. In a national cohort of 17,711 admissions with cirrhosis and ascites, only 61% underwent paracentesis, and the procedure was associated with lower in-hospital mortality (adjusted OR 0.55), with early procedures outperforming delayed ones (Orman et al., 2014). In spontaneous

bacterial peritonitis, paracentesis delayed beyond 12 hours was associated with roughly double the in-hospital mortality (27% vs 13%) (Kim et al., 2014). A second national analysis of 31,614 admissions, a single-centre study, and a 2024 meta-analysis all link early diagnostic paracentesis, ideally within one day of admission, to lower mortality and shorter stays (Badal et al., 2024; Gaetano et al., 2016; Tolia et al., 2020). Any practice that postpones paracentesis while waiting for coagulation results or blood products therefore carries a real cost.

The same population typically has abnormal conventional coagulation tests. A prolonged prothrombin time (PT) and INR reflect reduced hepatic synthesis of procoagulant factors, and thrombocytopenia results from splenic sequestration and reduced thrombopoietin production. Historically these laboratory values were read as markers of a bleeding diathesis, and pre-procedure “correction” with FFP and platelets became embedded in practice. A 2024 multispecialty Delphi panel noted that roughly one in three hospitalized patients with cirrhosis receives plasma, and that most of this plasma is given as pre-procedure prophylaxis (Tapper et al., 2024). Earlier audits tell the same story: in one US centre, patients with liver disease made up 7.7% of transfused patients but received 32.4% of plasma units (Shah et al., 2012); a 76-hospital Ontario audit judged 28.6% of plasma requests inappropriate, most often because the INR was used as the trigger without bleeding (Tinmouth et al., 2013); and a multicentre Chinese study found that most non-bleeding plasma recipients with cirrhosis had no planned procedure at all (Sun et al., 2016).

Several guidelines now advise against routine correction of coagulation tests before low-risk procedures, yet they address paracentesis briefly and within broader recommendations on hemostasis, and they rarely consider the realities of resource-limited health systems. This review adds to that guidance by bringing together, in one synthesis, the paracentesis-specific evidence on bleeding incidence and predictors, the efficacy and harms of prophylactic plasma and platelets, the contribution of ultrasound technique and operator training, and the health-system conditions that determine whether

transfusion-sparing practice can be implemented. The aim was to determine whether routine pre-procedure transfusion is justified for ultrasound-guided paracentesis in cirrhosis and to identify what should replace it.

Research Method

Search strategy and information sources

This structured narrative review followed a predefined set of clinical questions. The literature base included PubMed-indexed cohort studies, randomized controlled trials, systematic reviews, and meta-analyses addressing bleeding after abdominal paracentesis in adults with chronic liver disease, together with practice guidance from the American Association for the Study of Liver Diseases (AASLD), American Gastroenterological Association (AGA), European Association for the Study of the Liver (EASL), British Society of Gastroenterology (BSG), Society of Interventional Radiology (SIR), and Society of Hospital Medicine (SHM). Evidence available through 2024 was considered. Search terms combined paracentesis, ascites, cirrhosis, bleeding, hemorrhage, hemoperitoneum, INR, platelets, plasma, transfusion, thromboelastography, and ultrasound.

To situate the clinical evidence within health-system realities, particularly in resource-limited settings, the review also draws on a consolidated seed reference list covering diagnostic infrastructure, laboratory quality, pharmaceutical and blood supply chains, health informatics, workforce development, behavioral health, and nursing practice. These sources do not address paracentesis directly; they are cited only for implementation and system-level points and are marked with a dagger (†) in the reference list.

Eligibility criteria

Studies were eligible if they reported bleeding or transfusion outcomes after abdominal paracentesis in adults with chronic liver disease, evaluated the relationship between conventional or viscoelastic coagulation tests and procedural bleeding, assessed the effect of plasma, platelet, or thrombopoietin receptor agonist therapy on coagulation tests or bleeding, or compared ultrasound-guided with

landmark-guided technique. Mechanistic studies of hemostasis in cirrhosis, transfusion safety studies, and guidelines from hepatology, gastroenterology, hematology, transfusion medicine, interventional radiology, and hospital medicine societies were included as supporting evidence. Single case reports were used only to illustrate mechanisms of bleeding. Non-English publications and conference abstracts without full reports were excluded.

Data extraction and synthesis

Studies were prioritized by size, design, and relevance to the outcome of procedure-related bleeding. Because major bleeding is rare, most of the evidence is observational; certainty was graded qualitatively as high, moderate, low, or very low according to study design, consistency, directness, and precision, following the general logic of the GRADE approach (Table 4). “Major bleeding” is defined differently across studies (typically hemoperitoneum or abdominal wall hematoma requiring transfusion, intervention, or causing death), and this heterogeneity is noted where it matters.

For each study, design, setting, sample size, coagulation profile, bleeding definition, and principal findings were extracted. Because study designs, populations, and outcome definitions were heterogeneous, findings were synthesized narratively rather than pooled; quantitative estimates are reported as given in the source studies.

Results And Discussion

Hemostatic changes in cirrhosis and the validity of conventional tests

The concept of rebalanced hemostasis underpins modern guidance (Intagliata et al., 2018; Lisman & Porte, 2010; Tripodi & Mannucci, 2011). Cirrhosis reduces hepatic synthesis of procoagulant factors (II, V, VII, IX, X, XI), which prolongs the PT and INR. But it also reduces natural anticoagulants (protein C, protein S, antithrombin) that the PT does not measure. The INR was developed to monitor vitamin K antagonist therapy; it captures only the procoagulant side of thrombin generation and is blind to the parallel loss of anticoagulants. When thrombin generation is measured in the presence of

thrombomodulin, which activates protein C, plasma from many patients with cirrhosis generates thrombin comparable to that of healthy controls (Tripodi & Mannucci, 2011; Tripodi et al., 2005). In a larger series of 134 patients, cirrhotic plasma was in fact relatively resistant to thrombomodulin, driven by high factor VIII and low protein C, a profile that leans toward procoagulation as disease advances (Tripodi et al., 2009).

