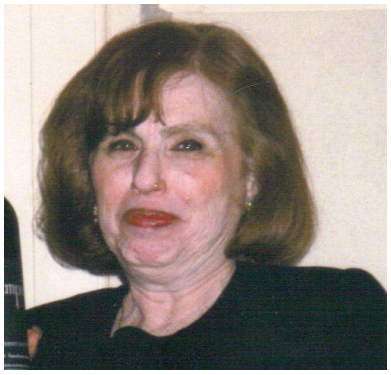
ILLINOIS ASSOCIATION OF BLOOD BANKS

The Phyllis Unger
Annual Case Studies Meeting

Thursday, February 16, 2017



This case studies meeting is dedicated to Phyllis Unger in memory of all the wonderful case studies she presented to students, technicians, technologists, residents, fellows and physicians. Phyllis was a dedicated blood banker who spent much of her time teaching and educating whether she was at Michael Reese, University of Illinois or LifeSource. She was always willing to answer questions or test a sample if you sent it to her. She inspired many blood bankers and gave them the desire to look further into a problem. Phyllis was the first Medical Technologist to be President of the ILABB. Prior to this only a physician could hold the office. She wrote many papers and contributed to a few books including "Blood Group System: MN and Gerbich." She had many things outside of blood banking that she enjoyed as well such as travel, music and bridge. Even these things helped give her blood banking perspective. She was known for never saying anything bad about anyone and always finding the best in them. We hope that this annual meeting will serve as a lasting memory to the knowledge she shared with all who came in contact with her over the years. Thank you Phyllis.

Agenda:

Social hour: 6-7pm

Presentations will begin promptly at 7pm.

1. Cold Agglutinin Disease with Features of Auto-Anti-Pr and Auto-Anti-M
   G Ramsey, PF Lindholm, and K Hartman

2. Polyagglutination in a Child and Pneumococcal Hemolytic Uremic Syndrome
   G Ramsey and LM Samuels

3. Relapsing Thrombotic Thrombocytopenic Purpura (TTP) in a Patient with a SLE/Scleroderma Overlap Syndrome
   P. DeChristopher, M. Saint Martin, and M. Wojciechowski

4. ABO Discrepancy Leads to Detection of Rarely Seen Subgroup
   C. Howard-Menk

5. Hyperhemolysis Syndrome with associated reticulocytosis after red cell exchange in a patient with sickle cell disease.
   Y. Zhu, D. Chapel and G. Wool

6. DARC: Another Fascinating Blood Group Story!
   J. Perkins

7. DTT treated reagent cells for use in resolving daratumumab interference: More than just Kell?
   M. Stewart, A. Treml and G. Wool

8. MTP Utilization at a Large Academic Center
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9. Translating Socratic Teaching for a Modern Audience
   J. James, A. Maduram, M. Papari, S. Campbell-Lee

Cold Agglutinin Disease with Features of Auto-Anti-Pr and Auto-Anti-M

G Ramsey, PF Lindholm, K Hartman
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Background. Anti-Pr, a cold agglutinin reacting to oligosaccharides on **Pr**otease-sensitive RBC glycophorins, can cause severe cold agglutinin disease (CAD).[1,2] Auto-anti-M antibodies are usually benign with low titers, but rare anti-Pr-like hemolytic autoantibodies have shown specificity at 25-37C for the M antigen on glycophorin A.[3-5] We encountered a case of CAD with serological features of both auto-anti-Pr and auto-anti-M.

Case History. An 82-yr-old man had CAD for 40 yr, but did not require treatment until age 81. Over 1 yr he received several courses of rituximab and plasmapheresis, and in the prior 5 months, 3 RBC transfusions (total 4 U) were given. His plasma IgM was elevated (248 mg/dL, normal 40-230) with a monoclonal IgM-κ band.

Methods. Direct antiglobulin test (DAT): tube. Indirect antiglobulin (anti-IgG) tests (IAT): automated solid phase red cell adherence (SPRCA) (Immucor, Norcross, GA) and manual polyethylene glycol (PEG). Cold screen: routinely collected plasma incubated with screening RBCs, group O cord RBCs and ficin-treated RBCs in saline at room temperature (RT) for 15 min. Specimen for titers: transported by blood bank staff immediately from phlebotomy to laboratory in ≥30C transport chamber for plasma separation. Titers: plasma serially diluted in saline and incubated with selected RBCs at 4C, RT and 30C for 1 hr. Titer endpoint: last 1+ reaction. DNA-based MNSs phenotype: PreciseType HEA BeadChip™ (Immucor BioArray, Warren, NJ).

