Utilization of a Massive Transfusion Protocol During Liver Lobe Resection: A Case Report

Bryan Tune, CRNA, DNP

The literature shows substantial data that acute coagulopathy and hemorrhage without rigorous resuscitative efforts has a high morbidity and mortality. The utilization of protocols for a massive transfusion and resuscitation can lead to improved outcomes in morbidity and mortality. Protocols for massive transfusion allow for improved access to blood components and delivery systems, improved timing of administration, and a transfusion ratio of red blood cells to fresh frozen plasma and to platelets that has been shown to decrease the overall transfusion requirements.

Blood product administration continues to be a controversial clinical topic of major importance to today's healthcare providers. This issue is of greatest interest to the anesthesia and surgical community, as blood product administration during the perioperative course is a common occurrence. The administration of human blood products does not come without risk. Transfusion-related acute lung injury (TRALI) is of great concern with autologous blood transfusion.1,2 Infection, immune system modulation, and antibody-antigen incompatibility are all additional potential complications that are inherent to blood transfusion. The administration of blood products carries a large financial burden to both the institution and the patient as well. The collection, testing, banking, and administration of blood products require a great deal of technology, equipment, and professionally trained staff.

Massive transfusion is loosely defined as the transfusion of more than 10 U of packed red blood cells (PRBCs) in a 24-hour period.3,4 It is also referred to in the literature as replacing an entire circulating blood volume in less than a 24-hour period.3 Identifying the presence of a massive transfusion or the potential need to engage in one can save a patient's life. Traumatic injury, obstetric hemorrhage, and vascular surgery all pose increased potential need for massive transfusion. Having a massive transfusion protocol (MTP) within an institution can improve access to blood products and minimize the time to administration.3

This case study will discuss anesthesia management and the use of MTP during liver lobe resection of a cancerous lesion. Recent data have demonstrated a reduction in the overall financial cost of a large blood volume resuscitation when an MTP is in place.3,5 In addition, data support that there is a decrease in the total volume of blood products administered when an MTP is implemented.3 A substantial amount of data has also shown that increasing the ratios of fresh frozen plasma (FFP) and platelets drastically reduces the 24-hour mortality and coagulopathy rate.3-10

Case Summary
A 52-year-old man was scheduled for an excision of a liver mass with probable lobe resection. Medical history included hypertension that was adequately managed with an angiotensin-converting enzyme (ACE) inhibitor. The patient admitted to a prior history of alcohol abuse and currently being a smoker. His level of physical activity was high, and he was employed in a produce packing shed. Except for hypertension, the review of systems was noncontributory. The patient’s surgical history included a laparoscopic cholecystectomy 10 years earlier, performed under general anesthesia without complication.

A thorough preoperative assessment was performed the morning of surgery, and all laboratory data were reviewed. The electrocardiogram showed normal sinus rhythm, and the hemoglobin level (13.8 g/dL), white blood cell count (8,000/µL), international normalized ratio (1.1), and electrolytes were all within normal limits. The chest radiograph demonstrated normal findings. The anesthesia plan was fully discussed with the patient, and consent was obtained. The plan included the preoperative placement of a low thoracic epidural catheter for the primary purpose of postoperative pain management via continuous epidural infusion. Radial artery cannulation would also be performed preoperatively, with localization at the site of catheter placement and mild sedation. The intraoperative anesthesia plan was for general endo-
tracheal anesthesia, as well as placement of a subclavian central line after the induction of general anesthesia. Consent was obtained for the intraoperative administration of blood products, with all risks and benefits described in detail to the patient. His blood was typed and crossmatched before surgery, and 4 U of PRBC and 4 U of FFP were available in the operating room. The patient was advised that postoperative mechanical ventilation might be required.

Preoperative sedation was administered with intravenous midazolam (2 mg), and standard monitors were applied as a 1-L bolus of lactated Ringer’s solution was administered. Placement of the epidural catheter at thoracic level T8-9 was successful on the first attempt with the patient in the sitting position. After a negative test dose, 0.5% ropivacaine at a volume of 5 mL was administered as an initial bolus. Within 10 minutes the patient admitted to mild abdominal loss of sensation, and a 15-mm Hg drop in blood pressure was noted. The right radial arterial line was then placed, and the patient was transported to the operating room. Following pre-oxygenation, general anesthesia was administered with an intravenous induction of fentanyl, 100 µg; lidocaine, 100 mg; propofol, 150 mg; and rocuronium, 50 mg. The trachea was easily intubated with an 8.0-mm endotracheal tube under direct laryngoscopy, with a grade 1 view appreciated. The left hemithorax was prepared and draped in sterile fashion for placement of the central line. A left subclavian double-lumen catheter was successfully placed on the first attempt. An initial central venous pressure reading of 6 mm Hg was recorded, with a good waveform present.

The attending surgeon and senior resident proceeded with the surgical incision and dissected to the liver. On full exposure of the liver, the mass that was previously seen on computed tomography was noted. Intraoperatively a core biopsy was performed surgically, and the pathologic study confirmed a malignancy. The surgical attending and resident decided to resect the affected cancerous lobe of the liver. Shortly into the resection phase of the operation, hepatic hemorrhage ensued. Surgical staff intermittently applied vascular clamps to major hepatic vessels in an attempt to decrease hemorrhage and identify the injury source. The initial blood loss exceeded 1,000 mL within minutes. Autologous blood transfusion was initiated immediately, and all 4 U of both RBC and FFP were transfused. At the point of hepatic hemorrhage the nurse anesthetist and surgeon collaboratively activated the hospital institutional MTP.

