

# Uncrossmatched blood transfusions for trauma patients in the emergency department: incidence, outcomes and recommendations

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**Background:** Early transfusion of blood products for severely injured patients can improve volume depletion, acidosis, dilution and coagulopathy. There is concern that some patients are unnecessarily exposed to the risks of emergent transfusion with uncrossmatched red blood cell products (URBC) in the emergency department (ED). The goal of this study was to evaluate the transfusion practices in our ED among all patients who received URBC.

**Methods:** We analyzed all injured patients transfused at least 1 URBC in the ED at a level-1 trauma centre between Jan. 15, 2007, and Jan. 14, 2008. Demographics, injuries and outcomes were reported. We used standard statistical methodology.

**Results:** At least 1 URBC product was transfused into 153 patients (5% of all patients, mean 2.6 products) in the ED (median Injury Severity Score [ISS] 28; hemodynamic instability 94%). Sixty-four percent of patients proceeded to an emergent operation and 17% required massive transfusion. The overall mortality rate was 45%, which increased to 52% and 100% in patients who received 4 and 5 or more URBC products, respectively. Nonsurvivors had a higher median ISS ( $p = 0.017$ ), received more URBC in the ED ( $p = 0.006$ ) and possessed more major vascular injuries ( $p < 0.001$ ). Among nonsurvivors, 67% died of uncontrollable hemorrhage. Unnecessary URBC transfusions in the ED occurred in 7% of patients.

**Conclusion:** Overtransfusion was minimal based on clinical acumen triggers. Early transfer of patients receiving URBC products in the ED to the operating room, intensive care unit or angiography suite for ongoing resuscitation and definitive hemorrhage control must be strongly considered.

**Contexte :** La transfusion rapide de produits du sang à des patients gravement traumatisés peut contrer la déplétion volumique, l'acidose, la dilution et la coagulopathie. On craint que certains patients ne soient inutilement exposés aux risques que présente une transfusion d'extrême urgence d'hématies non soumises à une épreuve de compatibilité croisée en service d'urgence. L'étude visait à évaluer les habitudes transfusionnelles à notre service d'urgence et les patients qui ont reçu des hématies non soumises à une épreuve de compatibilité croisée (HNSECC).

**Méthodes :** Nous avons analysé le dossier de tous les patients traumatisés qui ont reçu au moins 1 transfusion d'HNSECC à l'urgence dans un centre de traumatologie de niveau 1 entre le 15 janvier 2007 et le 14 janvier 2008. Les caractéristiques démographiques, les traumatismes et les résultats ont été signalés. Nous avons utilisé une méthodologie statistique normale.

**Résultats :** Au moins 1 produit d'HNSECC a été transfusé à 153 patients (5 % du total des patients, moyenne de 2,6 produits) à l'urgence (indice médian de gravité de la blessure [IGB] 28; instabilité hémodynamique, 94 %). Soixante-quatre pour cent des patients ont subi une intervention d'extrême urgence et 17 % ont eu besoin d'une transfusion massive. Le taux de mortalité total a atteint 45 %, pour passer à 52 % et 100 % chez les patients qui ont reçu 4 et 5 produits d'HNSECC respectivement. Les non-survivants présentaient un IGB médian plus élevé ( $p = 0,017$ ), ont reçu plus d'HNSECC à l'urgence ( $p = 0.006$ ) et avaient subi des traumatismes vasculaires plus importants ( $p < 0,001$ ). Chez les non-survivants, 67 % sont morts d'une hémorragie incontrôlable. Il y a eu transfusion inutile d'HNSECC à l'urgence chez 7 % des patients.

**Conclusion :** La transfusion excessive était minime compte tenu des facteurs déclencheurs de l'acuité clinique. Il faut envisager sérieusement de transférer rapidement les patients qui reçoivent des HNSECC à la salle d'opération, aux soins intensifs ou au service d'angiographie pour les soumettre à une réanimation continue et contrôler définitivement l'hémorragie.

