

# Data-driven education improves patient blood management: A pilot study

Authors: Joseph P. Connor, MD<sup>1</sup>, Ahmed Al-Niimi, MD<sup>2</sup>, Lisa Barroilhet, MD, MS<sup>2</sup>

Affiliations:

- 1) University of Wisconsin, Department of Pathology and Laboratory Medicine, Section of Transfusion Medicine, Madison, WI
- 2) University of Wisconsin, Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Madison, WI

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## Abstract:

### Introduction:

We sought to increase the use of a restrictive transfusion protocol through clinician education and a standard approach to Patient Blood Management (PBM) in our gynecologic oncology service. Optimal PBM requires the consistent application of evidence-based, restrictive transfusion guidelines, however the use of restrictive transfusion is understudied in surgical oncology populations. We hypothesized that provider specific education that includes data derived from their own clinical practice would result in improved compliance current evidence-based transfusion guidelines.

### Methods:

We created an educational activity that described evidence-based restrictive transfusion guidelines followed by data showing providers their own clinical transfusion practice where compliance with restrictive guidelines was poor. After the education, a plan to improve compliance was developed and put into place. Comparison of transfusion practices and complication/morbidity rates before and after the education was performed.

### Results:

During the 18 months post-education the number of RBC units transfused decreased from 316 to 152, a 52% reduction and monthly transfusion events were reduced by 42% from 12 to 7 per month. The percent of transfusions with a pre-transfusion hemoglobin less than 7 g/dL increased from 40% to 56%. The percent of transfusions with a hemoglobin less than 8 g/dL increased to 90%. Finally, the use of single unit transfusions increased from 49 to 85%, a major contributor to the reduction in units transfused.

### Conclusion:

We created a service-specific educational intervention that improved compliance with evidence-based restrictive transfusion practice. This intervention improved provider compliance with lower transfusion thresholds and increased the use of single-unit transfusions.

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**Corresponding Author:** Joseph Connor **E-mail:** JConnor@uwhealth.org

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## Introduction:

Patient Blood Management (PBM) is the timely application of evidence-based medical and surgical concepts designed to maintain hemoglobin concentration, optimize hemostasis and minimize blood loss in an effort to improve patient outcomes.<sup>1-</sup>

<sup>3</sup> One of the main tenants of effective PBM is the application of evidence-based transfusion guidelines to facilitate the appropriate utilization of blood products. Data from randomized clinical trials shows that reducing red blood cell (RBC) transfusions

through the application of restrictive transfusion thresholds, most commonly hemoglobin (Hgb) levels of 7 or 8 g/dL, is safe and can result in reduced morbidity without detrimental effects on mortality.<sup>3-5</sup> The use of these restrictive transfusion practices has been well documented in general patient populations; however, recommendations are less well defined in surgically based oncology specialties, including gynecologic oncology. In addition to the use of restrictive transfusion thresholds, the use of single unit transfusion over the historic practice of two or

more units per transfusion event has been well established as a means of reducing unnecessary over-transfusion without negative impact on patient outcomes.<sup>6-8</sup> The improvements in patient care seen with the application of evidence-based clinical care guidelines are only realized if the clinical care being provided adheres to published guidelines. In a previous study of transfusion practices in gynecologic oncology surgeries at our hospital we noted that over one-third of postoperative transfusions were not compliant with a restrictive threshold of 8 g/dL Hgb and that only 6% were compliant with the lower threshold of 7 g/dL. It was also noted that the majority of transfusions in this study were for 2 units, again contrary to current evidence-based restrictive transfusion guidelines.<sup>9</sup> Based on our own data we sought to improve our transfusion practice through provider education and by standardizing PBM on our hospital's gynecologic oncology service.

