

Hemodilution Technique Cut Need for Transfusion

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NEW YORK — Acute normovolemic hemodilution markedly reduced the need for blood products, compared with standard intraoperative management in a randomized trial of patients undergoing major hepatic resection.

In the 130-patient study, the red blood cell transfusion rate in patients managed with ANH was half that of patients who

received standard management, Dr. William H. Jarnagin reported at the annual meeting of the American Surgical Association.

ANH “should be used routinely when moderate to high blood loss is anticipated,” concluded Dr. Jarnagin, vice chair of surgical services and chief of the hepatopancreatobiliary service at Memorial Sloan-Kettering Cancer Center, New York.

Hepatic resection often entails major blood loss. While transfusion of allogeneic

blood products can often be lifesaving, it has many downsides, including increased risks of blood-borne infectious diseases, acute lung injury, transfusion reactions, immunomodulation, and other serious complications, as well as substantially higher direct and indirect costs of care.

ANH is a low-tech blood conservation technique that avoids exposing patients to the risks of allogeneic transfusion while preserving blood bank supplies for the situations where they are truly needed.

ANH involves intraoperative removal of whole blood by gravity collection prior to starting the resection. The lost volume is replaced with crystalloid and colloid. That way a smaller volume of the patient’s red blood cell (RBC) mass is lost per volume of surgical blood lost. At the end of the operation, after hemostasis is attained, the patient’s blood is transfused back.

“Compared with other blood conservation strategies, ANH has several advantages: It is technically and logistically simple, and there are minimal equipment requirements and no storage or administrative costs, no delay in procedure scheduling, and no waste of autologous units,” Dr. Jarnagin explained.

He presented a single-center prospective trial involving 130 patients undergoing resection of three or more hepatic segments

thrombophilias, have an increased risk of other maternal complications and fetal loss regardless of the type of anticoagulant used.

All patients receiving anticoagulants such as enoxaparin, including pregnant women, are at risk for bleeding. Pregnant women receiving enoxaparin should be carefully monitored for evidence of bleeding or excessive anticoagulation. Consideration for use of a shorter acting anticoagulant should be specifically addressed as delivery approaches [see *Boxed Warning*]. Hemorrhage can occur at any site and may lead to death of mother and/or fetus. Pregnant women should be apprised of the potential hazard to the fetus and the mother if enoxaparin is administered during pregnancy.

Data

• *Human Data* - There are no adequate and well-controlled studies in pregnant women.

A retrospective study reviewed the records of 604 women who used enoxaparin during pregnancy. A total of 624 pregnancies resulted in 693 live births. There were 72 hemorrhagic events (11 serious) in 63 women. There were 14 cases of neonatal hemorrhage. Major congenital anomalies in live births occurred at rates (2.5%) similar to background rates.

There have been postmarketing reports of fetal death when pregnant women received Lovenox. Causality for these cases has not been determined. Insufficient data, the underlying disease, and the possibility of inadequate anticoagulation complicate the evaluation of these cases.

A clinical study using enoxaparin in pregnant women with mechanical prosthetic heart valves has been conducted [see *Warnings and Precautions* (5.7)].

• *Animal Data* - Teratology studies have been conducted in pregnant rats and rabbits at SC doses of enoxaparin up to 30 mg/kg/day or 211 mg/m²/day and 410 mg/m²/day, respectively. There was no evidence of teratogenic effects or fetotoxicity due to enoxaparin. Because animal reproduction studies are not always predictive of human response, this drug should be used during pregnancy only if clearly needed.

8.3 Nursing Mothers

It is not known whether this drug is excreted in human milk. Because many drugs are excreted in human milk, caution should be exercised when Lovenox is administered to nursing women.

8.4 Pediatric Use

Safety and effectiveness of Lovenox in pediatric patients have not been established.

8.5 Geriatric Use

Prevention of DVT in hip, knee and abdominal surgery; Treatment of DVT; Prevention of ischemic complications of unstable angina and non-Q-wave myocardial infarction

Over 2800 patients, 65 years and older, have received Lovenox in pivotal clinical trials. The efficacy of Lovenox in the geriatric (≥65 years) was similar to that seen in younger patients (<65 years). The incidence of bleeding complications was similar between geriatric and younger patients when 30 mg every 12 hours or 40 mg once a day doses of Lovenox were employed. The incidence of bleeding complications was higher in geriatric patients as compared to younger patients when Lovenox was administered at doses of 1.5 mg/kg once a day or 1 mg/kg every 12 hours. The risk of Lovenox-associated bleeding increased with age. Serious adverse events increased with age for patients receiving Lovenox. Other clinical experience (including postmarketing surveillance and literature reports) has not revealed additional differences in the safety of Lovenox between geriatric and younger patients. Careful attention to dosing intervals and concomitant medications (especially antiplatelet medications) is advised. Lovenox should be used with care in geriatric patients who may show delayed elimination of enoxaparin. Monitoring of geriatric patients with low body weight (<45 kg) and those predisposed to decreased renal function should be considered [see *Warnings and Precautions* (5.9) and *Clinical Pharmacology* (12.3)].

Treatment of acute ST-segment Elevation Myocardial Infarction (STEMI)

In the clinical study for treatment of acute STEMI, there was no evidence of difference in efficacy between patients ≥75 years of age (n = 1241) and patients less than 75 years of age (n=9015). Patients ≥75 years of age did not receive a 30-mg IV bolus prior to the normal dosage regimen and had their SC dose adjusted to 0.75 mg/kg every 12 hours [see *Dosage and Administration* (2.3)]. The incidence of bleeding complications was higher in patients ≥65 years of age as compared to younger patients (<65 years).