The utility of early blood product transfusion in the treatment of severely injured patients is well understood.<sup>1,2</sup> It not only assists in addressing volume requirements and tissue oxygenation, but also acidosis, dilution and coagulopathy. Advanced trauma life support (ATLS) encourages a transition to red blood cell (RBC) products immediately after failure to achieve hemodynamic stability with 2 L of crystalloid solution.<sup>3,4</sup> Because emergent transfusions are typically needed before identifying a patient's specific blood type, uncrossmatched RBC (URBC) products are commonly used. To address this issue, some trauma centres maintain dedicated blood refrigerators within the emergency department (ED).<sup>1-12</sup> In addition to the extensive logistics and cost of an offsite refrigerator, patients can also be exposed to the risk of unnecessary URBC products. This risk has been reported to be as high as 64%.<sup>13-16</sup> More specifically, risks of transfusion include hemolysis, transfusion-associated lung injury, infection, immunosuppression (i.e., transfusion related immunomodulation), systemic inflammatory response syndrome<sup>17,18</sup> and death.<sup>19,20</sup>

Although the value of early plasma, platelet, cryoprecipitate and factor VIIa administration to combat the 24%–38% of injured patients who present with coagulopathies is becoming clear,<sup>5-12</sup> these products are rarely stored in a readily usable form within the ED. They are therefore unavailable for initial transfusions in the trauma bay. It is clear that with the coagulopathy, hypothermia and acidosis associated with severe trauma,<sup>10-12</sup> a combination of immediate surgical intervention and rapid transfusion is crucial for survival of massive hemorrhage.

The goal of this study was therefore to evaluate the emergent transfusion practices in our ED by identifying the incidence and outcomes of patients who received 1 or more URBC products.

**METHODS**

All injured patients who presented to an urban level-1 trauma centre (Grady Memorial Hospital) between Jan. 15, 2007, and Jan. 14, 2008, and received 1 or more URBC products from the ED refrigerator, were included in our study. The ED/trauma bay refrigerator at our institution stores 8 RBC products (4 group O, Rh negative and 4 group O, Rh positive) at all times. Initiation of transfusion is at the discretion of the treating clinician/surgeon. Although defined transfusion triggers are not mandated at our institution, common indications for URBC administration included continued hypotension (nonresponder) and obvious pelvic hemorrhage following blunt trauma in the context of preparing for angiography. Transfusions of URBC in the ED were considered appropriate when

- additional and rapid blood product transfusions were required after the initial use of URBC (regardless of location),
- emergent operative procedures were required,

- patients were identified as nonresponders after 2 L of crystalloid resuscitation (i.e., ATLS), and
- patients possessed major injuries associated with blood loss (vascular or solid organ trauma).

Grady Memorial Hospital also has a massive transfusion protocol (MTP) where defined ratios of RBC, plasma, platelet and cryoprecipitate products are administered to patients (Table 1). Factor VIIa is available on request, as well as automatically within the fourth round of the MTP protocol. Common circumstances for administration of factor VIIa include continued massive hemorrhage and obvious clinical coagulopathy.

We obtained patient demographic and clinical characteristics, including injury details, from the trauma registry, blood bank information system and patient charts. We excluded all injured patients who did not require an emergent ED transfusion of URBC products from our study. Autotransfusion of autologous blood from emergent tube thoracostomies was also excluded.

**Statistical analysis**

We performed a retrospective analysis using Stata version 8.0 (Stata Corp.). Normally or near-normally distributed variables were reported as means and non-normally distributed variables were reported as medians. Means were compared using the Student *t* test and medians using the Mann–Whitney *U* test. We assessed differences in proportions among categorical data using the Fisher exact test. We considered *p* < 0.05 to represent statistical significance for all comparisons.