Results. His DAT was 1+ for C3. Anti-M reactivity was present in SPRCA to all M+ cells, and weakly in PEG at anti-IgG to M+N- RBCs. However, his DNA-based phenotype was predicted to be M+N+S+s+. MNS serological typing was not feasible due to recent transfusion. In the cold screen, his plasma reacted 4+ to screening and cord RBCs and 1+ to ficin-treated RBCs. Thermal amplitude titers were examined 6 wk after last plasmapheresis. After extensive washing with warm saline, his circulating RBCs yielded a titer of 8192 at 4C with his plasma. Titers to reagent RBCs:

Temperature	M+N-	M-N+	Ficin-treated
4C	16,384	2048	8
RT	512	16	1
30C	256	8	1

The specimen was insufficient for further testing. The patient subsequently went to his warm-weather winter residence.

Discussion. IgM, IgG or IgA cold-reacting anti-Pr autoantibodies can cause hemolysis by complement fixation or by direct RBC membrane damage.[1,6] Roelcke et al proposed the term anti-PrM for the monoclonal IgM antibodies in 3 M+N+ CAD cases with anti-Pr-like reactivity at 4-10C and relative anti-M specificity at 25-37C.[3-5] Our patient's plasma reactivity was somewhat different, with predilection for M+ RBCs at 4C as well. Our patient may have either a single

(monoclonal IgM-κ?) anti-Pr-like cold agglutinin with relative anti-M specificity, or separate anti-M and anti-Pr autoantibodies detected with M+N- and M-N+ RBCs, respectively, and potentially distinguishable by adsorption. His anti-M reactivity by IAT in SPRCA and PEG suggests an IgG component, but IgM inactivation would be useful for confirmation. We are issuing M-negative RBCs if needed.

1. Garratty G. Transfusion 2010;50:274-7
2. Ruch J, McMahon B, Ramsey G, Kwaan HC. Am J Hematol 2009;84:120-2
3. Sangster JM, Kenwright MG, Walker MP, Pembroke AC. J Clin Pathol 1979;32:154-7
4. Chapman J, Murphy MF, Waters AH. Vox Sang 1982;42:272-7
5. Roelcke D, Dahr W, Kalden JR. Vox Sang 1986;51:207-11
6. Brain M, Ruether B, Valentine K, et al. Transfusion 2010;50:292-301

Polyagglutination in a Child with Pneumococcal Hemolytic Uremic Syndrome

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Background. Microbial enzymes can expose lectin-reactive RBC oligosaccharide cryptantigens, causing polyagglutination by normal plasma containing naturally occurring antibodies such as anti-T. Serological diagnosis can be challenging, and the clinical significance of this phenomenon for plasma-containing transfusions is controversial.

Case Report. A 13-month-old girl was admitted with rapidly developing severe pneumonia, *S. pneumoniae* bacteremia, anemia (nadir 7.1 g/dL Hgb), thrombocytopenia (nadir 24K/uL), and azotemia. Pneumococcal hemolytic uremic syndrome (PHUS) was diagnosed. Antibiotics, two plasma exchanges (albumin replacement) and 7 days of continuous hemofiltration were administered. She was group A, RhD+ with a negative antibody screen. Over days 0-4, 3 RBC and 4 platelet transfusions were given. On day 4 the blood bank was called about "T-cell activation" *[sic]* after an infectious-disease consultant recommended washed RBCs.

Method. Polyagglutination was sought using a technique slightly modified from Judd.[1] Group A_1 reagent RBCs and the patient's A RBCs were individually mixed with four plasma samples from group A patients >1 yr old, incubated at room temperature in saline for 15 min, centrifuged and evaluated for agglutination.

Results. The direct antiglobulin test (DAT) was 1+ with polyspecific and anti-IgG reagents and weak+ with anti-C3. The four group A patient plasmas were all nonreactive with reagent A_1 RBCs and 2-4+ reactive with the patient's A RBCs, consistent with RBC polyagglutination. Confirmation was discussed with two regional reference laboratories, but neither had active procedures for lectin testing or plasma-induced polyagglutination. Review of the patient's records after the initial unmodified RBC and platelet transfusions showed no overt laboratory evidence of additional acute hemolysis, as reflected by normal bilirubin and haptoglobin levels. Four washed RBC aliquots were subsequently given over days 4-12. Hyperconcentration of

subsequent platelets was planned, but none were needed. She was extubated on day 18 and discharged home on day 31.