Improving clinician's compliance with guidelines can be challenging. General educational efforts to inform providers about guidelines are often ineffective or result in a transient improvement in compliance.<sup>10</sup> We hypothesized that specialty-specific provider education based on data derived from the same provider's actual clinical practice would result in more robust motivation to improve compliance. To evaluate this hypothesis, we created an educational intervention that described the current evidence-based restrictive transfusion guidelines, followed by a presentation of data to show the providers their actual clinical transfusion practice. We focused this presentation on provider's current compliance with evidence-based restrictive transfusion guidelines. The educational process then concluded with the creation of a plan for how to work toward improvement. This study reports on the effect a service specific, data driven educational effort to improve compliance with restrictive transfusion practices on the gynecologic oncology service at a major tertiary care hospital with an evolving PBM program.

## Methods:

An educational intervention was developed to educate the faculty of the gynecologic oncology service on the use of restrictive transfusion threshold and the process of PBM in general. After this general educational information, service specific data from

our previous study of transfusion in ovarian cancer surgeries was reviewed with focus on the low level of compliance with restrictive RBC transfusion guidelines. The program described how in their current clinical practice 65% of transfusions were compliant with a transfusion threshold of 8 g/dL and that only 6% of them were compliant with a transfusion threshold of 7 g/dL and that the majority of transfusions they ordered were for two units despite evidence-based recommendations that single unit transfusion are preferred, and most often adequate to address anemia.

This service specific educational intervention concluded with a request that the clinical service providers discuss the information provided and consider a plan moving forward to focus efforts on improving compliance. After deliberation/discussion independent of the transfusion medicine facilitator (JPC) the service agreed to strive for a pre-transfusion threshold of 7 g/dL for women on their service and to work toward the use of single unit transfusions when appropriate to achieve the desired post transfusion Hgb goals.

Eighteen months after this plan was enacted we reviewed the transfusion practices for all patients cared for by the providers of the gynecologic oncology service and compared it to the 18-month span of time immediately prior to the intervention. RBC units ordered and transfused were identified from a hospital dashboard (QlikView, Qlik Software, King of Prussia, PA) that tracks all blood product orders placed within the University of Wisconsin Hospital's electronic medical record (EMR). The dashboard contains the date and time of each order, the selected indication for the transfusion, the authorizing provider for the order, the number of units in the order, and the pre-order Hgb or HCT. Twelve providers from the department of Obstetrics and Gynecology's division of Gynecologic Oncology were identified as ordering providers in the dashboard, 8 attending physicians, 2 Gynecologic Oncology fellows, and 2 mid-level providers. Orders for intra-operative/surgical RBC units or units for patients that were actively bleeding were excluded based on the order indications.

The decision to use a pre-transfusion Hgb threshold of 7g/dL for patients on the gynecology service was made in the last week of June 2018 therefore a starting date to monitor this change was

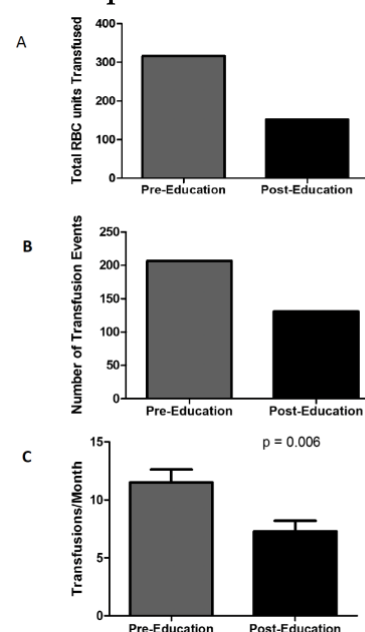
assigned as 7/1/2018. At the time of our analysis there was 18 months of data available on RBC orders after the educational program and the change in practice was initiated (7/1/2018 through 12/31/2019). We then created a pre-education control group of identical data from the 18 months immediately preceding the planned change (1/1/2017 through 6/30/2018).