Primary hemostasis is similarly rebalanced. Thrombocytopenia is offset in part by markedly elevated von Willebrand factor and reduced ADAMTS13, which enhance platelet adhesion; median von Willebrand factor levels rise from about 380% in Child-Pugh A to 760% in Child-Pugh C, and cirrhotic plasma supports platelet adhesion despite reduced functional capacity (Lisman et al., 2006). Thrombin generation does fall with platelet count, but in vitro data suggest that a platelet level of roughly 50 to $60 \times 10^9/L$ is sufficient to support near-normal thrombin generation (Tripodi et al., 2006). Fibrinolysis may be increased or decreased; global fibrinolysis tests identified hyperfibrinolysis in around 40% of patients, rising with Child-Pugh class (Rijken et al., 2012). The net result is a hemostatic system that functions, but with less reserve, so it can tip toward either bleeding or thrombosis when stressed by infection, renal failure, or other insults (Intagliata et al., 2018; Lisman & Porte, 2010). Patients with cirrhosis are not “auto-anticoagulated” and remain at risk of portal vein and venous thromboembolism (Lisman et al., 2021). About 0.5% of hospitalized patients with cirrhosis develop venous thromboembolism, and neither INR nor platelet count predicts it (Northup et al., 2006); the five-year cumulative incidence of portal vein thrombosis is about 10.7% (Nery et al., 2015), and its presence is associated with higher mortality (Stine et al., 2015).

Two practical consequences follow. First, an abnormal INR is better understood as a marker of liver synthetic function and prognosis (it is a component of the MELD score) than as a measure of bleeding risk. Even as a liver function marker it is imprecise: INR values in the same patients varied significantly across seven thromboplastin reagents, a variation removed only by calibrating

the test specifically for liver disease (Tripodi et al., 2007). Consistent with this, the INR shows little or no correlation with viscoelastic measures of clot formation in cirrhosis (Hum et al., 2020), and a broad evidence review found no convincing evidence that a raised PT or INR predicts bleeding after invasive procedures in any population (Segal & Dzik, 2005). Second, raising the INR toward normal with plasma does not necessarily improve the patient's actual capacity to form clot (Rassi et al., 2020).

Incidence and characteristics of procedure-related bleeding

Bleeding complications of paracentesis take three main forms: abdominal wall hematoma, usually from laceration of an inferior epigastric or other abdominal wall vessel; hemoperitoneum, from injury to mesenteric varices or collateral vessels, or from rupture of intraperitoneal varices as intra-abdominal pressure falls; and, less commonly, pseudoaneurysm. In a systematic review of 61 reported cases, these accounted for 52%, 41%, and 7% of hemorrhagic complications respectively, and 90% of affected patients had cirrhosis (Sharzei et al., 2014). Hemorrhage can present hours or even days after the procedure, and when it is severe it carries substantial mortality (Arnold et al., 1997; Webster et al., 1996). Retrospective radiology series show that inferior epigastric artery injury, frequently after paracentesis and often in coagulopathic patients, can cause massive abdominal wall hemorrhage that is best diagnosed by CT or angiography and treated by embolization (Ryu & Kwon, 2018; Sobkin et al., 2008).

Despite their potential severity, these events are rare, a conclusion reached as early as the 1980s (Runyon, 1986). Table 1 summarizes the principal studies.

Three consistent observations emerge. Major bleeding is uncommon even in cohorts with severe laboratory coagulopathy. Where risk factors have been sought, they relate to the severity of liver and kidney dysfunction rather than to the INR or platelet count. And the largest comparative data set links lower bleeding rates to ultrasound guidance. The important exception is acute-on-chronic liver failure, where bleeding rates are several times higher and

carry grave prognostic meaning (Guo et al., 2020; Lin et al., 2015).

Predictors of bleeding

No large paracentesis cohort has demonstrated a dose-response relationship between INR or platelet count and bleeding. In the Grabau series, more than half of procedures were performed with platelets below $50 \times 10^9/L$ and over a quarter with INR above 2.0, yet no major bleeding occurred (Grabau et al., 2004). In the Pache series, only two of nine severe bleeds occurred in patients with platelets below $50 \times 10^9/L$ or INR above 2.0 (Pache & Bilodeau, 2005). Very low platelet counts (below about $20 \times 10^9/L$) are represented by small numbers, which is why some guidance retains a cautious threshold in this range (Patel et al., 2019; Tapper et al., 2024). Outside the paracentesis literature the pattern is similar. In the prospective PRO-LIVER cohort of 280 patients followed for a median of over three years, platelet count did not predict bleeding, whereas prior gastrointestinal bleeding and encephalopathy did (Basili et al., 2018), and bleeding after invasive procedures in thrombocytopenic patients with advanced liver disease has been examined in relation to platelet count with similar conclusions (Giannini et al., 2010). In critically ill patients, by contrast, very low fibrinogen (below 60 mg/dL) and platelets (below $30 \times 10^9/L$) were among the strongest predictors of major bleeding (Drolz et al., 2016), which suggests that risk concentrates at the extremes rather than rising steadily with the INR.

The extremes deserve respect. In the PACER trial, which enrolled patients with thrombocytopenia (mostly hematological or critically ill) undergoing central venous catheter placement with platelets between 10 and $50 \times 10^9/L$, withholding prophylactic platelets failed to show noninferiority, with grade 2 to 4 bleeding in 11.9% versus 4.8% (van Baarle et al., 2023). These patients differ from those with cirrhosis, whose hemostasis is rebalanced, and catheter insertion differs from a fine-needle paracentesis, but the trial is a reminder that the case against prophylaxis is strongest at moderate thrombocytopenia and weakest at very low counts.