8.6 Patients with Mechanical Prosthetic Heart Valves

The use of Lovenox has not been adequately studied for thromboprophylaxis in patients with mechanical prosthetic heart valves and has not been adequately studied for long-term use in this patient population. Isolated cases of prosthetic heart valve thrombosis have been reported in patients with mechanical prosthetic heart valves who have received enoxaparin for thromboprophylaxis. Some of these cases were pregnant women in whom thrombosis led to maternal and fetal deaths. Insufficient data, the underlying disease and the possibility of inadequate anticoagulation complicate the evaluation of these cases. Pregnant women with mechanical prosthetic heart valves may be at higher risk for thromboembolism [see *Warnings and Precautions* (5.7)].

8.7 Renal Impairment

In patients with renal impairment, there is an increase in exposure of enoxaparin sodium. All such patients should be observed carefully for signs and symptoms of bleeding. Because exposure of enoxaparin sodium is significantly increased in patients with severe renal impairment (creatinine clearance <30 mL/min), a dosage adjustment is recommended for therapeutic and prophylactic dosage ranges. No dosage adjustment is recommended in patients with moderate (creatinine clearance 30-50 mL/min) and mild (creatinine clearance 50-80 mL/min) renal impairment [see *Dosage and Administration* (2.2) and *Clinical Pharmacology* (12.3)]. In patients with renal failure, treatment with enoxaparin has been associated with the development of hyperkalemia [see *Adverse Reactions* (6.2)].

8.8 Hepatic Impairment

The impact of hepatic impairment on enoxaparin’s exposure and antithrombotic effect has not been investigated. Caution should be exercised when administering enoxaparin to patients with hepatic impairment.

8.9 Low-Weight Patients

An increase in exposure of enoxaparin sodium with prophylactic dosages (non-weight adjusted) has been observed in low-weight women (<45 kg) and low-weight men (<57 kg). All such patients should be observed carefully for signs and symptoms of bleeding [see *Clinical Pharmacology* (12.3)].

10 OVERDOSAGE

Accidental overdosage following administration of Lovenox may lead to hemorrhagic complications. Injected Lovenox may be largely neutralized by the slow IV injection of protamine sulfate (1% solution). The dose of protamine sulfate should be equal to the dose of Lovenox injected: 1 mg protamine sulfate should be administered to neutralize 1 mg Lovenox, if enoxaparin sodium was administered in the previous 8 hours. An infusion of 0.5 mg protamine per 1 mg of enoxaparin sodium may be administered if enoxaparin sodium was administered greater than 8 hours previous to the protamine administration, or if it has been determined that a second dose of protamine is required. The second infusion of 0.5 mg protamine sulfate per 1 mg of Lovenox may be administered if the aPTT measured 2 to 4 hours after the first infusion remains prolonged.

If at least 12 hours have elapsed since the last enoxaparin sodium injection, protamine administration may not be required; however, even with higher doses of protamine, the aPTT may remain more prolonged than following administration of heparin. In all cases, the anti-Factor Xa activity is never completely neutralized (maximum about 60%). Particular care should be taken to avoid overdosage with protamine sulfate. Administration of protamine sulfate can cause severe hypotensive and anaphylactoid reactions. Because fatal reactions, often resembling anaphylaxis, have been reported with protamine sulfate, it should be given only when resuscitation techniques and treatment of anaphylactic shock are readily available. For additional information consult the labeling of protamine sulfate injection products.

17 PATIENT COUNSELING INFORMATION

Patients should be told that it may take them longer than usual to stop bleeding, that they may bruise and/or bleed more easily when they are treated with Lovenox, and that they should report any unusual bleeding or bruising to their physician [see *Warnings and Precautions* (5.1, 5.5)].

Patients should inform physicians and dentists that they are taking Lovenox and/or any other product known to affect bleeding before any surgery is scheduled and before any new drug is taken [see *Warnings and Precautions* (5.3)].

Patients should inform their physicians and dentists of all medications they are taking, including those obtained without a prescription [see *Drug Interactions* (7)].

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DR. JARNAGIN

who were randomized to ANH or standard intraoperative management. In the ANH group, blood was removed to a target hemoglobin of 8.0 g/dL. Patients had a median of 2,250 mL of blood removed; the hemodilution took 37 minutes on average to complete.

The RBC transfusion rate was 25% in controls and 13% with ANH, for a 50% reduction. Intraoperatively, a hemoglobin below 7.0 g/dL required transfusion; only 1.6% of patients managed with ANH required an intraoperative transfusion, versus 10% with standard management.

Historically, roughly 50% of patients at Sloan-Kettering undergoing major hepatic resection have required allogeneic transfusions. With contemporary techniques, the rate in the usual-care group in this study was just half that. “In fact, ANH wasn’t necessary in many of our patients,” the surgeon noted.

ANH proved most useful for patients with an operative blood loss of at least 800 mL, which was actually the median blood loss in the study. Among that population, 42% of controls required allogeneic RBC transfusion, compared with 18% in the ANH group. Moreover, 21% of patients in the ANH group required fresh frozen plasma, compared with 48% on standard intraoperative management.

Sixty-day major morbidity rates were similar at about 30% in the two study arms.

Discussant Dr. William C. Chapman said the well-designed study provides convincing evidence that ANH is safe and effective. He predicted that as a result ANH will be instituted at many centers in selected high-risk patients.

“I don’t think there’s any doubt that this strategy works,” said Dr. Chapman, professor of surgery and chief of the section of transplantation at Washington University, St. Louis. ■