Pathophysiology and Portal Dynamics

Pathogenesis of Portal Hypertension

In patients with cirrhosis, portal hypertension results from both an increase in resistance to portal blood flow and enhanced portal blood flow.\[1,2,3\] The increased resistance in the liver results from architectural distortion due to fibrosis and regenerative nodules combined with increased intrahepatic vasoconstriction due to decreased endogenous nitric oxide production and endothelial dysfunction. In the presence of angiogenic factors and increased nitrous oxide production in the splanchnic vascular bed, splanchnic arteriolar vasodilatation and increased cardiac output increase portal venous blood inflow.\[2,4\]

Portosystemic Collaterals

Collaterals develop in response to the portal hypertension at sites of communication between the portal and systemic circulations; these collaterals are accompanied by splanchnic vasodilatation.\[1,2\] In comparison to other collaterals, gastroesophageal varices are important due to their risk of rupture and bleeding.

Hepatic Venous Pressure Gradient

The hepatic venous pressure gradient is a measure of portal (sinusoidal) pressure and can be obtained by passing a balloon catheter under radiologic guidance into the hepatic vein via the jugular or femoral vein.\[2,4\] The free hepatic vein pressure is subtracted from the wedged hepatic vein pressure to calculate the hepatic venous pressure gradient, which is normally 3 to 5 mm Hg, and an elevated value indicates an intrahepatic cause of portal hypertension.\[2,4\] Due to the invasive nature of the procedure used to obtain the hepatic venous pressure gradient, it is not widely used in the United States for prognostic or therapeutic monitoring purposes.\[2,5\] The hepatic venous pressure gradient predicts the risk of developing varices and overall prognosis (Figure 1).\[2,5\] It can also be followed to monitor response to therapy and progression of liver disease. The following definitions summarize contemporary definitions for portal hypertension based on the hepatic venous pressure gradient.\[1,3,4\]

- **Portal Hypertension**: any hepatic venous pressure gradient greater than 5 mm Hg is considered as portal hypertension.
- **Mild Portal Hypertension**: defined as a hepatic venous pressure gradient greater than 5 mm Hg but less than 10 mm Hg.
- **Clinically Significant Portal Hypertension**: defined as hepatic venous pressure gradient value of 10 mm Hg or greater.
Patients with clinically significant portal hypertension are at risk for developing varices, overt clinical decompensation (e.g. ascites, variceal hemorrhage, or hepatic encephalopathy), decompensation after surgery, and hepatocellular carcinoma. In general, variceal hemorrhage is unlikely to occur unless the hepatic venous pressure gradient is greater than or equal to 12 mm Hg; pressures above 20 mm Hg predict inability to stop bleeding and increased mortality.\[2,4,6,7\] The goal of therapy is to reduce the hepatic venous pressure gradient to less than 12 mm Hg or decrease by 20% from baseline values.\[3,5\]
Indications, Methods, and Follow-Up for Variceal Screening

Variceal Screening

Varices are present in 30 to 40% of patients with compensated cirrhosis and in 60 to 85% of patients with decompensated cirrhosis (at the time of diagnosis of cirrhosis).\[3\] Since untreated varices have a significant risk of bleeding, it is important to determine who should undergo screening endoscopy to diagnose varices. Upon diagnosis of cirrhosis, screening esophagogastroduodenoscopy (EGD) is recommended to evaluate for the presence of gastroesophageal varices.\[3\] Performing an EGD evaluation for the presence of varices will determine whether the patient should receive prophylaxis for variceal bleeding with a nonselective beta-blocker, as well as other potential preventive measures.