Renal dysfunction is the most reproducible clinical risk factor. In a case-control study of

Table 1: Key studies of bleeding after paracentesis in patients with chronic liver disease

<i>Study</i>	<i>Design / size</i>	<i>Coagulation profile</i>	<i>Bleeding findings</i>
McVay & Toy (1991)	Retrospective; several hundred paracenteses and thoracenteses	Mild PT/platelet abnormalities common	Bleeding not increased with mild coagulation abnormalities; transfusion did not appear protective
Grabau et al. (2004)	Retrospective; >1,100 LVPs over 7 years, outpatient clinic	27% INR >2.0; 54% platelets <50 × 10 ⁹ /L; INR up to 8.7, platelets down to 19 × 10 ⁹ /L	No major bleeding events; no pre-procedure transfusion used
Pache & Bilodeau (2005)	Retrospective; 4,729 paracenteses in a liver unit	Mean INR about 2.0; mean platelets about 100 × 10 ⁹ /L	9 severe hemorrhages (0.19%); not related to INR or platelet count; more common with renal dysfunction and higher Child-Pugh score
De Gottardi et al. (2009)	Prospective multicentre; 515 patients	Typical decompensated cirrhosis	Bleeding in 0.97%; complications linked to more advanced liver disease rather than INR or platelets
Lin et al. (2005)	Emergency department; 186 paracenteses in 60 patients	INR up to 4.7; platelets down to 6 × 10 ⁹ /L	Only 2 (1.1%) minor bleeds; authors concluded pre-procedure coagulation tests were unnecessary
Mercaldi & Lanes (2013)	Administrative cohort; 69,859 patients, >600 hospitals	Not reported in detail	Overall bleeding 0.8%; 0.27% with ultrasound vs 1.27% without (adjusted OR 0.32)
Kurup et al. (2015)	Retrospective; ultrasound-guided paracentesis in thrombocytopenic patients	All platelets <50 × 10 ⁹ /L	Very low bleeding rate; no bleeding among patients with platelets <20 × 10 ⁹ /L
Lin et al. (2015)	Retrospective, propensity-matched; 602 paracenteses in ACLF	Severe coagulopathy typical of ACLF	Bleeding in 2.99% (4 wall hematomas, 14 intraperitoneal); 72.2% of those who bled died or were transplanted within 2 weeks
Barsuk et al. (2018)	Pre/post study; 5,777 procedures by a hospitalist procedure service	Unselected inpatients	Major bleeding 0.3% with low-frequency probe only vs 0.08% with added vascular probe (P = 0.07)
Rowley et al. (2019)	Real-time ultrasound-guided paracentesis by radiologists	Coagulopathy not corrected	Hemorrhage risk close to zero without correction of coagulopathy
Tan et al. (2024)	Systematic review; 8 studies (6 with incidence data)	Mean INR 1.4 to 2.0; mean platelets 50 to 153 × 10 ⁹ /L	Pooled bleeding 0.32% (95% CI 0.15% to 0.69%); major bleeding 0% to 0.97% across cohorts

LVP, large-volume paracentesis; OR, odds ratio; CI, confidence interval. Definitions of bleeding vary between studies.

CT-confirmed post-paracentesis hemoperitoneum among hospitalized patients with decompensated cirrhosis, acute kidney injury (AKI) before the procedure was the only independent predictor (OR 4.3; 95% CI 1.3 to 13.5), independent of MELD score, sepsis, LVP, platelet count, INR, and hemoglobin (Hung & Garcia-Tsao, 2018). A subsequent prospective study found that AKI in decompensated cirrhosis is associated with both hypocoagulable features (including lower factor XIII) and hypercoagulable features, and that these changes are not captured by the INR (Zanetto et al., 2020). Uremic platelet dysfunction is a plausible additional mechanism.

Higher Child-Pugh and MELD scores have been associated with bleeding in several series (De Gottardi et al., 2009; Pache & Bilodeau, 2005). Acute-on-chronic liver failure (ACLF), sepsis, and active alcohol-associated hepatitis are often cited as higher-risk states. In hepatitis B-related ACLF, low fibrinogen and low factor VII predicted bleeding, and bleeding was associated with lower 90-day survival (Guo et al., 2020). Procedural factors also matter: needle entry over the rectus sheath or through visible collateral veins, multiple passes, and the use of large-bore catheters. A proposed mechanism for delayed hemoperitoneum is the rapid fall in intra-abdominal pressure during LVP, which increases the transmural

pressure gradient across fragile mesenteric varices (Barsuk et al., 2018). None of these factors is modifiable by giving plasma.

Efficacy and harms of prophylactic transfusion

No randomized trial has compared prophylactic FFP or platelets against no transfusion for paracentesis with bleeding as the outcome. Given the low event rate, such a trial would require many thousands of patients. What exists is consistent observational evidence that bleeding rates are equally low with and without transfusion, and that the many patients managed without correction did not bleed more (Crowe et al., 2021; Grabau et al., 2004; McVay & Toy, 1991; Pache & Bilodeau, 2005). The closest randomized evidence comes from critical care: in a trial of 81 coagulopathic intensive care patients randomized to prophylactic FFP or none before invasive procedures, bleeding was uncommon in both arms, and FFP brought the INR below 1.5 in only 54% of recipients (Muller et al., 2015).

The most direct randomized evidence comes from viscoelastic testing. De Pietri and colleagues randomized 60 patients with cirrhosis and severe laboratory coagulopathy (INR above 1.8 and/or platelets below $50 \times 10^9/L$) undergoing invasive procedures to thromboelastography (TEG)-guided transfusion or standard care based on INR and platelet count. Blood products were given to 16.7% of the TEG group versus 100% of the standard-care group, with no increase in bleeding; the only post-procedure bleed occurred after LVP in the standard-care (transfused) arm (De Pietri et al., 2016). A second randomized trial in higher-risk liver procedures reported a similar large reduction in blood product use with TEG guidance (Vuyyuru et al., 2020). Trials in bleeding patients point the same way: TEG guidance reduced component use in non-variceal bleeding (26.5% vs 87.2% received all three components) without worse outcomes (Kumar et al., 2020), and in variceal bleeding only 13.3% of the TEG group were transfused versus 100% of controls, with lower 42-day rebleeding (Rout et al., 2020). A 2023 meta-analysis of five randomized trials confirmed reduced plasma, platelet, and cryoprecipitate use without excess bleeding (Hartmann et al., 2023).