Discussion. PHUS usually occurs in young children, with 2-12% mortality and end-stage kidney disease in 10-16% of survivors.[2] The US incidence has increased in recent years from serotypes not included in the routine pneumococcal vaccine.[2,3] Bacterial neuraminidase exposes the RBC T antigen in >95% of cases and causes a positive DAT in >90%, and might contribute to pathogenesis through T-activation of renal glomerular cells and platelets.[4] Polyagglutination is caused by plasma IgM anti-T normally present after early infancy. Washed RBCs and avoidance of plasma transfusions are often recommended, but evidence of transfusion hemolysis in PHUS is scarce. Plasma exchange with albumin replacement is potentially beneficial in selected cases by reducing anti-T and neuraminidase levels (American Society for Apheresis Class III indication[5]). Peanut *(Arachis hypogaea)* and soybean *(Glycine soja)* lectins agglutinate T-activated RBCs. Lectin testing can assist in rapid diagnosis of PHUS[6] and with further study "might be the most appropriate test for a direct diagnosis".[4] However, US commercial production of polyagglutination lectin kits for blood banks was recently discontinued (Hemo Bioscience, Morrisville, NC). To perform investigational T-activation testing, immunohematology laboratories currently must either use outdated US reagent, import unlicensed reagent (e.g., Source Bioscience, Nottingham, UK) or make it from seeds or purified lectins.[1]

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2. Spinale JM, Ruebner RL, Kaplan BS, et al. Curr Opin Pediatr 2013;25:203-8
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4. Loupiac A, Elayan A, Cailliez M, et al. Pediatr Infect Dis J 2013;32:1045-9
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Relapsing Thrombotic Thrombocytopenic Purpura (TTP) in a Patient with a SLE / Scleroderma Overlap Syndrome

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BACKGROUND: Acute, acquired, idiopathic TTP is an autoimmune disease frequently associated with autoantibodies to and markedly decreased levels of ADAMTS13 metalloprotease. Common autoimmune diseases such as SLE are usually not complicated by TTP; mixed connective tissue disease (MCTD) is even more rarely complicated by TTP.
CASE REPORT: A 44-y/o AAM with h/o a "reported MCTD" presented with a 3-day h/o substernal non-radiating chest pain associated with SOB, palpitations and difficulty swallowing, associated with elevated Troponin I levels (0.22 ng/dL). He was non-compliant with prescribed rheumatologic medications for a period of many months. At presentation, microangiopathic hemolytic anemia (MAHA) and thrombocytopenia (H & H 6.7 g/dL / 18.9%, platelets 6 K / µL)

and, LDH of 785 IU/L were present. Renal function tests were normal and here was no evidence of bleeding or abnormal neurologic symptoms. We commenced therapeutic plasma exchange (TPE) to treat suspected TTP. He was transfused 1 unit of RBC, started on IV methylprednisolone. (Subsequent Rheumatologic workup with positive serologic markers [ANA, titer > 1280; anti-Sm, anti-RNP, Raynaud's phenomenon and sclerodactlyly] pointed to a diagnosis of SLE / overlap with scleroderma features.) Preliminary ADAMTS13 activity was < 5%. TTP episode #1 responded promptly to six (6), 1-plasma-volume TPEs, replaced with up to 50:50 mixtures of 5% human albumin and thawed plasma. Although prescribed outpatient prednisone, Plaquenil (hydroxychloroquine) and Imuran (azathioprine) for his underlying disease, he remained non-compliant. TTP episode #2 recurred within 2.5 months, again successfully treated with steroids and 7 TPEs. Seven (7) months later, TTP recurrent episode #3 developed, again responsive to steroids and TPE. Data are noted in the table:

At Presentation				**Treatment**	**At "Remission"**		
DATE	Platelet Count (K/µL)	LDH (IU / L)	**ADAMTS13 (%)**	Number of TPE's	DATE	Platelet Count (K/µL)	**ADAMTS13 (%)**
08-10-15	**6**	**785**	**< 5%** Inhibitor = 0.5 (H); Antibody = **61** (H)	6	08-15-15	307	30% Inhibitor = <0.4; Antibody = 12
10-31-15	**15**	**640**	**< 5%** Inhibitor = 0.8 (H)	7	11-09-15	300	51%
05-26-16	**8**	**742**	**19%** Inhibitor = < 0.4 Antibody = **33** (H)	7	06-01-16	360	ND
07-16-16	**13**	**386**	**100%**	None; 4 doses of rituximab (375 mg / me2)	06-17 to 08-13-16	20 6 - 282	**100%**

Within 2 months of TTP episode #3, another flare-up of MAHA recurred, but at that time, the ADAMTS13 activity level was 100%. The Hematologist elected to treat with 4 weekly doses of rituximab. The patient remained in an apparent stable remission for the next 5 months.

CONCLUSIONS: TTP remains an unusual autoimmune complication of connective tissue diseases. Clinical and laboratory features guided urgent initiation of TPE in the recurrent episodes in this case. Although ADAMTS13 activity levels and inhibitory antibodies are not "diagnostic" of TTP, such inhibitory antibodies, observed in up to 90% of such patients, are aids to diagnostic certainty. The persistence of inhibitor and/or anti-auto-ADAMTS13 during apparent "remissions" of TTP is associated with an increased risk for subsequent clinical relapse: This appears to be the case here. Each TTP episode responded well and promptly to steroids and TPE. Although usually reserved for "refractory" TTP, the use of rituximab appeared effective.

ABO Discrepancy Leads to Detection of Rarely Seen Subgroup

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Background: A.C., a 35 year old, healthy, Asian female, was admitted for delivery of her second child. An ABO discrepancy was noted from a previous type and the sample sent to the Red Cell Reference Laboratory for resolution.

Methods: Repeat ABO testing was performed using Gel. A.C. forwarding as group AB, reversing as group O. Both A1 and B cells on reverse typing showed a mixed field appearance in Gel. Patient DAT was negative.

Forward and reverse testing were repeated in tube using additional reagents: Anti-A,B, A2 cells, anti-A1 lectin and auto control. Anti-A1 lectin testing was negative, indicating the presence of an A subgroup. Patient cells were weakly reactive with anti-B antisera, showing a mixed field appearance. Various sources of anti-B antisera were tested against patient cells at IS, RT and 4C, all were all positive. The patient cells were tested with acidified anti-B reagent and a lectin panel to rule out the presence of acquired B phenotype and polyagglutination. There was no history of a bone marrow transplant or a chimera.

Reverse grouping showed anti-B reacting at IS, RT and 4C. A cold autoagglutinin was also detected at RT and 4C. The cold autoagglutinin was removed by cold auto absorption of patient plasma with ficin treated cells and retested to show the presence of anti-A1 at 4C. The cold autoabsorbed plasma also showed the presence of anti-B at IS, RT and 4C. Anti-B reactivity was not seen using prewarmed technique.

The cord blood from the baby was obtained to determine if the baby had a weakened B type. Cord blood testing showed a similar testing pattern as the mother. The A antigen appeared as mixed field. The same anti-B reagents used to type the mother's cells were used to type the baby's cord cells. The anti-B reagents were weakly positive against the baby's cells, and demonstrated a mixed field appearance. A heel stick was obtained to rule out possible maternal contamination during collection. All retested results remained unchanged. The baby, also, typed as an AsubB Rh positive.

Due to similar typing in the baby to the mother, it was suspected that the mother was the rare cisAB phenotype. DNA sequencing confirmed this suspicion. This example was reported as Allele ABO*68, which encodes an O phenotype, reported in dbRBC nomenclature because no ISBT nomenclature exists for it. Requests for specimens on the baby and father for DNA, sequencing was unsuccessful.

Conclusion: The patient ABO/Rh type was reported as AsubBsub Rh positive with cold autoagglutinin and anti-A1 at 4C and anti-B at IS, RT and 4C. The cisAB phenotype is more common in Asian individuals and well documented in the literature. Due to its rarity, it is seldom seen in practice. Routine, serological techniques were able to resolve the ABO discrepancy for immediate transfusion purposes with follow up DNA sequencing for confirmation of ABO type.