NonInvasive Marker to Predict Varices

Certain noninvasive markers for the presence of varices, such as the platelet count or platelet count to spleen diameter ratio, do not reliably predict the presence of esophageal varices.\[8,9\] In contrast, studies have shown transient elastography can accurately predict the presence of varices; these studies, however, were predominantly performed in persons with cirrhosis from viral hepatitis or alcohol.\[3,10,11\] In 2017, the American Gastroenterological Association (AGA) issued guidelines on the role of elastography in the evaluation of liver fibrosis.\[12\] In these guidelines, the AGA recommends that in individuals with suspected compensated cirrhosis who undergo testing with vibration controlled elastography, a value of 19.5 kPa or greater indicates a need for EGD to identify high-risk esophageal varices.\[12\] Similarly, the American Association for the Study of Liver Diseases (AASLD) recommends using a transient elastography value of greater than 20 kPa as a strong indicator for the presence of clinically significant portal hypertension.\[3\] In addition, these guidelines note that presence of portosystemic collaterals on an imaging test is considered sufficient to diagnose clinically significant portal hypertension.\[3\] Patients with a liver stiffness less than 20 kPa (as estimated by transient elastography) and a platelet count greater than 150,000/mm\(^3\) are very unlikely to have high-risk varices and EGD can be avoided.\[3\] Newer methods, such as magnetic resonance elastography and shear wave elastography have been used to measure spleen and liver stiffness, but these tests are not recommended for routine use at this time for predicting clinically significant portal hypertension.

Follow-Up EGD in Patients with Cirrhosis

If EGD is performed in a patient with compensated cirrhosis and no varices are found (Figure 2), a follow-up EGD should be performed in 2 to 3 years.\[3,13\] The 2-year interval is recommended in persons who have ongoing liver injury or associated comorbidities, such as obesity or alcohol use; the 3-year interval is considered appropriate when the liver injury is considered quiescent, such as following viral elimination or abstinence from alcohol.\[3\] If esophageal varices are found (Figure 3), they should be classified into one of two grades: small (less than or equal to 5 mm) or large (greater than 5 mm). Annual follow-up endoscopy is recommended for patients with small varices and ongoing liver injury; those with small varices and no ongoing liver injury should have follow-up endoscopy every 2 years.\[3\] In addition, the size of the varices impacts the management and prophylaxis against variceal hemorrhage, as discussed below. An upper endoscopy should also be performed at the onset of a decompensating event in persons with small or no known esophageal varices to assess for progression of portal hypertension. Individuals already taking a nonselective beta-blocker (e.g. propranolol or nadolol) or carvedilol do not need to undergo repeat EGD screening in the absence of a prior history of variceal hemorrhage.\[3,13\]

Alternatives to Endoscopy for Visualizing Varices

Since performing an EGD requires conscious sedation of the patient, use of wireless video capsule
endoscopy (patient swallows a capsule the size of large pill with a video camera on both ends) has been explored as an alternative to endoscopy, particularly for patients who are not candidates for sedation or who refuse traditional endoscopy.[14] Video capsule endoscopy is well-tolerated and safe, but it is not sufficiently accurate to warrant use as a first-line variceal screening modality.[14,15,16]
Prophylaxis of Variceal Bleeding

Patients with compensated cirrhosis will typically develop varices at a rate of 7 to 8% per year.\[17\] In addition, patients with small esophageal varices have progression to large varices at a rate of 10 to 12% per year.\[18\] It is important to decrease the risk of variceal hemorrhage, which occurs at a rate of approximately 10 to 15% per year; the highest rates of hemorrhage occur in patients with large varices, decompensated cirrhosis, or red wale markings on the varices.\[19,20\] The following summarizes the terminology used to describe prophylaxis of variceal bleeding.

- **Preprimary Prophylaxis**: prevention of the development of varices in patients with portal hypertension.
- **Primary Prophylaxis**: the prevention of variceal hemorrhage in patients with known esophageal varices, but no history of variceal hemorrhage.
- **Secondary Prophylaxis**: variceal hemorrhage prevention measures for patients with a known history of variceal hemorrhage.