Plasma has an INR of roughly 1.0 to 1.3, so it cannot bring a patient's INR fully to normal, and large volumes are needed to shift it meaningfully. In a dual-phase study, standard FFP doses fully corrected the INR in only a small minority of patients with chronic liver disease (Youssef et al., 2003). In a prospective study using thrombomodulin-modified thrombin generation, FFP produced modest changes in the PT but little meaningful improvement in thrombin generation, because patients already had near-normal capacity (Rassi et al., 2020). In vitro supplementation of cirrhotic plasma with normal plasma, mimicking a 10 mL/kg dose, shortened the PT but left thrombin generation essentially unchanged (Tripodi et al., 2012). Outside liver disease the picture is the same: FFP given for mildly raised INR normalized the PT in under 1% of 121 patients, with a median INR fall of 0.07 (Abdel-Wahab et al., 2006), and the change in INR after plasma is largely predicted by the starting INR, so values in the 1.5 to 2.0 range barely move (Holland & Brooks, 2006). Platelet transfusion performs little better: in patients with cirrhosis undergoing variceal ligation, a standard adult dose raised the median platelet count only from 39 to $52 \times 10^9/L$, with minimal change in thrombin generation (Tripodi et al., 2013).

The AGA advises that blood products be used sparingly in cirrhosis because they raise portal pressure and carry risks of transfusion-associated circulatory overload (TACO), transfusion-related acute lung injury (TRALI), infection, alloimmunization, and transfusion reactions (O'Leary et al., 2019). Volume expansion with plasma in a patient with portal hypertension and ascites can worsen the very condition being treated; portal pressure rises roughly linearly with blood volume in cirrhosis (Zimmon & Kessler, 1974), and a restrictive red cell transfusion strategy improved survival in acute upper gastrointestinal bleeding, with benefit in Child-Pugh A and B cirrhosis (Villanueva et al., 2013). TACO occurs in about 1 in 100 transfused hospital patients, with plasma a recognized risk factor, and affected patients more often need ventilation and die (Roubinian et al., 2018); active surveillance detects TACO after plasma far more often than passive reporting (1 in 68 vs 1

in 1,566 cases) (Narick et al., 2012). Plasma remains a leading cause of TRALI, although incidence fell markedly after female-donor plasma was restricted (Toy et al., 2012). In acute variceal hemorrhage, FFP transfusion has been associated with worse outcomes in a multicentre cohort (Mohanty et al., 2021). Platelet alloimmunization can compromise later transfusion support, for example during transplantation; even with leukoreduction, a minority of repeatedly transfused patients become alloimmunized and refractory (Trial to Reduce Alloimmunization to Platelets Study Group, 1997). Pre-procedure transfusion also delays diagnostic paracentesis, and delay in diagnosing spontaneous bacterial peritonitis is itself associated with higher mortality; avoidable waits for laboratory results and blood products are a recognized source of clinical decision delay (Nnaji & Akinlolu, 2022). Finally, blood products are costly and finite. Blood collection networks in many health systems, particularly in low- and middle-income countries, operate under supply constraints, so every unit given without clear benefit is a unit unavailable for patients who are actively bleeding (Ogbete et al., 2022).

Thrombopoietin receptor agonists (avatrombopag, lusutrombopag) raise platelet counts before scheduled procedures and reduce the need for platelet transfusion in patients with chronic liver disease and platelets below $50 \times 10^9/L$ (Peck-Radosavljevic et al., 2019; Terrault et al., 2018). Lusutrombopag allowed 79.2% of patients to avoid platelet transfusion versus 12.5% on placebo in L-PLUS 1 (Hidaka et al., 2019). However, these agents take about 10 days to act, add cost, and may increase portal vein thrombosis risk: the ELEVATE trial of eltrombopag was stopped early because of portal venous thrombosis (Afdhal et al., 2012), and a meta-analysis found a significant signal for eltrombopag though not for the class overall (Loffredo & Violi, 2019). Cost and availability are especially limiting in resource-constrained health systems, where supply chain inefficiencies already restrict access to essential medicines (Asiedu & Asiedu, 2023). The AGA suggests against their routine use before common low-risk procedures such as paracentesis (O'Shea et al., 2021). Viscoelastic testing (TEG or ROTEM) can be considered when a clinician is concerned about a specific patient, as

it substantially reduces product use compared with INR and platelet-based protocols (De Pietri et al., 2016; Tan et al., 2024).

Ultrasound guidance and operator factors

Ultrasound is the intervention with the strongest evidence for reducing paracentesis bleeding. In the Premier database cohort of 69,859 patients, bleeding complications occurred in 0.27% of ultrasound-guided procedures versus 1.27% of procedures without guidance. After adjustment, ultrasound guidance reduced the odds of bleeding by 68% (OR 0.32; 95% CI 0.25 to 0.41). Each bleeding event added an average of USD 19,066 in hospital costs and 4.3 days to length of stay (Mercaldi & Lanes, 2013).