Hyperhemolysis syndrome with associated reticulocytosis after red cell exchange in a patient with sickle cell disease

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Background: Hyperhemolysis syndrome (HHS) is a severe complication of red blood cell (RBC) transfusion, most commonly seen in patients with sickle cell disease. It is speculated that macrophage activation in HHS leads to hemolysis of both transfused and self RBCs. Reticulocytopenia is often seen in HHS. Recommended management includes intravenous immune globulin (IVIG), corticosteroids, and abstention from further RBC transfusion.

Case report: An African-American man in his 40s with sickle cell disease (HbSS) was admitted to UCM for vaso-occlusive crisis (VOC), which progressed to acute chest syndrome despite symptomatic treatment. The patient's baseline hemoglobin was 8-9 g/dL. The patient had had five prior negative antibody screens at UCM over 16 months. He reported a remote history of transfusion at another institution and denied any history of RBC antibodies or transfusion reaction.

He underwent RBC exchange transfusion (RCE) with seven units of C/E/K-matched, HbS-negative, electronically compatible RBCs on day three of admission. Pre-exchange and post-exchange hemoglobin were 6.2 and 8.7 g/dl, respectively. The percentage HbS declined from 88.2% to 28.5% after RCE. The patient was discharged with Hb 9.6 g/dL on day seven of admission (four days after RCE). He was readmitted four days after discharge with persistent VOC pain, as well as fever and nausea. Hb was 4.9 g/dl, LDH 1492 U/L, total bilirubin 10.1 mg/dL, haptoglobin <20 mg/dL, and reticulocytes 18.5%. The patient's HgbS percentage was 61.1%. Antibody screen and DAT (with IgG and C3) were negative on the day of readmission. He received two units of RBCs one day after readmission. His hemoglobin increased from 4.9 to 7.8 g/dl, but fell to 5.8 g/dl one day later; the patient subsequently received another RBC unit with no post-transfusion increase in hemoglobin. Repeat antibody screen on day 2 of readmission was negative. No transfusion reactions were suspected clinically.

Due to the concern for HHS, RBC transfusions were halted and IVIG and methylprednisolone were administered. Hemoglobin decreased to a nadir of 4.1 g/dl eight days after readmission before gradually increasing to 7.7 g/dl at discharge (13 days after readmission). Reticulocyte increased to 30.5% two days before discharge.

Conclusion & discussion:

The differential diagnosis for this case included sickle-related hemolysis, delayed hemolytic transfusion reaction (DHTR), and HHS. This patient had no history of antibodies and none were found on subsequent work-up.

Drop in Hb below pre-RCE values as well as dramatic increase in HbS percentage argues for hemolysis of both self and transfused RBC. The repeatedly negative antibody screens and negative DAT oppose DHTR (per Hemovigilance criteria). HHS frequently presents in the days following transfusion with a negative antibody screen and post-transfusion hemoglobin lower than pre-transfusion levels. HbS percentage may increase sharply in HHS, as donated RBCs are destroyed.

Interestingly, our patient's reticulocyte count was elevated, while HHS is classically associated with reticulocytopenia. This may reflect a subset of HHS cases that lack the immune-mediated

suppression of erythropoiesis that has been postulated in HHS with reticulocytopenia, or simply missing the reticulocyte nadir in the inter-admission period.

DARC: Another Fascinating Blood Group Story!

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Introduction: Over a 3 month period the blood bank received three requests for Duffy phenotyping from a hematologist. When contacted she related that the patients were referred for neutropenia, and that the test order was to support a diagnosis of benign ethnic neutropenia (BEN) as prompted by a recent article entitled "How we evaluate and treat neutropenia in adults" {Blood(2014)124;1251-8}. Unaware of a specific relationship between BEN and the Fy(a-b-) phenotype we hit the books!

Cases: The patients included a 20 y.o. African-American man with absolute neutrophil counts (ANC) of 800 and 900/µL, a 72 y.o. African-American man, and a 21 y.o. Egyptian woman with Raynaud's-like symptoms. The latter two patients were known to be neutropenic for years with baseline ANCs of ~1,000/ µL, increasing to low-normal levels during stressful medical events. All were Fy(a-b-).

Discussion: Blood bankers generally are aware that the Fy(a-b-) phenotype is common in African-Americans and throughout many African populations and that it confers resistance to vivax malaria since Duffy glycoprotein is required for invasion of RBCs by *Plasmodium vivax*. We're also generally aware of the genetics of this association, namely that the African Fy(a-b-) phenotype is produced by an 'erythroid-specific' regulatory mutation of *Fy*B* identified as *FY*Null* or *FY*B*^{ES}. Since Fy^{b} expression is not affected on other cells that utilize a different transcription factor, this explains why Fy(a-b-) African-Americans don't make anti-Fy^{b}.