To evaluate the rate of complications in each of the time periods studied we generated a list from our EMR data-base of all patients that had at least one encounter with any of the gynecologic oncology providers who are represented in the transfusion dashboard and then queried the EMR for diagnosis codes of major morbidities for each of the patients including; Infectious events (urinary tract infections, cellulitis, wound infections/separations/dehiscence, peritonitis, endocarditis, and sepsis) cardiac events (angina ( new diagnosis), myocardial infarction (all types), cardiac arrhythmias, or other ischemic heart disease), thromboembolic events (deep venous thrombosis and pulmonary embolism), Renal failure/insufficiency, Gastrointestinal obstruction, and Intensive care unit admissions for any diagnosis. Statistical Analysis: Comparison of transfusion practice and complication/morbidity rates between the two study periods was done by the Student's t-test or Mann Whitney tests for continuous variables or by contingency table analysis by Chi-square or Fisher's exact test for categorical variables. A p-value of < 0.05 in each two tailed analysis was used to define statistical significance in all comparisons.

## Results:

During the 18 months post-education the total number of RBC units transfused was reduced from 316 to 152 units, a 52% reduction (figure 1 panel A). The number of transfusion events was reduced from 207 before education to 130 after the education, a drop of 37% (figure 1 panel B) resulting in a reduced rate of transfusion from  $11.5 \pm 1.1$  transfusion events per months to  $7.3 \pm 0.9$  transfusion events per month (figure 1 panel C). The percent of transfusions with a pre-transfusion hemoglobin less than 7 g/dL increased from 40% to 56% and the percent of transfusions with a hemoglobin less than 8 g/dL increased to 90%.

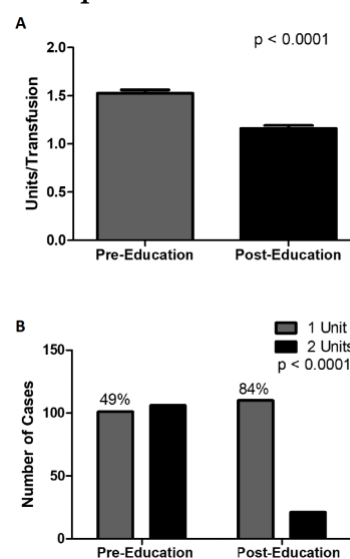
**Figure 1: Pre and post education transfusions**



The total number of RBC units transfused was reduced by 52% (panel A). The total number of transfusion events was reduced from 207 events to 130 events after the education, a 37% reduction in transfusion events (panels B and C).

Figure 2 panel A shows that the median number of units per transfusion event decrease from 2 units to 1 unit ( $p < 0.0001$ ) with the percent of single unit transfusions increasing from 49 to 85% of prescribed transfusion events (figure 2 panel B).

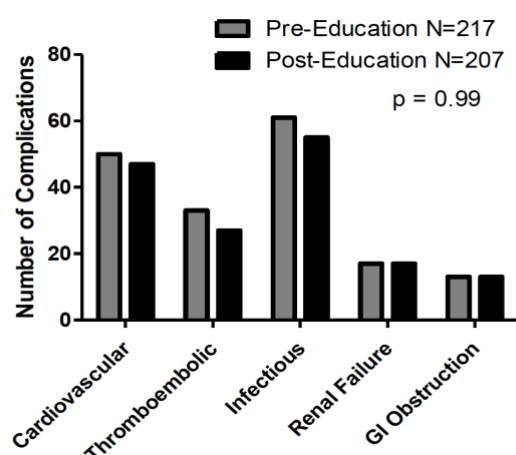
**Figure 2: Units per transfusion**



After the educational intervention, the mean number of units transfused per transfusion was reduced from  $1.5 \pm 0.04$  (median 2) to  $1.2 \pm 0.03$  (median 1) units (panel A). Consistent with this the percentage of single unit transfusions increased from 49% to 84% (panel B).