Preprimary Prophylaxis

For patients with cirrhosis and clinically significant portal hypertension (hepatic venous pressure gradient greater than or equal to 10 mm Hg), but no evidence of varices on EGD, preprimary prophylaxis is not recommended to prevent the development of varices.\[3\] In a large, multicenter, placebo-controlled, double-blinded trial that enrolled participants with compensated cirrhosis (i.e. absence of ascites, encephalopathy, jaundice, and varices), investigators showed that nonselective beta-blockers do not prevent the development of varices and are associated with unwanted side effects.\[17\] For individuals with compensated cirrhosis and absence of varices, the focus should be to prevent clinical decompensation.\[3\]

Primary Prophylaxis

The approach to primary prophylaxis depends on findings of the screening EGD (Figure 4).\[3\] If no varices are observed at the time of EGD, then primary prophylaxis is not indicated. As noted above, these patients should have follow-up EGD in 2 to 3 years.\[3\]

Small Esophageal Varices

Experts have usually defined small esophageal varices as 5 mm or less, straight (nontortuous), and minimally elevated above the esophageal mucosal surface (Figure 5).\[4,21,22\] For patients with small esophageal varices that have not bled, nonselective beta-blockers may slow down variceal formation, but have not been shown to confer a survival advantage.\[23\] Given the potential for side effects, the use of nonselective beta-blockers for primary prophylaxis in patients with small esophageal varices is recommended only for those at higher risk of hemorrhage, namely patients with small varices that have red wale marks (red marks or red spots) (Figure 6) or those with Child-Turcotte-Pugh (CTP) class C cirrhosis (Figure 7).\[3\] For patients not receiving prophylaxis with a nonselective beta-blocker, EGD should be repeated (1) annually if there is ongoing liver injury or hepatic decompensation, (2) every 2 years for those individuals with liver injury that is quiescent, or (3) at the time of hepatic decompensation. Patients taking a nonselective beta-blocker do not need a follow-up EGD.

Medium and Large Esophageal Varices

The 2016 AASLD practice guidance on Portal Hypertensive Bleeding in Cirrhosis classifies medium and large varices in the same category for variceal bleeding prophylaxis recommendations.\[3\] The medium/large varices category consist of varices greater than 5 mm in size that typically have a more prominent and tortuous appearance within the esophageal lumen than seen with small varices.
For patients with medium/large varices, use of a nonselective beta-blocker or treatment with endoscopic variceal ligation has been shown to significantly reduce risk of variceal bleeding.\cite{19,24,25,26} In a meta-analysis, endoscopic variceal ligation reduced the risk of bleeding slightly more than nonselective beta-blocker use, but there was no difference in mortality and endoscopic variceal ligation is associated with a risk of procedure-related complications.\cite{24} One randomized controlled trial examined combined use of nonselective beta-blockers and endoscopic variceal ligation versus endoscopic variceal ligation alone and found the combined therapy had no benefit but was associated with increased adverse effects.\cite{27} For patients with medium/large varices, the 2016 AASLD guidance recommends primary prophylaxis with either (1) a nonselective beta-blocker (propranolol or nadolol) or carvedilol, or (2) endoscopic variceal ligation.\cite{3} The use of combination therapy with a nonselective beta-blocker (or carvedilol) and endoscopic variceal ligation is not recommended.\cite{3}

Gastric Varices

The data for primary prophylaxis for typical cardiofundal varices or isolated fundic varices is more limited, but the 2016 AASLD guideline recommends using the same nonselective beta-blocker dosing goals used for esophageal varices.\cite{3} There are insufficient data to support transjugular intrahepatic portosystemic shunt (TIPS) or balloon occluded retrograde transvenous obliteration (BRTO) to prevent initial variceal hemorrhage.

Nonselective Beta-Blockers and Carvedilol

The nonselective beta-blockers decrease cardiac output (beta-1 effect) and induce splanchnic vasoconstriction (beta-2 effect), which decreases venous portal blood inflow. With propranolol and nadolol, experts recommend initiating at a low dose and increasing every 2 to 3 days, aiming for a heart rate of approximately 55 beats per minute while maintaining a systolic blood pressure of at least 90 mm Hg (and not exceeding the recommended maximal daily dose) (\textit{Figure 9}).\cite{3} There is also strong data on carvedilol as a well-tolerated alternative to the nonselective beta-blockers.\cite{25,26,28} Patients receiving variceal prophylaxis need to continue the nonselective beta-blocker or carvedilol indefinitely, but they do not need follow-up EGD.