**RESULTS**

In all, 153 injured patients received at least 1 URBC product in the ED. The yearly incidence of URBC transfusion in the ED at our institution was 5% (153 of 3414) of all admitted trauma patients. The total number of transfused

**Table 1. Massive transfusion protocol: package contents\***

Package no. (time administered)	Package contents; no. of units (blood type)			
	PRBCs	Plasma	Platelets	Cryoprecipitate
Initiation	6 (UD/TS)	6 (UD)		
1 (0.5 h)	6 (UD/TS)	6 (UD)	1 apheresis§	
2 (1 h)	6 (UD/TS)	6 (TS)		20
3 (1.5 h)†	6 (UD/TS)	6 (TS)	1 apheresis§	
4 (2 h)	6 (UD/TS)	6 (TS)		10
5 (2.5 h)	6 (UD/TS)	6 (TS)	1 apheresis§	
6 (3 h)‡	6 (UD/TS)	6 (TS)		10

PRBCs = packed red blood cells; TS = type-specific; UD = universal donor.  
 \*PRBCs and plasma can be doubled to 12 each per cycle by request.  
 †Recombinant factor VIIa may be used at attending physician discretion (dose = 3.6 mg, 1 repeat dose as needed in 30 min).  
 ‡If protocol still active, alternate packages identical to packages 5 and 6 until protocol terminated.  
 §1 apheresis unit of platelets is considered to equal 8–10 standard.

URBC products was 511. Patient and injury characteristics were consistent with those of the entire population of trauma patients at Grady Memorial Hospital, except the study cohort had a higher mean age (45.2 yr) and proportion of blunt mechanism of injury (75%; Table 2). Only 6% of patients in the study cohort initially presented with hemodynamic stability (systolic blood pressure > 100 mm Hg and heart rate < 120 beats per min). Each of these 9 patients displayed hypotension on a subsequent measurement while in the ED. Four (44%) of these initially hemodynamically stable patients died.

Sixty-four percent of patients receiving URBC products in the ED proceeded to an emergent operation (Table 2). Initial procedures included laparotomy (53%), thoracotomy (21%) and limb (21%) and neck (5%) explorations. Twelve percent of patients required exploration of mul-

iple cavities or anatomic areas. Thirty-four (22%) patients presented with injuries to named blood vessels. Forty-six (67%) patients died of uncontrollable massive hemorrhage (Table 3). Injuries to the thoracic great vessels or pulmonary hilum (35%), brain (13%), heart (7%), liver (7%), pelvis (7%) and other named vessels (carotid = 3%, abdominal aorta = 7%, iliac vessels = 10%) were substantial contributors to the patients' deaths. An additional 11% of deaths were related to multiple organ blunt trauma.

Most patients received 1 (27%), 2 (31%), 3 (16%) or 4 (19%) URBC products in the ED. Fifty-four percent eventually underwent a massive transfusion (> 10 RBC products within 24 h). Only 35% (26 of 74) of the patients who triggered the MTP received a first unit of URBC in the ED. The mean patient length of stay in the ED was significantly shorter for the MTP patients (10 min) versus the non-MTP patients (34 min). Of the 8 patients who eventually received a massive transfusion, but did not trigger the formalized protocol, 6 received multiple small aliquots of packed red blood cells (PRBC) over an extended period within the initial 24 hours. All patients (12) who received 5 or more URBC products in the ED died (Table 4). Length of time in the ED did not correlate with either the number of URBC units ( $p = 0.21$ ) transfused or patient mortality ( $p = 0.28$ ).

Based on objective registry data, 10 patients received unnecessary URBC products in the ED (14 units). Of these, 6 had isolated traumatic brain injuries and 4 had isolated spinal fractures. All survived and were hemodynamically stable with the exception of a single measurement indicating a reduced systolic blood pressure.

Major complications among the study cohort included sepsis (45%), acute kidney injury (40%), acute lung injury (34%), pneumonia (17%), urinary tract infection (16%), deep venous thrombosis/pulmonary embolus (10%), cardiac arrhythmia (7%), myocardial ischemia (5%) and aspiration (4%).

