Impact of minimizing diagnostic blood loss in the critically ill

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Background. *The use of a small-volume phlebotomy tube (SVPT) versus conventional-volume phlebotomy tube (CVPT) has led to a decrease in daily blood loss. Blood loss due to phlebotomy can lead ultimately to decreased rates of anemia and blood transfusions, which can be important in the critically ill patient.*
Methods. *We compared SVPT vs CVPT retrospectively in critically ill adult patients age ≥18 years admitted to a surgical intensive care unit for ≥48 hours. CVPT were evaluated from January 2011 to May 2011 and SVPT from June 2012 to October 2012.*
Results. *Amount of blood drawn for laboratory tests and transfusions were evaluated in 248 patients (116 SVPT vs 132 CVPT). When compared with CVPT, total blood volume removed (mean ± SD) with SVPT was less overall, 174 ± 182 mL vs 299 ± 355 mL,* P = .001. *Daily blood draws also were less, 22.5 ± 17.3 mL vs 31.7 ± 15.5 mL,* P < .001. *The units of packed red blood cells given were not significant, 4.4 ± 3.6 units vs 6.0 ± 8.2 units,* P = .16.
Conclusion. *The use of SVPT blood sampling led to a decreased amount of blood drawn. Strategies that use SVPT in a larger cohort also may decrease the number of transfusions in selected patients. Every effort should be made to use SVPT. (Surgery 2015;158:1083-8.)*

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Anemia is a common problem in critically ill patients.[1] Studies have examined the relationships between blood draws and outcomes in this population. Some studies report phlebotomized volumes in excess of 600 mL for long-term, ventilated, critically ill patients during their hospital stay.[1] Shaffer[2] found a significant correlation between severity of illness, number of blood draws, and total amount of blood drawn.

Anemia secondary to phlebotomy accounted for 40% of packed red blood cells (pRBC) transfusion requirements.[3] In addition, anemia and resultant blood transfusions may lead to greater rates of sepsis, transfusion-related reactions, greater severity of illness, and prolonged durations of hospital stay.[3]

The use of small-volume phlebotomy tubes (SVPTs) is a blood conservation strategy to minimize blood volumes lost with laboratory testing.[4] The use of SVPT compared with conventional-volume phlebotomy tubes (CVPTs) has resulted in a 46% decrease in blood loss.[4] The purpose of this study was to evaluate SVPTs versus CVPTs in critically ill adult patients to determine whether a significant decrease in blood loss from phlebotomy would occur and if the use of SVPTs decreased the need for blood transfusion.

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MATERIALS AND METHODS

After approval from the Wayne State University Human Investigation Committee, this retrospective cohort evaluated patients admitted for ≥48 hours to the surgical intensive care unit (ICU) with an open admission policy and age ≥18 years. Patients in whom CVPTs were used were evaluated from January 2011 to May 2011 and compared with patients whom SVPTs were used from June 2012 to October 2012. After education by a dedicated clinical nurse practitioner, all patients admitted to the surgical intensive care were switched to phlebotomy with SVPT on June 1, 2012.

On the basis of the practice model our institution, 95% of our patients are admitted through the emergency department. In patients presenting with active bleeding from trauma, gastrointestinal bleeding, or bleeding from any other cause, homeostasis was obtained before evaluation in this

study, and, thus, units of blood transfused were not evaluated in this population.

Baseline demographics, Acute Physiology and Chronic Health Evaluation (APACHE) II, admitting service, and laboratory data, including hemoglobin (Hgb), were evaluated. Analysis of phlebotomy included the number of blood studies performed, the blood volume removed per ICU day, and the total blood volume for the entire ICU stay. pRBC transfusions, ICU and hospital durations of stay, and in-hospital mortality were compared between groups.

