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Perioperative blood transfusion and complications in children undergoing surgery for solid tumors

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ABSTRACT

Background: The objective was to assess whether perioperative blood transfusion (PBT) is associated with postoperative complications in children undergoing surgery for a solid tumor.
Methods: Using 2012-2014 National Surgical Quality Improvement Program Pediatric data, we identified patients aged 0-18 years who underwent surgery (biopsy or resection) for solid tumors. We compared demographic, clinical, and 30-day outcome characteristics between children who did and did not receive a PBT within 72 hours after surgery. Propensity score–matched analyses were used to estimate the effect of PBT on postoperative complications, in the overall cohort, the subgroup undergoing resection, and the subgroup with liver tumors.
Results: Of 961 patients who underwent surgery for solid tumors, 27.8% required PBT. Patients requiring PBT were more likely to have preoperative risk factors, including ventilator dependence, hematologic disorders, chemotherapy, sepsis, transfusion before surgery, and an American Society of Anesthesiologists class ≥3 (all $P \leq 0.01$). In propensity score–matched analyses, PBT was not associated with overall complication risk (odds ratio [OR]: 1.50, $P = 0.07$) but was associated with an increased risk of postoperative mechanical ventilation (OR: 3.78, $P < 0.001$). Of the 750 patients undergoing tumor resection, 36.3% required PBT. After propensity matching, PBT was associated with overall postoperative complications (OR: 1.76, $P = 0.02$). Of 163 patients with liver tumors, 52.8% required PBT. After propensity matching, PBT was not associated with postoperative complications (OR: 2.00, $P = 0.09$). PBT was associated with a longer postoperative length of stay in all three analyses (all $P < 0.01$).
Conclusions: PBT was associated with higher risks for postoperative complications in children undergoing surgery for solid tumors.

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Introduction

Approximately 5% of children treated at tertiary children's hospitals require blood transfusions.[1] Across institutions, there is interhospital variability in ordering practices of blood products.[2,3] Although transfusions have been demonstrated in some adult studies to be associated with a higher risk of complications,[4-6] there is a paucity of data on outcomes related to perioperative blood transfusion (PBT) in the pediatric population.[1,7]

Patients with solid tumors have a particularly high risk of anemia,[8] partly due to the myelosuppressive effects of aggressive chemotherapeutic regimens. Surgical procedures in this population often necessitate PBTs. However, there are no well-established guidelines on the indications for transfusion in children undergoing surgical procedures. The objective of this study was to assess whether PBT is associated with a higher risk of postoperative complications in pediatric patients undergoing surgery for solid tumors.

Materials and methods

Data source and cohort development

We conducted a retrospective review of the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) Pediatric (NSQIP) 2012-2014 Participant Use Files. ACS NSQIP Pediatric was developed by the ACS in collaboration with the American Pediatric Surgical Association. The program provides peer-reviewed, risk-adjusted 30-day postoperative outcomes to participating institutions, for the purposes of benchmarking and quality improvement. During 2012-2014, between 50 and 59 North American institutions, including freestanding children's hospitals, specialty children's hospitals, and general acute care hospitals with a pediatric ward, participated in ACS NSQIP Pediatric each year. At participating institutions, specially trained surgical clinical reviewers collect data on 147 variables, including preoperative characteristics, intraoperative variables, and postoperative outcomes, for patients undergoing surgical procedures. Additional details on the ACS NSQIP Pediatric and the Participant Use Files can be found in the user guides for these files.[9]

Using *International Classification of Diseases, Ninth Revision, Clinical Modification* codes, we identified patients aged 0-18 years who underwent surgery for solid tumors of the liver (155.0, 155.2), retroperitoneum (158.0), mediastinum (164.2, 164.3, 164.8, and 164.9), skeleton (170.3, 170.6, and 170.9), soft tissue (171.4, 171.5, 171.6, 171.8, and 171.9), ovary (183.0), kidney (189.0 and 189.1), or adrenal gland (194.0). Procedure codes for both biopsies and resections were included, as incisional biopsies of solid tumors can oftentimes hemorrhage and require transfusion. Patient demographic characteristics (age, gender, and race/ethnicity), comorbidities (including cardiac, pulmonary, and neurologic risk factors, congenital malformations, developmental delay, bleeding and hematologic disorders, previous chemotherapy, preoperative transfusion, transplant, renal failure, and sepsis), American Society of Anesthesiologists (ASA) class (which was dichotomized because initial analyses revealed very few patients with ASA class 1 or 5), tumor site, operative characteristics (total operation time, duration of time in the operating room, and total anesthesia time), and case type (elective *versus* urgent) were assessed.

Outcomes

The primary outcome of this study was the occurrence of any postoperative complication within 30 days of surgery. This was defined as any incisional complication, central line–associated blood stream infection, sepsis, unplanned readmission or reoperation, death, or complication related to the respiratory, cardiovascular, urinary, or neurologic system. Each of these complications and two others that were only collected in 2013-2014, namely the need for nutritional support at discharge and the need for oxygen at discharge, were also examined individually. Because PBT was defined as any blood transfusion occurring within 72 hours after the start of surgery (including intraoperative and postoperative transfusions), it was possible that the postoperative complications under evaluation could have occurred before transfusion. For this reason, complications that occurred on the same day as or a day preceding a patient's first perioperative transfusion were not considered complications in this analysis.

Statistical analysis

Demographic and clinical variables were summarized using medians and interquartile ranges for continuous variables and frequencies and proportions for categorical variables. Continuous variables were compared between patients who did and did not receive a PBT using Wilcoxon rank-sum tests, and categorical variables were compared between patients who did and did not receive a PBT using Pearson chi-square tests or Fisher's exact tests as appropriate. Propensity score–matched analysis was used to estimate the effect of PBT on the risk of a postoperative complication within 30 days. All preoperative characteristics present in at least five patients and associated with PBT at $P < 0.25$ were entered into a multivariable logistic regression model for treatment group (PBT *versus* no PBT), and forward stepwise selection was used to add first-order interactions until none remained to be added that was significant at $P < 0.05$. Patients with and without PBT were matched on the logit of their propensity score using 1:1 nearest neighbor matching within calipers of width equal to 0.20 times the standard deviation of the logit of the propensity score. To assess the balance in all known preoperative patient characteristics between the treatment groups after propensity score matching, standardized differences were computed to confirm that all were ≤ 0.10. A conditional logistic regression model for any postoperative complication was then used to estimate the effect of PBT on overall complication risk among those who received PBT. Finally, interactions between treatment group and tumor location and between treatment group and whether a preoperative transfusion occurred in the 48 hours before surgery were evaluated to assess whether the effect of PBT on complication risk varied across