## DISCUSSION

The incidence of URBC transfusion in the ED approximates 5% of all injured patients presenting to an urban level-1 trauma centre. This is slightly lower than the 8%

**Table 2. Characteristics and outcomes of 153 patients who received at least 1 uncrossmatched red blood cell product in the emergency department, Jan. 15, 2007, to Jan. 14, 2008**

Characteristic	No. (%) <sup>*</sup>
Age, mean (range) yr	45.2 (15–86)
Male sex	115 (75)
Median ISS	28
Blunt mechanism	114 (75)
Motor vehicle collision	79 (52)
Pedestrian–automobile	19 (12)
Assault	16 (10)
Penetrating mechanism	39 (25)
Stab wound	7 (5)
Gunshot wound	32 (21)
Hemodynamically unstable at presentation	144 (94)
Uncrossmatched RBC products in ED, mean no. (range)	2.6 (1–10)
Patients proceeding to massive transfusion protocol	26 (17)
Patients proceeding to emergent operative procedure	98 (64)
Length of stay, mean (range) d	9.1 (1–105)
Mortality	69 (45)
Postadmission complication rate	82 (98) <sup>†</sup>

ED = emergency department; ISS = Injury Severity Score; RBC = red blood cell.  
<sup>\*</sup>Unless otherwise indicated.  
<sup>†</sup>Of survivors.

**Table 3. Differences between survivors and nonsurvivors**

Variable	Survivors	Nonsurvivors
Total no.	84	69
Median ISS	24	30 <sup>*</sup>
Uncrossmatched RBC products in ED, mean no.	2.2	3.1 <sup>*</sup>
Age, mean yr	40.8	45.6
Hemodynamically unstable at presentation, %	93	95
Penetrating mechanism, %	17	27
Major vascular injury, %	13	33 <sup>*</sup>
Time in the ED, median min	28	19
Early mortality (< 24 h), no. (%)	0	46 (67)

ED = emergency department; ISS = Injury Severity Score; RBC = red blood cell.  
<sup>\*</sup> $p < 0.05$  in comparisons between survivors and nonsurvivors.

**Table 4. Patient mortality**

No. of URBC products	Mortality, %
1	39
2	38
3	35
4	52
5	100
6	100
7	100
8	100
9	100
10	100

URBC = uncrossmatched red blood cell.

incidence of ED transfusion noted in a study of 481 patients with blunt injuries.<sup>14</sup> A recent abstract also demonstrated a 5% incidence among 1236 transfused URBC products during the “initial resuscitation,” but makes no specific comment as to the location of infusion (i.e., ED, operating room or intensive care unit) or to the total percentage of patients.<sup>21</sup> Unfortunately, all remaining studies in the literature outline general RBC transfusions within the first 24 hours rather than isolating the cohort of patients who receive URBC products within the ED itself. This makes the validity of comparisons between our data and a published incidence of 10%–12% unclear.<sup>10,17</sup>

The overall mortality rate of patients requiring URBC products in the ED was 45%. This is similar to a rate of 48% among 116 patients with blunt injuries receiving URBC products,<sup>13</sup> but is substantially higher than the 26% observed in these authors’ follow-up study.<sup>14</sup> If mortality is extrapolated from all URBC products administered within the first 24 hours, it appears to range from 35% to 54% in a stepwise fashion (i.e., from 1 to 10 products).<sup>21</sup> This trend was similar to our cohort, which displayed an increase in mortality when 4 or more URBC products were transfused in the ED. When the observed mortality rate of 45% is coupled with the frequent (64%) requirement for an emergency operation and the extreme severity of illness among our patients (median ISS 26, initial hemodynamic instability 94%, postadmission complication rate 98% of survivors), it becomes evident that most patients requiring URBC products were in physiologic extremis. It should be noted that it is the actual severity of these injuries, not the transfusion of URBCs, that acts as a direct surrogate for the high observed mortality.