Endoscopic Variceal Ligation

For those patients who undergo endoscopic variceal ligation as primary prophylaxis for variceal bleeding, the procedure should be repeated every 2 to 8 weeks until the varices are eradicated.\cite{3} Following eradication of the varices, EGD should be performed 3 to 6 months later and then every 6 to 12 months thereafter.\cite{3}
Treatment of Acute Variceal Bleeding

Variceal bleeding accounts for at least 70% of cases of upper gastrointestinal bleeding in patients with portal hypertension.\[29,30,31\] The mortality associated with an index variceal bleed is approximately 20%.\[32,33\] Initial treatment of bleeding is effective in 80 to 90% of patients, but 25 to 35% rebleed in the subsequent 6 weeks, with approximately 50% of these episodes occurring within 5 to 10 days.\[34,35,36\] A hepatic venous pressure greater than 20 mm Hg (measured within 24 hours of hospital admission) and CTP class C cirrhosis are strong predictors for failure to control bleeding, risk of rebleeding, and death.\[4,32,37\] Mortality associated with acute variceal bleeding is approximately 15 to 20%, with most deaths due to liver failure, hepatorenal syndrome, and infections.\[32,34\] The management of variceal bleeding requires a multi-pronged approach as indicated in the following recommendations based on the excellent 2016 AASLD practice guidance on Portal Hypertensive Bleeding in Cirrhosis.\[3\]

General Management

The major goals in the management of persons with acute variceal bleeding are: (1) control bleeding, (2) prevent early rebleeding (within 5 days), and (3) reduce 6-week mortality.\[3\] Patients with suspected variceal hemorrhage should be admitted to the intensive care unit and immediate efforts should be made to establish intravenous access and provide volume resuscitation to achieve hemodynamic stability.\[3\]

Transfusions of Packed Red Blood Cells

Transfusion of packed red blood cells should be restricted to a hemoglobin level of approximately 7 g/dL or lower, as excessive transfusion increases portal pressure, risk of rebleeding, and mortality.\[3,38\] For persons requiring red blood cell transfusions, the goal is to maintain a hemoglobin level between 7 and 9 g/dL.\[3\]

Correction of Coagulopathy

There is no evidence that correcting coagulopathy with use of recombinant factor VIIa or fresh frozen plasma improves outcomes and therefore attempts to correct international ionized ratio is not recommended.\[3,39,40,41\] There are insufficient data to recommend for or against use of platelet transfusions.\[3\]

Vasoactive Agents

Use of vasoactive agents in persons with acute variceal bleeding clearly lowers transfusion requirements and improves 7-day mortality.\[3,42\] The vasoactive agents are splanchnic vasoconstrictors and include intravenous vasoconstrictors and somatostatin analogs.\[43\] A vasoactive agent should be started immediately in a patient with suspected variceal bleeding and octreotide, somatostatin, terlipressin, and vasopressin have similar efficacy, but different side effect profiles.\[44,45\] Somatostatin, terlipressin, and vasopressin are not commercially available in the United States.\[43\] Octreotide, a somatostatin analogue, should be given as an initial intravenous bolus (50 micrograms), with the option to repeat within 60 minutes if bleeding does not stop; following the initial bolus, the octreotide should be given as a continuous intravenous infusion (rate of 50 micrograms per hour) for 2 to 5 days, unless a TIPS is placed.\[46\] Its efficacy is controversial as it is associated with tachyphylaxis, but it may provide some benefit when used in combination with endoscopic therapy.\[19,47\]