In an activated MTP, the blood bank will send a waveform present.

### Table. Fluid and Blood Resuscitation

<table>
<thead>
<tr>
<th>Blood products/fluids</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRBC (U)</td>
<td>51</td>
</tr>
<tr>
<td>FFP (U)</td>
<td>53</td>
</tr>
<tr>
<td>Platelets (U)</td>
<td>6</td>
</tr>
<tr>
<td>Cryoprecipitate (U)</td>
<td>3</td>
</tr>
<tr>
<td>Crystalloid (L)</td>
<td>12</td>
</tr>
<tr>
<td>Calcium chloride (g)</td>
<td>8</td>
</tr>
</tbody>
</table>

Abbreviations: PRBC, packed red blood cells; FFP, fresh frozen plasma.

Administration of 5 U of PRBC, FFP, and platelets in a 1:1:1 ratio is considered to be 1 cycle of the MTP. During the massive transfusion phase, frequent laboratory studies are drawn, typically every 1 to 2 cycles of the protocol. Studies include a complete blood cell count, metabolic panel, arterial blood gas, serum lactate level, and a full coagulation panel. After 2 cycles of the 1:1:1 ratio, 1 U of cryoprecipitate is administered if indicated by the coagulation studies. The benefits of factor VII administration are also continually assessed if temperature and pH are normalized.

Surgical control of hemorrhage was eventually met, and resection of the cancerous hepatic lobe continued. Throughout the duration of the case the MTP was utilized for more than 10 cycles. Intraoperatively, 113 U of blood products were administered by a team composed of 2 Certified Registered Nurse Anesthetists (CRNAs) and a student registered nurse anesthetist (Table). The estimated blood loss exceeded 10,000 mL. Urine output during the entire case averaged 0.5 mL/kg/h; however, during times of massive hemorrhage, urine output was not observed. The patient was admitted to the intensive care unit postoperatively, where he remained intubated and mechanically ventilated. No continuous vasoactive agents were used intraoperatively or postoperatively (see Table).

On the second postoperative day the patient was fully awake, with a Glasgow Coma Scale of 11. He remained mechanically ventilated with minimal pressure support. All other vital signs were within normal limits, and the surgical team elected to keep the patient sedated and intubated throughout the second postoperative day, with plans for early extubation on the third postoperative day. The epidural infusion was restarted by anesthesia staff on the second postoperative day as an attempt to decrease or eliminate opioid infusion requirements and allow for ease of extubation the following morning. The patient was successfully extubated on the third postoperative day. He was transferred to the intensive care stepdown unit, where he remained for 24 hours. The epidural infusion of 0.1% ropivacaine plus 3.5 µg/mL of fentanyl was continued at 12 mL/h, and the patient expressed only a feeling of abdominal soreness.
He was then transferred to the medical-surgical floor on postoperative day 4, and the epidural catheter was removed fully intact. The afternoon of the fourth postoperative day the patient was ambulating with physical therapy and tolerating physical activity well. He was subsequently discharged from the hospital on postoperative day number 8.

Discussion
Preoperatively the use of a blood salvaging system was discussed with the perioperative team, as the potential for substantial blood loss was present. It was decided, however, that an autologous blood recovery machine (eg, Cell Saver, Haemonetics, Braintree, Massachusetts) might be inappropriate because of the surgical goal of a cancerous lesion resection. The use of a cell salvage system during the resection of a cancerous lesion has been shown to potentially lead to reinfusion of blood systemically that is contaminated with cancerous cells.11

The utilization of an MTP can lead to improved patient physiologic stabilization and a decrease in mortality.3,8,10,12,13 Current evidence in the literature demonstrates that having an MTP in place improves patient outcomes greater than does a system that requires clinician-initiated individual unit ordering.3,5,7,14 Having the available blood product resources and fluid volume likely spared this patient’s life. Coagulopathic crisis was avoided, and potentially less overall transfusion of blood components was required.

The risk of TRALI is certainly of concern in large blood volume transfusions. According to a review article, TRALI is the third most common reason for transfusion-associated death.5 However, without the use of an MTP, this patient would have likely not survived the surgical procedure. The time requirements for nursing, blood bank, and ancillary staff to obtain the required blood products would have likely been too great, resulting in life-threatening hypovolemia, tissue hypoxia, and likely death.

Conclusion
The implementation of an MTP in acute care facilities that manage traumatically injured and hemorrhagic patients has shown strong evidence in improving patient outcomes. Morbidity and mortality rates of patients who are hemorrhaging are decreased when an MTP is utilized. Current evidence also shows a decrease in blood bank and hospital charges when massive transfusion is protocol driven within the institution.3

The availability of an MTP in the author’s institution allowed for rapid resuscitation of a patient with an acute vascular hemorrhage. There was a substantial reduction in blood bank processing and transport time, which allowed for improved intraoperative availability of needed blood products. The protocol facilitated a ratio of RBC to FFP to platelets that is supported in the literature and is shown to improve morbidity and mortality, improve coagulation, and decrease the overall transfusion volume.

In analyzing the current data on the benefits of an MTP, it behooves anesthesia providers to question whether such a protocol exists in their institution. If an MTP does not exist in the institution, it may be appropriate to investigate the implementation of this evidence-based protocol.

REFERENCES

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