On closer examination of the 6.5% of patients who may have avoided an unnecessary URBC transfusion, it appeared that their injuries were limited to either the brain or spinal cord. These cohorts exemplify injuries that not uncommonly display temporary hemodynamic instability without obvious hemorrhage. Although the decision to transfuse URBC products into these patients exposed them to multiple risks, these transfusions represented only 2% of all URBC products administered in the ED. This is far removed from the 64% overtransfusion rate noted in a study using a scoring system (employing age, admission, mechanism, blood pressure, abdominal ultrasonography and clinical pelvic stability) to determine the necessity of ED transfusion.<sup>13</sup> Although this group successfully used their formula to reduce overtransfusion and generate an economic savings in patients with blunt trauma,<sup>14</sup> it appears that our clinicians are not overadministering emergent URBC products in the ED.

When the survivors who received URBC products in the ED were compared with those who died, nonsurvivors had more severe injuries, a higher mean ISS and a greater percentage of major vascular injuries. The nonsurvivors also received a statistically increased number of URBC products. When coupled with the reality that 67% of non-

survivors died of uncontrollable hemorrhage, it appears that some of these patients may have benefited from earlier transfer to the operating room for surgical intervention and ongoing resuscitation (i.e., with no stop in the ED). Although time spent in the ED was not statistically correlated with the number of transfused URBC products, all patients who received 5 or more units in the ED died. Whereas isolated indices such as hypotension,<sup>22,23</sup> tachycardia,<sup>22</sup> reduced respiratory rate,<sup>24</sup> low Glasgow Coma Scale score,<sup>25</sup> hematocrit lower than 30%,<sup>26</sup> emergency operation,<sup>26</sup> ISS<sup>26,27</sup> and base deficit<sup>28</sup> indicate a high risk for early blood administration, no single parameter has ever proven sufficiently predictive. As a result, rapid determination of patients appropriate for URBC transfusion in the ED remains difficult. Although the list of common clinical triggers for initiating URBC transfusion in the ED in this series was short (continued hypotension [nonresponder] and pelvic hemorrhage following blunt trauma in the context of preparing for angiography), the utility of a single defined list of triggers that would mandate transfusion is unlikely to supplant experienced clinical acumen.

In addition to the previously mentioned parameters indicating a high severity of illness in our patients, it is also useful to identify those who went on to require a massive transfusion. Seventeen percent of the study cohort, or 35% of all patients who eventually required the MTP, received their initial URBC units in the ED. Although this may seem low, closer evaluation reveals that the severity of injury was typically recognized in a rapid manner, and the patients were emergently transferred to the operating room, intensive care unit or angiography suite for ongoing stabilization. Furthermore, all but 2 patients who actually received more than 10 URBC units within 24 hours of admission actually triggered the MTP. Whereas it is unclear what percentage of URBC products were truly transfused within the ED in an abstract by Inaba and colleagues,<sup>21</sup> receiving uncrossmatched blood was an independent predictor for requiring a massive transfusion.

Although the specific focus of our study was to evaluate the use of URBC in the ED among injured patients, our overall experience with an MTP is previously discussed elsewhere.<sup>29,30</sup>

## CONCLUSION

In summary, it appears that based on individual clinicians’ real-time assessments, transfusion of URBC in the ED was not overused. Given the high mortality among this selected patient cohort, however, clinicians must consider immediate transfer of injured patients to the operating room, intensive care unit or angiography suite for definitive therapy concurrent to the decision to transfuse URBC in the ED. Subsequent initiation of an MTP for these patients in physiologic extremis, in conjunction with definitive therapy, is also commonly required.

**Competing interests:** None declared.

**Contributors:** Drs. Ball, Salomone, Shaz, Dente, Rozycki and Feliciano designed the study. Drs. Ball, Salomone and Shaz and Ms. Tallah and Ms. Anderson acquired the data, which Drs. Ball, Salomone, Dente and Feliciano analyzed. Drs. Ball, Salomone, Dente, Roszycki and Feliciano and Ms. Tallah and Ms. Anderson wrote the article, which Drs. Ball, Salomone and Shaz critically reviewed. All authors approved publication of the article.

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