The SHM position statement recommends ultrasound guidance for paracentesis to reduce serious complications, the most common being bleeding; to avoid attempting the procedure when there is insufficient fluid; and to improve procedural success. In a randomized emergency department study, ultrasound-assisted paracentesis obtained fluid in 95% of attempts versus 61% with the landmark technique, and ultrasound led to cancellation of procedures in patients with insufficient fluid (Nazeer et al., 2005). Even site selection is better informed by imaging: ultrasound measurements of abdominal wall thickness and fluid depth differ meaningfully between the midline and the left lower quadrant (Sakai et al., 2005). The statement recommends considering real-time guidance when the fluid pocket is small or difficult to access (Cho et al., 2019). Ultrasound allows the operator to confirm an adequate fluid pocket and select the deepest, safest site; to avoid bowel, bladder, an enlarged spleen or liver, and loculated collections; to identify abdominal wall vessels, including the inferior epigastric arteries and recanalized umbilical or collateral veins, using a high-frequency linear probe with color Doppler; and to reduce the number of needle passes.

The “two-probe technique” adds a high-frequency vascular scan of the planned needle tract to the standard low-frequency survey. In 5,777 procedures, major bleeding fell from 0.3% to 0.08% after the technique was adopted, a fourfold relative reduction that approached but did not reach statistical significance ($P = 0.07$) (Barsuk et al., 2018). Given

its negligible cost and time, many procedure services now treat vascular scanning as standard. With real-time guidance by radiologists, hemorrhage risk has been reported as close to zero without any correction of coagulopathy (Rowley et al., 2019).

Who performs the procedure also matters. Simulation-based mastery learning raised residents' paracentesis checklist scores from 33.0% to 92.7% (Barsuk et al., 2012), and outcomes of bedside procedures by simulation-trained residents have been compared directly with those of interventional radiology (Barsuk et al., 2013). A hospitalist-run procedure service reduced the time from admission to paracentesis by 40% compared with radiology referral (Ritter et al., 2021), which is relevant given the mortality cost of delay discussed in Section 1.

Ultrasound does not eliminate all bleeding. Hemoperitoneum from intraperitoneal varices, which can result from pressure shifts rather than direct needle injury, is not prevented by better needle placement. This is a further reason why post-procedure vigilance remains important in high-risk patients.

Professional society recommendations

Guidance has converged over the past decade. Table 2 summarizes the main recommendations relevant to paracentesis.

Health-system and implementation evidence

The clinical case against routine transfusion is clear; acting on it depends on the systems in which paracentesis is delivered. The health-systems literature reviewed, much of it from low- and middle-income settings, identifies the infrastructure, supply, workforce, and data conditions that support safe, ultrasound-guided, transfusion-sparing practice. These sources are indirect evidence and are cited for system-level context only.

Safe paracentesis requires reliable access to ultrasound, ascitic fluid analysis, and laboratory services. Sustainable diagnostic laboratory and infrastructure models for resource-constrained health systems (Aminu-Ibrahim et al., 2018; Aminu-Ibrahim et al., 2019; Aminu-Ibrahim et al., 2021; Ogbete et al., 2023), well-governed capital projects and public-private partnerships for healthcare facilities

(Amayo et al., 2023; Aminu-Ibrahim et al., 2024; Ogbete et al., 2021), and laboratory designs that support accuracy, safety, regulatory compliance, and preparedness (Aminu-Ibrahim et al., 2022; Ogbete et al., 2018; Ogbete et al., 2019; Ogbete et al., 2020) all shape whether a hospital can offer bedside ultrasound and timely laboratory results. Where these are lacking, clinicians may fall back on familiar but uninformative tests such as the INR.

The diagnostic work-up that accompanies paracentesis is itself a laboratory process. Integrated microbiology and serology workflows (Asiedu, 2023), laboratory information systems that improve infection detection (Abdulrazaq et al., 2019), and multi-laboratory antimicrobial resistance surveillance (Aneke et al., 2022b; Yusuf et al., 2020) all bear directly on the diagnosis and treatment of spontaneous bacterial peritonitis. More broadly, any test used to guide treatment should be judged by its diagnostic accuracy and clinical utility (Asiedu, 2024), which is precisely where the INR fails as a bleeding predictor. The adoption of better tests, such as viscoelastic assays, faces familiar barriers of cost, training, and workflow that have been described for other diagnostic technologies (Abdulrazaq et al., 2021; Abdulrazaq et al., 2023). Imaging-based risk stratification and automated image analysis, already explored in cardiology and mammography (Ejofodomi et al., 2014; Okwah, 2022), may in future support ultrasound-based vessel detection before needle insertion.

Every unit of plasma or platelets given without benefit is drawn from a finite supply. Resilient pharmaceutical and health supply chains (Akinleye, 2024; Asiedu & Asiedu, 2024b; Awulu et al., 2022b), early warning systems for shortages of essential medicines (Eze et al., 2022), real-time risk dashboards for hospital supply management (Filani et al., 2022), and traceability and chain-of-custody frameworks (Aneke & Adesemoye, 2019) are as relevant to blood components and albumin as they are to drugs. Supply governance and sustainable access to essential medicines in emerging economies (Asiedu & Asiedu, 2022; Eze et al., 2023), lean approaches to distribution bottlenecks (Obukadata et al., 2021), supplier risk assessment (Akin-Oluyomi

Table 2: Society guidance on coagulation testing and transfusion before paracentesis