Infection Prophylaxis

In patients with gastrointestinal bleeding, including variceal bleeding, the use of a 7-day course of
prophylactic antibiotics (norfloxacin or ceftriaxone) has been shown to decrease the rate of bacterial infection, risk of early rebleeding, and mortality.[48] The preferred initial treatment consists of ceftriaxone 1 g daily.[2,49] The 2012 AASLD guidance for the Management of Adult Patients with Ascites Due to Cirrhosis recommends initiating therapy in this situation with intravenous ceftriaxone, with the option to switch to oral therapy (norfloxacin) once bleeding stops and the patient has resumed oral intake.[49] Since norfloxacin is no longer available in the United States, most experts substitute oral ciprofloxacin 500 mg twice daily for norfloxacin in this situation. If intravenous ceftriaxone cannot be used due to a severe beta-lactam allergy, intravenous ciprofloxacin 400 mg every 12 hours can be used as the initial intravenous prophylaxis regimen during active bleeding.

Nonselective Beta-Blockers

Nonselective beta-blockers should not be started immediately in patients with acute variceal bleeding. If the patient is taking a nonselective beta-blocker, it should be held during the first several days of bleeding, especially if the patient is hemodynamically unstable. If a patient receives a 2 to 5 day course of intravenous octreotide, the nonselective beta-blocker can be started (or restarted) after completion of the octreotide course.[3] If the patient has a TIPS procedure performed, a nonselective beta-blocker is no longer needed.

Endoscopic Therapy

Esophagogastroduodenoscopy should be performed within 12 hours of admission, with immediate endoscopic variceal ligation of confirmed or suspected varices.[3] This procedure involves placing a small elastic band around the varices. Endoscopic sclerotherapy, which consists of injecting a sclerosant solution into the varices, has also been shown to be effective in stopping acute variceal bleeding, but is not recommended as an initial endoscopic therapeutic option, primarily because of better outcomes with endoscopic variceal ligation.[50,51]

Transjugular Intrahepatic Portosystemic Shunt (TIPS)

Several studies have shown placement of transjugular intrahepatic portosystemic shunt (TIPS) within 72 hours of endoscopic variceal ligation in high-risk patients results in lower risk of rebleeding and improved survival, but these patients were highly selected and constituted less than 20% of those admitted with variceal hemorrhage in one of the studies.[2,52,53] Patients with Child-Turcotte-Pugh (CTP) class C with a score of 10 to 13 or CTP class B with active bleeding visualized on endoscopy despite intravenous vasoactive drug therapy were considered for TIPS placement.[3] Retrospective observational TIPS studies have not consistently confirmed a survival benefit of early TIPS placement so more studies are needed.[54,55] For patients with uncontrolled variceal hemorrhage despite intravenous vasoactive drugs and endoscopic therapy, rescue TIPS can be considered. If a TIPS is placed, then the intravenous vasoactive agent (octreotide) can be discontinued.[3]

Balloon Tamponade

Use of standard measures fails to control bleeding in approximately 10 to 20% of persons with variceal bleeding. In this setting, use of balloon tamponade may be necessary as a temporary stabilizing therapy until a more definitive procedure, such as endoscopic variceal ligation or TIPS, can be performed.[3,56] The use of balloon tamponade is associated with serious potential adverse effects and it should not be used for longer than 24 hours.[3] Self-expandable metal esophageal stents were shown in a small multicenter randomized controlled trial to be a reasonable alternative to achieve hemostasis in those who did not respond to medical and endoscopic therapy, and these can remain in place up to seven days, while awaiting more definitive therapy.[57]