Studies of Duffy glycoprotein revealed homology to receptors for chemotactic cytokines or 'chemokines' giving rise to the concept of "DARC" (Duffy Antigen Receptor for Chemokine's). The DARC protein has 7 membrane-spanning α-helices with an extracellular N-terminus and 3 extracellular loops. The N-terminal sequence carries the Fya/b single amino acid polymorphism and the high-frequency Fy6 site needed for *P vivax* invasion. (Note however that P vivax may be evolving the ability to invade in its absence.)

Most chemokine receptors are coupled to a G-protein signaling mechanism and activate specific cellular processes, but DARC lacks the typical signal-coupling sequence. Signaling receptors are typically specific to one or a few chemokines of a single class, whereas DARC is "promiscuous" in binding multiple inflammatory chemokines of different classes. This led 25 years ago to the 'chemokine sink' hypothesis that DARC binds excess chemokines thus removing them from the circulation or otherwise regulating the levels and gradients responsible for their chemotactic function.

The more recent (2008) demonstration that BEN is closely associated with the Fy(a-b-) phenotype supports a role for DARC in chemokine regulation in a general sense, although the exact pathogenesis may not be simple. Nonetheless it might simplify the diagnosis of BEN which for many hematologists has previously been a diagnosis of exclusion. Thus a *positive* finding {an Fy(a-b-) phenotype} in a healthy may allow one to avoid multiple other expensive tests. Certainly it was useful in diagnosing BEN in the Egyptian woman.

Conclusion: Duffy phenotyping may greatly simplify the diagnosis of BEN. And blood groups continue to fascinate!

DTT treated reagent red cells for use in resolving daratumumab interference: More than just Kell?

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BACKGROUND: Daratumumab (DARA) is an anti-myeloma and anti-lymphoma agent that is known to interfere with routine Blood Bank antibody screening tests. DARA is an IgG monoclonal antibody that binds CD38 that is present on the red cell surface. At the University Of Chicago Blood Bank, we have seen many patients treated with DARA and were showing this interfering reactivity. It has been well described that CD38 is a disulfide-linked molecule and its immune epitopes are disrupted by reducing agents such as DTT. We performed a validation of DTT-treatment of reagent RBC to abrogate DARA interference.

CASE REPORT:

The validation was done to prove that DTT treated red cells could be used to screen patients receiving DARA and still detect clinically significant alloantibodies. Screening cells and panel cells selected for DTT treatment were those RBC homozygous for clinically significant antigens, therefore allowing rule-outs of clinically significant antibodies in patient plasma. Several patients that had received the DARA drug protocol were selected for testing as well as many patients that had allo- and autoantibodies (but not DARA treatment). Reagent screening cells and panel cells were treated with 0.2M DTT prepared using the SOP from Judd's Methods in Immunohematology and the AABB Technical Manual. The treated cells were preserved between testing episodes using Alsever's solution, stored at 2-5C, and observed for hemolysis (none was seen for up to 21 days). All immunohematology testing using DTT-treated cells was performed using gel methodology. Untreated and DTT treated cells were tested with anti k before any patient testing was performed. The untreated cells reacted 2-4+ with the anti k, and the treated cells were negative. These controls were run and tested each time DTT treatment was done.

Thirty eight patient samples, including six DARA patient samples were tested. Of the six patients who had DARA interference in their untreated antibody screens, all samples had negative reactions with the DTT treated cells except one patient, which had weak reactions in one cell. This specimen was repeated three times and all repeats had weak positive reactions in the

same cell. This sample was sent to the ARC reference lab for DTT treatment and all clinically significant antibodies were ruled out.
Patients with alloantibodies present in their plasma did react with the DTT treated cells as would be expected based on the underlying alloantibody, with the exception of newly formed anti-E antibodies in 4 patients. Plasma from these four patients with a nascent anti –E all showed no reactivity with DTT treated cells. Plasma from fourteen patients with a long history of anti-E (greater than 6 months) did react with the DTT treated cells.
CONCLUSION: DTT treatment of reagent RBC eliminates DARA interference as previously described, but also unexpectedly lessens the ability of treated cells to react with nascent anti-E. Because of this inability to detect a subset of allo-anti E antibodies, DARA-treated patients at UCM will be given both Kell and E negative blood if they have immunohematology testing performed using DTT reagent cells.