<i>Source</i>	<i>Position relevant to paracentesis</i>
AASLD Ascites Guideline (Runyon, 2009)	Earlier AASLD guidance already stated that routine prophylactic FFP or platelets before paracentesis is not needed in most patients, reserving caution for clinically evident fibrinolysis or DIC.
AABB Plasma Guideline (Roback et al., 2010)	Found insufficient evidence to recommend for or against prophylactic plasma in non-bleeding patients undergoing procedures.
AABB Platelet Guideline (Kaufman et al., 2015)	Sets procedure-specific prophylactic thresholds (for example $20 \times 10^9/L$ for central venous catheter placement) and rates the supporting evidence as low quality.
BSH Platelet Guideline (Estcourt et al., 2017)	Recommends procedure-specific platelet thresholds rather than blanket correction before invasive procedures.
BSH Plasma Guideline (Green et al., 2018)	Advises against routine prophylactic FFP to correct abnormal coagulation tests before procedures in patients without bleeding.
EASL Decompensated Cirrhosis CPG (European Association for the Study of the Liver, 2018)	Covers LVP technique and albumin replacement; does not support routine correction of coagulation tests before paracentesis.
AGA Clinical Practice Update (O'Leary et al., 2019)	Clinicians should not routinely correct thrombocytopenia and coagulopathy before low-risk procedures such as therapeutic paracentesis. Blood products should be used sparingly because of portal pressure, TACO, TRALI, and other risks. Suggested targets for active bleeding or high-risk procedures only: hematocrit 25% or more, platelets above $50 \times 10^9/L$, fibrinogen above 120 mg/dL.
SIR Consensus Guidelines (Patel et al., 2019)	Classifies paracentesis as low bleeding risk. Relaxed thresholds for low-risk procedures, with platelet transfusion suggested only below $20 \times 10^9/L$; acknowledges INR is a poor marker in chronic liver disease.
SHM Position Statement (Cho et al., 2019)	Recommends ultrasound guidance for paracentesis to reduce bleeding and improve success; notes that ultrasound-guided paracentesis appears safe even with low platelets or elevated INR.
AASLD Procedural Bleeding Guidance (Northup et al., 2021)	Paracentesis is low risk. Routine pre-procedure correction of INR or platelet count is not recommended; INR should not be used to estimate procedural bleeding risk in cirrhosis.
AASLD Ascites Guidance (Biggins et al., 2021)	Routine measurement of PT/INR and platelet count before diagnostic or therapeutic paracentesis, and routine infusion of FFP or platelets, are not recommended.
BSG Ascites Guidelines (Aithal et al., 2021)	Routine correction of coagulopathy with FFP or platelets before paracentesis is not required; paracentesis can be performed safely in most patients with deranged clotting.
AGA Clinical Guideline (O'Shea et al., 2021)	Suggests against extensive pre-procedure coagulation testing in stable cirrhosis undergoing common procedures, and against routine thrombopoietin receptor agonists before low-risk procedures.
EASL CPG on Bleeding and Thrombosis (Villa et al., 2022)	Stratifies procedures as low risk (bleeding 1.5% or less) or high risk. Correction of a prolonged INR with FFP is not recommended before any procedure, low or high risk; no routine platelet correction before low-risk procedures.
ISTH SSC Guidance (Roberts et al., 2022)	Advises against routine correction of abnormal INR and low platelet counts before procedures in cirrhosis; individualized management at very low platelet counts before high-risk procedures.
Multispecialty Delphi Consensus (Tapper et al., 2024)	INR testing is not required before diagnostic or therapeutic paracentesis. Plasma transfusion should be avoided for all paracenteses. Risks of prophylactic platelets exceed benefits for outpatient diagnostic paracentesis and when platelets exceed $20 \times 10^9/L$. Clopidogrel is permissible for diagnostic and therapeutic paracentesis.

TACO, transfusion-associated circulatory overload; TRALI, transfusion-related acute lung injury; CPG, clinical practice guidelines.

et al., 2023), and novel supply technologies (Ike et al., 2024) determine whether albumin is available for post-paracentesis volume replacement. Product quality also matters: substandard and falsified medicines remain a concern in some markets (Aneke & Adesemoye, 2024), and regulatory harmonization, including across African markets, affects whether newer agents such as thrombopoietin receptor agonists are available at all (Aneke et al., 2024; Eze

et al., 2024a). Value-based pricing and risk-based regulatory decisions shape their affordability and approval (Aneke & Adesemoye, 2020; Awulu et al., 2024; Eze et al., 2024b), and pharmacy-led delivery models can widen access to medicines in primary care (Ilodigwe & Adesemoye, 2020).

Ultrasound-guided paracentesis is a skill. Data-informed digital learning platforms, performance dashboards, and learning analytics in health

professional education (Orise & Niniola, 2020; Orise & Niniola, 2022; Orise & Niniola, 2024b) can support the kind of mastery learning shown to improve paracentesis competence, while attention to ethical data practices and digital equity in clinical training ensures that such programs reach all learners (Orise & Niniola, 2023; Orise & Niniola, 2024a). Structured supervision of house officers, which improves preparedness and perioperative care quality in low-resource hospitals (Peteranaba et al., 2023b), is equally relevant to the junior clinicians who perform most bedside paracenteses. Building resilient health systems depends on workforce capability as much as technology (Ilodigwe & Adesemoye, 2024b), and safe nurse staffing and workforce planning (Omaghomi et al., 2023) underpin the post-procedure monitoring that high-risk patients need.

Nursing practice frameworks are directly relevant to the hours after paracentesis: integrated communication pathways for post-procedure pain and symptom assessment (Fapohunda et al., 2024), evidence-based wound and puncture-site care (Ohunyon et al., 2024), infection prevention and control compliance (Omaghomi et al., 2022), and fall prevention in patients who may become hypotensive after large-volume drainage (Omaghomi et al., 2024). Structured medication interaction screening (Asiedu, 2022) supports the review of antithrombotic and other drugs before the procedure. Facility preparedness for escalation (Akinlolu et al., 2024) and analytics that reduce workflow inefficiencies (Nnaji & Akinlolu, 2023) help ensure that the rare bleed is recognized and managed promptly. Accurate digital documentation of the procedure, pre-procedure laboratory values, and transfusion decisions, designed for data integrity and HIPAA compliance (Peteranaba et al., 2023a), also creates the audit trail needed to monitor practice.

De-implementing low-value transfusion requires measurement. Quality measure sets and performance metrics (Anioke & Atima, 2023b; Awulu et al., 2022a; Ekemezie et al., 2023a), real-time dashboards (Oparah et al., 2023), and AI-supported decision support for healthcare operations (Adelanwa et al., 2024; Afrihyia et al., 2023) can track indicators such as the proportion of paracenteses preceded by plasma or platelet transfusion and the time from

admission to diagnostic paracentesis. Analytics already used for financial oversight and anomaly detection in healthcare (Abetoh & Atakpa, 2024; Atakpa & Fobellah, 2023; Atakpa et al., 2024a) could flag unusual transfusion patterns, and root-cause and corrective-action methods from quality management (Aneke et al., 2022a) offer a structure for reviewing bleeding events.