Gastric Varices
Gastric varices are present in 20% of patients with portal hypertension, but episodes of bleeding tend to be even more severe than esophageal variceal bleeding.\cite{2,3,58} Acute fundal gastric variceal bleeding (1 to 3% of all variceal bleeding episodes) is associated with a higher rate of death than gastroesophageal varices as the bleeding is usually more severe.\cite{58} Initial treatment includes volume resuscitation, intravenous vasoactive therapy, and prophylactic antibiotics. In cases of severe hemorrhage, balloon tamponade (using an inflated gastric balloon to apply pressure to the gastroesophageal junction) can be used as a temporizing measure. Endoscopic variceal ligation can be technically challenging to perform depending upon the location of the gastric varices. Endoscopic variceal obturation with tissue adhesive (e.g. N-butyl-2-cyanoacrylate, isobutyl-2-cyanoacrylate, or thrombin) is preferred over endoscopic variceal ligation for initial management of bleeding from gastric varices.\cite{59,60} This technique requires special endoscopic expertise, so if it is not available, TIPS can also be used to control the bleeding successfully as first-line therapy or in cases of recurrent bleeding.\cite{61}
Secondary Prophylaxis of Variceal Bleeding

Untreated cirrhotic patients with a history of variceal bleeding have a 60% risk of rebleeding within 1 year. The risk of dying with each rebleeding episode is approximately 20%. Modalities used to prevent rebleeding are considered secondary prophylaxis of variceal bleeding.

Pharmacologic Therapy

Nonselective beta-blockers can reduce the risk of rebleeding by about 40% and improve overall survival by 20%. Adding isosorbide mononitrate to a nonselective beta-blocker may slightly lower the rebleeding rate, but the dual medication therapy does not improve mortality and it is associated with more side effects. The recommended nonselective beta-blockers are propranolol and nadolol: the data for carvedilol is insufficient, so it cannot be recommended for secondary prophylaxis of variceal bleeding. Typical doses of propranolol are 20 to 40 mg twice daily (maximum daily dose of 320 mg in persons without ascites and 160 mg in persons with ascites). The typical nadolol dose is 20 to 40 mg once a day (maximum daily dose 160 mg in persons without ascites and 80 mg in persons with ascites). For both propranolol and nadolol the dose should be titrated with the goal of a resting heart rate of 55 to 60 beats per minute while maintaining a systolic blood pressure of at least 90 mm Hg.

Endoscopic Variceal Ligation Therapy

Endoscopic variceal ligation therapy is superior to sclerotherapy for secondary prophylaxis and decreases the rebleeding rate to around 32%. Sessions should be repeated every 7 to 28 days until the varices are eradicated and then EGD should be repeated every 3 to 6 months for surveillance (to determine whether additional endoscopic variceal ligation therapy is required).

Combination Therapy

For secondary prophylaxis of variceal bleeding, the combination of a nonselective beta-blocker and endoscopic variceal ligation therapy is superior to either modality alone; combination therapy decreases the rebleeding rate to about 14 to 23%, although there is no statistical difference in mortality. Combination therapy with a nonselective beta-blocker and endoscopic variceal ligation therapy is considered the standard first-line therapy for secondary prophylaxis of variceal bleeding. Thus, in the absence of TIPS placement with the acute episode, patients who received endoscopic variceal ligation therapy should be started on therapy with a nonselective beta-blocker prior to discharge from the hospital.

Transjugular Intrahepatic Portosystemic Shunt (TIPS)

Placement of TIPS has been shown to be superior to endoscopic variceal ligation therapy and pharmacologic therapy in reducing the risk of rebleeding, but with no improvement in mortality and an increase in hepatic encephalopathy. If a patient had placement of a TIPS during an acute bleeding episode, they do not need additional therapy for portal hypertension or varices, but they should be referred for liver transplantation evaluation. If a patient has rebleeding after combination therapy with nonselective beta-blockers and endoscopic variceal ligation therapy, placement of a TIPS is the recommended rescue therapy. In clinical practice, the older uncovered TIPS have been replaced by polytetrafluoroethylene-covered TIPS. The patency of the TIPS should be reassessed by Doppler ultrasound every 6 months and from a practical standpoint this evaluation can be coupled with hepatic ultrasound hepatocellular carcinoma surveillance.