To verify that the reduced use of transfusion (total number of transfusions and volume/dose of blood per transfusion) did not negatively impact overall patient morbidity a retrospective study of major complications for all patients cared for by the 12 providers on the gynecology service done. In the 18 months pre-education 217 individual patients were seen for at least one encounter with at least one of the 12 providers. Similarly, 207 unique patients were seen in the 18 months post-education. As seen in figure 3 no differences in the incidence of major morbidity including cardiovascular events, thromboembolic events, major infectious morbidity, the incidence of renal failure, or the presence of intestinal obstruction were identified in this large cohort of women between the patients cared for in either of the time frames studied.

**Figure 3: Incidence of major complications**



There were no significant changes in the incidence of major complications before and after the education in the cohort of women cared for by the providers included in the analysis of transfusions in this study.

Finally, a review of the most recent 18 months of transfusion practice for the gynecologic oncology providers studied showed sustained improvement with 91% of transfusions with a pre-transfusion Hgb of < 8 g/dL and with 80% single unit transfusions.

## Discussion:

Improved compliance with evidence-based clinical guidelines through education can be achieved however this method has historically been less than optimal.<sup>10,11</sup> The data presented in this pilot study underscore the importance of a well-constructed

educational intervention and shows that education driven by service-specific data can be effective in improving compliance with guidelines. This was most evident by the 36 % increase in the use of single unit transfusions and to a lesser extent by the increases in the use of the evidence-based restrictive transfusion thresholds of 7 g/dL. Long-term follow-up of 3 years since the intervention supports that these practice changes have been successfully maintained.

The development and application of evidence-based clinical guidelines with a goal of improving patient outcomes has been described in the medical literature since the early 1970s with an increase and more frequent use of clinical guidelines being noted in the 90s.<sup>12</sup> Concurrent with the early use of clinical guidelines came the concerns for, and descriptions of, the many barriers to their use and reasons for poor guideline compliance. One common theme in the literature on this topic is the necessity of quality, evidence-based guidelines that should in and of themselves encourage good compliance. Criterion for the development of effective guidelines are well-established however, the barriers to compliance are many and varied and it is not infrequent that multiple barriers play into provider's noncompliance in any one case.<sup>13-16</sup>

Numerous avenues to enhance compliance with guidelines have been proposed including the application of decision support tools,<sup>17,18</sup> the use of scheduled audits of provider compliance with corrective actions were necessary, and as we focus on in this manuscript, the application of provider education focused on the evidence-based guideline and their appropriate application.<sup>19-21</sup>

The use of education to improve provider compliance with well accepted, evidence-based guidelines has demonstrated frequent short-term improvement, however many of these efforts are found to be non-sustainable with regression to noncompliance over time. Strategies to improve educational interventions with the intent of improving compliance with clinical practice guidelines have been extensively studied. In a 2002 paper Tu et-al showed that improved physician compliance with evidence-based guidelines was more successful when educational efforts focused on a single target issue rather than the distribution of general guideline information with multiple recommendations. Targeting an intervention to a

single or focused small group of outcomes was shown to be more effective than the use of a comprehensive educational approach.<sup>10</sup>

Another key to successful education is the identification of provider specific gaps in knowledge. This was underscored by Courier in a 2000 study on Type 2 Diabetes management. The authors noted that providers with fewer knowledge gaps demonstrated better compliance with evidence-based guidelines over providers who had knowledge deficits in the clinical care of Type 2 DM. Identification of specific knowledge gaps and which providers display those gaps allows for the development of education specific to the knowledge gaps and allows the education efforts to be focused on the providers who need it most. In the current manuscript we capitalized on this concept after identifying gaps in care/compliance and using these gaps as part of our educational intervention.<sup>22</sup>