Registries that capture delayed bleeding and transfusion exposure depend on interoperable, high-quality, and secure data (Ekemezie et al., 2018; Ilodigwe & Adesemoye, 2021). Health data governance, privacy-preserving architecture, and record protection (Afrihyia et al., 2024b; Aliliele et al., 2024; Aneke et al., 2023; Nnaji & Akinlolu, 2024a; Peteranaba et al., 2022), together with cybersecurity investment and health IT platform governance (Adebayo et al., 2023; Badmus et al., 2019; Ozowara et al., 2022), are prerequisites for multicentre data sharing. Governance of AI tools in healthcare (Afrihyia et al., 2024a), public health informatics and surveillance infrastructure (Anioke & Atima, 2023c; Atakpa et al., 2023; Ogunboye et al., 2023), predictive and risk-stratification models (Atakpa et al., 2024b; Oparah et al., 2021a; Oparah et al., 2022; Oparah et al., 2024b), and business intelligence for resource allocation (Anioke & Atima, 2023a; Nnaji & Akinlolu, 2024b) provide methods that could be adapted to monitor procedural safety at scale.

Patients with cirrhosis and refractory ascites often need repeated outpatient LVP. Health financing arrangements influence whether unnecessary blood products and their costs fall on patients (Ilodigwe & Adesemoye, 2019a), and socioeconomic and rural inequities in access to care (Akinse et al., 2023) shape who can reach a procedure unit promptly. Telehealth, mobile health monitoring, and patient engagement tools (Eyetsemitan et al., 2024; Oparah et al., 2021b; Oparah et al., 2024a), together with continuity-of-care models in home health and hospital pharmacy (Asiedu & Asiedu, 2024a; Ogundipe & Ominde, 2024), can support scheduled outpatient paracentesis, early recognition of complications, and fewer emergency admissions. Care plans that integrate behavioral, medical, and community services for underserved

Table 3: Evidence-based practice points for paracentesis in cirrhosis

Practice point	Detail and rationale
Do not delay diagnostic paracentesis	Do not wait for for coagulation results or blood products, particularly when spontaneous bacterial peritonitis is suspected (Badal et al., 2024; Kim et al., 2014).
Do not order INR solely to decide on transfusion	An INR may still be useful as a marker of liver function or prognosis, but it should not trigger FFP before paracentesis.
Do not give prophylactic FFP	Before paracentesis, regardless of the INR.
Do not routinely transfuse platelets	Consider individualized assessment, and possibly viscoelastic testing, when platelets are below about $20 \times 10^9/L$, especially for inpatient LVP.
Use ultrasound for every paracentesis	Survey with a low-frequency probe for the largest safe pocket, then scan the planned tract with a high-frequency probe and color Doppler to avoid abdominal wall vessels and collaterals. Prefer a lateral approach, lateral to the rectus sheath.
Identify higher-risk patients	Including those with AKI or uremia, Child-Pugh C or high MELD, ACLF, sepsis, or visible abdominal wall collaterals. For these patients, ensure an experienced operator, minimize passes, and observe closely after the procedure; do not transfuse based on INR alone.
Manage antithrombotic drugs individually	The 2024 Delphi found clopidogrel permissible for paracentesis; decisions on anticoagulants should weigh the indication and local guidance.
Recognize and treat bleeding promptly	Watch for abdominal wall swelling, new pain, hypotension, or a falling hemoglobin, including in the days after the procedure. Obtain contrast CT and involve interventional radiology early; transcatheter embolization outperformed surgery in reported cases (Sharzei et al., 2014). Targeted blood products are appropriate for active bleeding, guided by the AGA thresholds or viscoelastic testing (Hartmann et al., 2023; Roberts et al., 2022).
Give albumin after LVP	For drainage of more than 5 L (6 to 8 g per litre removed) to prevent post-paracentesis circulatory dysfunction, which is a distinct issue from bleeding (Biggins et al., 2021). Without albumin, renal impairment or severe hyponatremia occurred in 11 of 53 patients versus 1 of 52 with albumin (Gines et al., 1988); albumin outperformed synthetic expanders (Gines et al., 1996), reduced circulatory dysfunction and hyponatremia in a meta-analysis (Bernardi et al., 2012), and circulatory dysfunction itself is accompanied by a rise in portal pressure (Ruiz-del-Arbol et al., 1997).

LVP, large-volume paracentesis; INR, international normalized ratio; FFP, fresh frozen plasma; AKI, acute kidney injury; ACLF, acute-on-chronic liver failure.

urban populations (Peteranaba et al., 2024) can address the social barriers behind missed procedures. Many of these patients also live with alcohol use disorder, depression, or high psychological stress, and integrative CBT-DBT treatment planning (Eribenne et al., 2024), mindfulness-based stress reduction (Osinem et al., 2023), and support for activities of daily living as a clinical intervention (Osinem et al., 2021) show how behavioral and functional support can be built into long-term ascites care.

Synthesis of principal findings

Taken together, the results show consistent evidence that major bleeding after paracentesis in cirrhosis is uncommon, that conventional coagulation tests do not identify the patients who bleed, and that prophylactic plasma and platelet transfusion has no demonstrated benefit while carrying measurable harm. The interventions with the strongest support

are not haematological but procedural: ultrasound guidance, vascular scanning of the needle tract, and trained operators. The patients who do bleed are better characterized by acute kidney injury, advanced liver failure, and acute-on-chronic liver failure than by their INR or platelet count.