Portacaval Shunt Surgery
Surgical placement of a portacaval shunt is effective in preventing rebleeding; this procedure, however, does not improve survival, increases the risk of developing hepatic encephalopathy, and has largely been replaced by TIPS. Portacaval shunt surgery is primarily reserved for patients with Child-Turcotte-Pugh class A liver disease.[4]

**Gastric Varices**

The combination of nonselective beta-blocker and endoscopic therapy can be used for secondary variceal hemorrhage prophylaxis for gastroesophageal varices but for fundal varices, TIPS and/or BRTO (transvenous occlusion of gastro- or splenorenal collateral via the left renal vein using sclerosants or embolic agents), can be performed.[72, 73]
Summary Points

- Portal hypertension results from increased resistance to portal flow (fixed and dynamic) and increased portal venous blood inflow (splanchnic vasodilatation and increased cardiac output).
- All cirrhotic patients should undergo EGD for variceal screening at the time of diagnosis, unless they are already using a nonselective beta-blocker or carvedilol. If no varices are found, the EGD examination should be repeated in 2 to 3 years or at the time of hepatic decompensation.
- Small esophageal varices (in the absence of red wale marks or Child-Turcotte-Pugh class C cirrhosis) do not warrant prophylaxis but repeat EGD should be repeated every 1 to 2 years or at time of hepatic decompensation.
- The nonselective beta-blockers are recommended for the prevention of the first variceal hemorrhage in those with large esophageal varices or small esophageal varices at high risk of bleeding (red wale marks or Child-Turcotte-Pugh class C cirrhosis). If nonselective beta-blockers are contraindicated or not tolerated, endoscopic variceal ligation can be performed.
- Acute variceal hemorrhage is managed with the combination of an intravenous vasoconstrictor agent, such as octreotide, and endoscopic variceal ligation. Transjugular intrahepatic portosystemic shunt is reserved as rescue therapy and may be considered earlier in patients at high risk for rebleeding (e.g. hepatic venous pressure gradient greater than or equal to 20 mmHg or Child-Turcotte-Pugh class C cirrhosis.) Use of prophylactic antibiotics during acute variceal bleeding reduces the risk of rebleeding and mortality.
- Bleeding gastric varices can be treated using endoscopic variceal obturation using tissue adhesives or a transjugular intrahepatic portosystemic shunt.
- In patients who have previously bled, the combination of nonselective beta-blockers and endoscopic variceal ligation reduces the risk of rebleeding. A transjugular intrahepatic portosystemic shunt procedure decreases the risk of rebleeding further but does not impact survival, so it is reserved for those who fail combination pharmacologic and endoscopic therapy. Balloon occluded retrograde transvenous obliteration is another option for the prevention of rebleeding from gastric varices.
Citations


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Figures

Figure 1 Prognostic Value of Hepatic Venous Pressure Gradient (HVPG) in Patients with Chronic Liver Disease


<table>
<thead>
<tr>
<th>Measurement</th>
<th>Significance</th>
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<tbody>
<tr>
<td>1-5 mm Hg</td>
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<tr>
<td>6-10 mm Hg</td>
<td>Preclinical sinusoidal portal hypertension</td>
</tr>
<tr>
<td>≥ 10 mm Hg</td>
<td>Clinically significant portal hypertension</td>
</tr>
<tr>
<td>≥ 12 mm Hg</td>
<td>Increased risk for rupture of varices</td>
</tr>
<tr>
<td>≥ 16 mm Hg</td>
<td>Increased risk of mortality</td>
</tr>
<tr>
<td>≥ 20 mm Hg</td>
<td>Treatment failure and mortality in acute variceal bleeding</td>
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</table>
Figure 2 Cirrhotic Liver without Esophageal Varices

The left side of the illustration shows a patient with moderately advanced cirrhosis. The inset shows an internal longitudinal view of the esophagus, with absence of esophageal varices. The far right inset shows the esophageal view as seen from the operator of the endoscope.

Illustration by David W. Ehlert, CMI, MAMS. Cognition Studio
Figure 3 Cirrhotic Liver with Esophageal Varices

The left side of the illustration shows a patient with advanced cirrhosis and marked dilatation of surrounding veins. The inset shows an internal longitudinal view of the esophagus, with the presence of esophageal varices. The far right inset shows the esophageal view of the visible varices as seen from the operator of the endoscope.