One of the few papers to address educational efforts to improve transfusion practice in the surgical setting was published in 1993 by Sumer and colleagues from the Harvard Medical School. At the time, the evidence-based transfusion threshold for RBCs was a Hgb of 8g/dL, however chart review at their hospital demonstrated poor compliance with this and that many patients were being over-transfused to Hgb in the 10 to 12 g/dL range. The authors of this paper created a surgeon specific, 30 minutes, in person, face-to-face educational intervention to describe the rationale and evidence behind the use of the 8 g/dL Hgb transfusion threshold. The hospital's surgeons were then randomized to either participate or not in this education. The authors demonstrated that the educational effort resulted in significant improvement in compliance with the more restrictive transfusion threshold and that follow up at six months demonstrated sustainability in this provider population.<sup>23</sup>

In the current study we utilized several of the factors just described in creating a service-specific educational intervention with the goal of improving compliance with restrictive transfusion practice for a specific clinical service at a major academic medical center. After a previous study demonstrated knowledge gaps as to the use of restrictive transfusion thresholds and the use of single unit transfusions<sup>9</sup> we created an educational intervention

that included a description of the current state of transfusion practice among the gynecologic oncology service, and thus made them aware of their own lack of compliance with the most current evidence-based guidelines. Although the educational intervention did give some general educational description of PBM and restrictive thresholds, we focused the educational intervention on the single task of improved compliance with restrictive transfusion practice. The educational endeavor included feedback and input from the involved physician providers. This intervention not only improve/increased provider compliance with lower transfusion threshold we also saw a significant improvement in the use of single unit transfusions after the educational intervention. The improved compliance was sustained over the original 18-month study period and over the most recent 18 month for a total of over 3 years after the educational intervention. Although success over 3 years is encouraging, longer-term follow-up will be important to verify that this intervention resulted in long-term improvement in transfusion practice among the gynecology service at our institution. We also must interpret this data with the understanding that guidelines are clearly not meant to be accepted in 100% of cases and that any evaluation of physician compliance will always be less than 100%. As noted by Elrod and colleagues there are always good reasons to not comply with evidence-based clinical guidelines and acceptance will never achieve 100%. However, striving for maximum improvement and adherence should remain standard.<sup>14</sup>

### Conclusion:

We created a service-specific educational intervention that improved compliance with evidence-based restrictive transfusion practice. This intervention improved provider compliance with lower transfusion thresholds and increased the use of single-unit transfusions.

### Author Contributions:

All authors contributed equally to the conception and design, acquisition of data, or analysis, interpretation of data, manuscript preparation and review.

### Potential Conflicts of Interest Disclosures:

The authors disclose that there were no conflicts of interest or financial support in the development of this project. All data is authentic and accurate.

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## References:

1. Althoff FC, Neb H, Herrmann E, Trentino KM, Vernich L, Fullenbach C, et al. Multimodal Patient Blood Management Program Based on a Three-pillar Strategy: A Systematic Review and Meta-analysis. *Annals of surgery*. 2019;269(5):794-804. Epub 2018/11/13.
2. Franchini M, Marano G, Veropalumbo E, et al. Patient Blood Management: a revolutionary approach to transfusion medicine. *Blood transfusion = Trasfusione del sangue*. 2019;17(3):191-5. Epub 2019/06/28.
3. Murphy MF, Goodnough LT. The scientific basis for patient blood management. *Transfusion clinique et biologique : journal de la Societe francaise de transfusion sanguine*. 2015;22(3):90-6. Epub 2015/05/12.
4. Carson JL, Carless PA, Hebert PC. Transfusion thresholds and other strategies for guiding allogeneic red blood cell transfusion. *The Cochrane database of systematic reviews*. 2012(4):CD002042. Epub 2012/04/20.
5. Carson JL, Guyatt G, Heddle NM, et al. Clinical Practice Guidelines From the AABB: Red Blood Cell Transfusion Thresholds and Storage. *Jama*. 2016;316(19):2025-35. Epub 2016/10/13.
6. Podlasek SJ, Thakkar RN, Rotello LC, et al. Implementing a "Why give 2 when 1 will do?" Choosing Wisely campaign. *Transfusion*. 2016;56(9):2164. Epub 2016/09/15.
7. Shih AW, Liu A, Elsharawi R, Crowther MA, Cook RJ, Heddle NM. Systematic reviews of guidelines and studies for single versus multiple unit transfusion strategies. *Transfusion*. 2018;58(12):2841-60. Epub 2018/10/23.
8. Warner MA, Schaefer KK, Madde N, Burt JM, Higgins AA, Kor DJ. Improvements in red blood cell transfusion utilization following implementation of a single-unit default for electronic ordering. *Transfusion*. 2019;59(7):2218-22. Epub 2019/04/20.
9. Connor JP, O'Shea A, McCool K, Sampene E, Barroilhet LM. Peri-operative allogeneic blood transfusion is associated with poor overall survival in advanced epithelial ovarian Cancer; potential impact of patient blood management on Cancer outcomes. *Gynecologic oncology*. 2018;151(2):294-8. Epub 2018/09/12.
10. Tu K, Davis D. Can we alter physician behavior by educational methods? Lessons learned from studies of the management and follow-up of hypertension. *The Journal of continuing education in the health professions*. 2002;22(1):11-22. Epub 2002/05/15.
11. Psarris A, Sindos M, Theodora M, et al. Routine immunizations during pregnancy, doctors' compliance and patient hesitancy: A two stage study on vaccination uptake. *European journal of obstetrics, gynecology, and reproductive biology*. 2019;243:36-40. Epub 2019/11/02.
12. Grimshaw JM, Russell IT. Achieving health gain through clinical guidelines II: Ensuring guidelines change medical practice. *Quality in health care : QHC*. 1994;3(1):45-52. Epub 1994/02/07.
13. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *Jama*. 1999;282(15):1458-65. Epub 1999/10/27.
14. Ellrodt AG, Conner L, Riedinger M, Weingarten S. Measuring and improving physician compliance with clinical practice guidelines. A controlled interventional trial. *Annals of internal medicine*. 1995;122(4):277-82. Epub 1995/02/15.
15. Pronovost PJ. Enhancing physicians' use of clinical guidelines. *Jama*. 2013;310(23):2501-2. Epub 2013/12/07.
16. Redelico TJ, Walton SM, LaFollette J, Adams Curry M, Bernal-Mizrachi L. Assessment of Provider Adherence to Recommended Monitoring Parameters for Oral Anticancer Medications. *Journal of oncology practice*. 2018;14(7):e446-e50. Epub 2018/05/31.
17. Clemens E, Cutler T, Canaria J, Pandya K, Parker P. Prescriber Compliance with a New Computerized Insulin Guideline for Noncritically Ill Adults. *The Annals of pharmacotherapy*. 2011;45(2):154-61. Epub 2011/01/20.
18. Lobach DF, Hammond WE. Computerized decision support based on a clinical practice guideline improves compliance with care standards. *The American journal of medicine*. 1997;102(1):89-98. Epub 1997/01/01.
19. Eisenberg JM, Williams SV. Cost containment and changing physicians' practice behavior. Can the fox learn to guard the chicken coop? *Jama*. 1981;246(19):2195-201. Epub 1981/11/13.
20. Goldman L. Changing physicians' behavior. The pot and the kettle. *The New England journal of medicine*. 1990;322(21):1524-5. Epub 1990/05/24.
21. Statland BE, Winkel P. Utilization review and management of laboratory testing in the ambulatory setting. *The Medical clinics of North America*. 1987;71(4):719-32. Epub 1987/07/01.
22. Corriere MD, Minang LB, Sisson SD, Brancati FL, Kalyani RR. The use of clinical guidelines highlights ongoing educational gaps in physicians' knowledge and decision making related to diabetes. *BMC medical education*. 2014;14:186. Epub 2014/09/10.
23. Soumerai SB, Salem-Schatz S, Avorn J, Casteris CS, Ross-Degnan D, Popovsky MA. A controlled trial of educational outreach to improve blood transfusion practice. *Jama*. 1993;270(8):961-6. Epub 1993/08/25.