These findings are coherent with the physiology described in Section 3.1. Because cirrhosis lowers procoagulant and anticoagulant factors together, a prolonged INR overstates bleeding tendency, and infusing plasma shifts the test more than it shifts the patient’s capacity to form clot. The convergence of observational cohorts, mechanistic studies, viscoelastic trials, and more than a dozen society statements makes it unlikely that a future trial would overturn the central conclusion for moderate coagulopathy, although uncertainty remains at the extremes of thrombocytopenia and hypofibrinogenemia.

Table 4: Summary of evidence certainty

Question	Certainty	Comment
Major bleeding after paracentesis in cirrhosis is rare (about 0.2% to 1%)	Moderate	Consistent across large cohorts and meta-analysis; definitions vary
INR and platelet count do not predict bleeding	Low to moderate	Consistent observational data; sparse data at platelets <20 × 10 ⁹ /L
Prophylactic FFP/platelets do not reduce bleeding	Low	No direct RCT; indirect evidence from cohorts and TEG trials
Transfusion causes harm (TACO, TRALI, portal pressure, delay)	Moderate	Well established in transfusion medicine and cirrhosis physiology
Ultrasound guidance reduces bleeding	Moderate	Large adjusted cohort; residual confounding possible
Vascular (high-frequency) scanning reduces major bleeding further	Low	Single-centre pre/post study; P = 0.07
AKI is a risk factor for post-paracentesis bleeding	Low	Single-centre case-control study plus mechanistic data

Clinical implications

Table 3 translates the evidence and guidance into practice points for adults with cirrhosis undergoing diagnostic or therapeutic paracentesis. They are a synthesis for clinical teams and should be adapted to local protocols.

Implementation and the persistent practice gap

Despite this consensus, prophylactic transfusion persists. The 2024 Delphi was convened precisely because practice has lagged behind guidance, and its authors framed their output as candidate quality metrics for peri-procedure coagulation management (Tapper et al., 2024). Drivers include availability bias from memorable bleeding events, medicolegal concern, institutional protocols written for non-cirrhotic patients, and the intuitive but incorrect reading of the INR as a bleeding test. Evidence alone rarely changes outcomes unless the delivery system around it changes too (Ilodigwe & Adesemoye, 2019b). Institutional protocols, dedicated multidisciplinary procedure services that apply guidance consistently, and education on rebalanced hemostasis are the main levers for change; multidisciplinary collaboration has been associated with better patient outcomes in acute care settings (Ohunyon et al., 2023). The Delphi process measures lend themselves to routine audit as key performance indicators, for example the proportion of paracenteses preceded by plasma transfusion, within a tiered accountability model (Ekemezie et al., 2023b).

Most of the evidence above comes from well-resourced centres in North America and Europe. In many regions, access to bedside ultrasound, trained operators, and viscoelastic testing is uneven, and expansion of diagnostic infrastructure to underserved and rural areas remains a health system priority (Aminu-Ibrahim & Ogbete, 2023; Aminu-Ibrahim et al., 2020; Ogbete & Aminu-Ibrahim, 2024). The quality of conventional coagulation testing also varies between laboratories, which further weakens the case for basing transfusion decisions on a single INR result (Yusuf & Abdulrazaq, 2018). These constraints strengthen rather than weaken the argument against routine transfusion: where blood products and laboratory capacity are scarce, the most efficient safety investment is a portable ultrasound device and operator training, not pre-procedure plasma.

Strengths and limitations

Table 4 summarizes the certainty of the main conclusions.

The principal limitations are the reliance on observational and largely retrospective data; inconsistent definitions of “major” bleeding; possible under-ascertainment of delayed bleeds in outpatient series; and selection bias, since clinicians may have transfused or deferred the patients they judged highest risk. Administrative data such as the Premier cohort cannot fully account for operator experience or patient selection. Very few patients with platelets

below $20 \times 10^9/L$ or with ACLF are represented, so evidence at these extremes is thinnest.

This review also has limitations of its own. It is a structured narrative review rather than a systematic review with duplicate screening and formal risk-of-bias assessment, so some eligible studies may have been missed and selection may reflect the authors' judgement. Quantitative findings were not re-pooled. The health-systems sources used for implementation context are indirect evidence that do not evaluate paracentesis itself, and their conclusions should be read as hypotheses for local adaptation rather than as tested interventions. Its strengths are the breadth of evidence considered, from mechanistic hemostasis studies to randomized trials and guidelines across six specialties, and the explicit attention to resource-limited settings, where much of the global burden of cirrhosis lies.

Directions for future research

Several questions remain open. Prospective multicentre registries with standardized definitions of major and minor bleeding and systematic follow-up for delayed hemorrhage are needed, ideally built on real-world evidence and data-driven analytics drawn from electronic records (Ilodigwe & Adesemoye, 2024a). Better data are required in patients with platelets below $20 \times 10^9/L$, fibrinogen below about 100 mg/dL, acute-on-chronic liver failure, and acute kidney injury. Viscoelastic thresholds should be validated against actual paracentesis bleeding rather than against blood product use alone. Pragmatic or cluster-randomized implementation studies could test de-implementation strategies for low-value transfusion, and the two-probe ultrasound technique and operator training standards merit prospective evaluation.

CONCLUSION

Ultrasound-guided paracentesis in cirrhosis is a safe procedure with a low rate of major bleeding, even in patients whose INR and platelet counts would traditionally be considered prohibitive. Conventional coagulation tests do not capture the rebalanced hemostasis of liver disease and do not predict who will bleed, and prophylactic plasma and platelet transfusion offers no demonstrated benefit

while exposing patients to volume overload, rising portal pressure, lung injury, and delay. Routine pre-procedure correction should therefore be abandoned. The priorities are to perform paracentesis promptly and under ultrasound with attention to abdominal wall vessels, to recognize the clinical states such as acute kidney injury and advanced liver failure that genuinely raise risk, to manage the rare bleed decisively, and to build the training, supply, and audit systems that allow transfusion-sparing practice to become routine, including in resource-limited settings.

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