Illustration by David W. Ehlert, CMI, MAMS. Cognition Studio
Figure 4 Management of Patients with Cirrhosis Following EGD Screening

^The 2-year interval is recommended in persons who have ongoing liver injury or associated comorbidities, such as obesity or alcohol use. The 3-year interval is appropriate when the liver injury is considered quiescent, such as following viral elimination or abstinence from alcohol.

^Patients with small varices not on a recommended beta-blocker should have endoscopy repeated every year (with ongoing liver injury) or every 2 years (if liver injury is quiescent)

**Figure 5 Endoscopic View of Small Esophageal Varices**

Endoscopic view of the esophagus, looking down into the esophageal lumen. The white arrows indicate the presence of small esophageal varices.

Photograph courtesy of Dr. Iris Liou, University of Washington.
Figure 6 Endoscopic View Red Wale Markings on Esophagus

Endoscopic view of the esophagus, looking down into the esophageal lumen. The black arrows indicate the presence of red wale markings (red marks or red spots) on esophageal varices.

Photograph courtesy of Dr. Iris Liou, University of Washington.
Figure 7 Child-Turcotte-Pugh (CTP) Classification

The Child-Turcotte-Pugh (CTP) classification system utilizes two clinical parameters (encephalopathy and ascites) and three laboratory values (bilirubin, albumin, and prothrombin time). Patients are classified as class A, B, or C based on their total points.


<table>
<thead>
<tr>
<th>Child-Turcotte-Pugh Classification for Severity of Cirrhosis</th>
<th>Points*</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
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<tr>
<td>Encephalopathy</td>
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<tr>
<td>Ascites</td>
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<td>Albumin (g/dL)</td>
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<tr>
<td>INR</td>
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</table>

*Child-Turcotte-Pugh Class obtained by adding score for each parameter (total points)

Class A = 5 to 6 points (least severe liver disease)

Class B = 7 to 9 points (moderately severe liver disease)

Class C = 10 to 15 points (most severe liver disease)
Figure 8 Endoscopic View of Large Esophageal Varices

Endoscopic view of the esophagus, looking down into the esophageal lumen. The white arrows indicate the presence of two columns of large esophageal varices.

Photograph courtesy of Dr. Iris Liou, University of Washington.
Figure 9 Nonselective Beta-Blockers and Carvedilol for Primary Prophylaxis against Variceal Bleeding

*Indicates nonselective beta-blockers All medications listed are oral regimens.


<table>
<thead>
<tr>
<th>Therapy</th>
<th>Starting Dose</th>
<th>Dose Titration</th>
<th>Maximal Dose</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carvedilol</td>
<td>6.25 mg once daily</td>
<td>After 3 days, increase to 6.25 mg twice daily</td>
<td>12.5 mg/day (except in patients with persistent hypertension)</td>
<td>Maintain systolic blood pressure ≥90 mm Hg</td>
</tr>
<tr>
<td>*Nadolol</td>
<td>20 to 40 mg once daily</td>
<td>Increase every 2-3 days until treatment goal reached or at maximum dose</td>
<td>• 160 mg/day in patients without ascites&lt;br&gt;• 80 mg/day in patients with ascites</td>
<td>• Resting heart rate 55-60 beats per minute&lt;br&gt;• Maintain systolic blood pressure ≥90 mm Hg</td>
</tr>
<tr>
<td>*Propanol</td>
<td>20 to 40 mg twice daily</td>
<td>Increase every 2-3 days until treatment goal reached or at maximum dose</td>
<td>• 320 mg/day in patients without ascites&lt;br&gt;• 160 mg/day in patients with ascites</td>
<td>• Resting heart rate 55-60 beats per minute&lt;br&gt;• Maintain systolic blood pressure ≥90 mm Hg</td>
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