BD Vacutainer phlebotomy tubes (Becton, Dickinson, and Company, Franklin Lakes, NJ) were used for both groups during the study periods. In the CVPT group, 8.5 mL was used for a basic metabolic panel (serum electrolytes and creatine and blood urea nitrogen) and therapeutic drug levels. For complete blood count (CBC) and crossmatch, 6.0 mL was used in a K2 EDTA tube (Becton, Dickinson, and Company). A buffered sodium citrate 0.109 M, 3.2% 2.7 mL was used for prothrombin time, international normalized ratio, and partial thromboplastin times. In the SVPT group, 5.0 mL was used for basic metabolic panel and therapeutic drug levels. The K2 EDTA 2.0 mL tube was used for CBC and crossmatch. A buffered sodium citrate 0.109 M, 3.2% 1.8 mL was used for prothrombin time, international normalized ratio, and partial thromboplastin times. For both groups, arterial blood gas analysis used 3 mL. Blood cultures were drawn using BD Bactec bottles, one aerobic and one anaerobic, using 10 mL each. For CVPT and SVPT, the core laboratory at the Detroit Medical Center used the Dimension Vista for electrolytes and SYSMEX for CBC and other analyzes.

When laboratory studies were ordered, phlebotomy was obtained routinely from a triple lumen, central venous catheter or peripherally inserted central catheter (ie, PICC) line. Arterial blood gas analysis was performed via an arterial catheter. Per our critical care practice policy, a venous arterial blood management protection system was used to minimize blood loss with phlebotomy. Waste occurred during the initial phase of phlebotomy when the blood sample was first removed. Waste was defined as two times the volume of the catheter. The central venous catheter used during the study period was the ARROWgard Blue PLUS (Arrow International, Reading, PA) with the maximum priming volume of 0.42 mL with the distal lumen. Hence, the maximum waste would be ~1 mL per phlebotomy episode.

No restriction was placed on the number of phlebotomies performed. Additionally, no change in transfusion thresholds was made during the study periods. On the basis of the Hgb, anemia was defined based on the following severity: mild Hgb 9.0–11.0 g/dL, moderate for a Hgb 7.0–8.9 g/dL, and severe <7.0 g/dL. The decision to transfuse was at the discretion of the primary team with a restrictive transfusion policy of a Hgb <7.0 g/dL unless hemodynamic instability or active bleeding was present.[5]

Statistical analysis was performed using SPSS v 21 (IBM, Armonk, NY). Univariate analyses evaluated baseline differences between groups. Categorical variables were compared using Pearson's χ^2 analysis. Continuous variables were analyzed with the Student *t* test or Mann–Whitney *U* as appropriate. Continuous variables are presented as the mean ± SD. Power analysis revealed 62 patients were needed in each group to see a decrease in pRBC transfusions by one unit.

RESULTS

The study evaluated 248 patients: 116 SVPT versus 132 CVPT. The mean age was 56 ± 19 years, and 62% of the patients were male. When we compared patients with SVPT vs CVPT, the APACHE II was not different between groups, 14.1 ± 8.6 vs 12.7 ± 6.9; $P = .17$ (Table I). Baseline Hgb levels, 11.7 ± 2.6 g/dL vs 11.6 ± 2.5 g/dL; $P = .70$, and the number of phlebotomy studies per ICU days were not different between groups, 5.5 ± 2.8 studies/ICU day SVPT vs 5.6 ± 2.4 studies/ICU day CVPT; $P = .74$.

The total blood volume removed in these critically ill patients with SVPT was less, 174 ± 182 mL vs 299 ± 355 mL; $P = .001$. In addition, overall ICU daily volume was less with SVPT, 22.5 ± 17.3 mL vs 31.7 ± 15.5 mL; $P < .001$ (Table II).

Analyzing transfusion practices, patients were of similar severity of illness (APACHE II), 14.1 ± 7.7 with transfusion versus 12.6 ± 7.8 without transfusion ($P = .13$). The units of pRBCs transfused were not different with SVPT, 4.4 ± 3.6 units vs 6.0 ± 8.2 units; $P = .16$ with no difference in rates of administration been groups. At least one episode of severe anemia (Hgb <7.0 g/dL) was seen less frequently in the SVPT group, 12/116 (10%) vs 29/132 (22%); $P = .01$. The surviving patients who did not receive a transfusion had a lesser duration of ICU stay (6 ± 5 days vs 12 ± 15 days for patients receiving transfusion; $P < .001$) and a lesser hospital duration of stay (11 ± 13 days vs 19 ± 16 days for patients receiving transfusion, $P < .001$).