MTP Utilization at a Large Academic Center

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University of Chicago. 1 Department of Pathology2 Center for Quality

Background: In urgent cases where large amounts of blood products are needed quickly, maintaining a standard massive transfusion protocol (MTP) is critical to the timely delivery of these products. Each MTP pack at UCM contains 6 packed red blood cells (pRBCs), 4 fresh frozen plasma (FFP) units, and 1 plateletpheresis pack; a unit of prepooled cryoprecipitate is also given if the patient is in Labor and Delivery (L&D) or if one is requested. At UCM, blood products are generally transported through the pneumatic tube system (PTS). We undertook a review of our MTP issuing practices and efficiency over a 16 month period.
Case Report: Between June 2015 to October 2016, 141 MTPs were activated at UCM: 64 on inpatient floor (including ICUs), 28 in the adult operating rooms, 23 in the adult Emergency Department, 10 in L&D, 7 in the pediatric ICU (PICU), 4 in the pediatric ER, 3 in imaging suites, 2 in the pediatric OR, and 1 in the cardiac catheterization lab.
Of the 1336 pRBCs that were issued, 809 were transfused and 527 were returned (60.5% utilized); of the 844 units of FFP that were issued, 520 were transfused and 324 were returned (61.6% utilized); of the 204 platelet packs that were issued, 128 were transfused and 66 were returned (62.7% utilized); of the 34 units of cryoprecipitate that were issued, 29 were transfused and 5 were returned (85% utilized).
Since March 2016, the time of first product issue after the initiation of an MTP has also been tracked. Of the 54 events that fall within this time period, the majority, 32 (59%), had the first product issued in 5 minutes or less. Another 14 (26%) were issued between 5-10 minutes, resulting in over 85% of patients being issued their first blood product within the first 10 minutes. Only 8 of 54 (15%) events had an initial time greater than 10 minutes and none were greater than 21 minutes.
Conclusion: The majority of our activations currently come from inpatient floors (primarily ICUs). As our institution anticipates the introduction of an adult level 1 trauma center, we anticipate this balance will shift. In addition, the data shows that (with the exception of cryoprecipitate) the utilization rate is nearly identical among the blood products sent during

MTP activations (~60%). Again, we anticipate utilization rate of issued MTP products to increase with the introduction of a new adult trauma center. We have recently begun tracking time to last product issued during an MTP, but cannot report on that variable at this time. Overall, our data show that our transfusion service is generally performing adequately to issue the first product within 10 minutes of MTP protocol activation. This data only reflects time to issue in the PTS; patient care areas can experience additional minutes delay in PTS delivery and arrival of product at bedside. We must continue to collaborate with our clinical colleagues to collect accurate data to provide the best and most efficient MTP care.

Translating Socratic Teaching for a Modern Audience

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1. University of Illinois-Chicago, 2. University of California San Diego 3. LifeSource/ITxM

Objectives: Despite the ubiquitous reliance on blood products in the hospital, most medical school and residency programs offer less than three hours of transfusion education. We believe that there is a growing need for developing alternative forms of online courses on blood transfusion that are efficient, enjoyable, and educational.

Methods: The Socratic principle of using questions to challenge assumptions and improve curiosity was used to design a course on RBC transfusion. Learners progressed through 20 mandatory multiple choice questions to complete the course; after answering each question, four related supplemental topics were made available for additional active learning. Elements of gamification (i.e. avatar, music, adventure story) were added to make the course more engaging and improve learner retention. The Flash-based course was programmed with Javascript and html coding to report 389 variables per course to a Google Forms spreadsheet. Learners were recruited to access the course at transfusiondoc.com with emails and flyers per IRB recommendations.

Results: Over nine months, over 400 learners accessed the website, with 190 learners choosing to start the course. Of the 68 learners who signed the consent form for data collection, 12 learners chose not to answer any questions, 27 learners completed some questions before exiting the course, and 29 learners completed all questions in the course. Learners self-reported as coming from all levels of medical training, and from multiple specialties (pathology, pediatrics, general internal medicine, hematology/oncology). Time-frequency analysis from learners who completed the entire test demonstrated that engagement with supplements is directly related to degree of confusion and to self-reported knowledge improvement within the course. Similarly, engagement with supplements is inversely related to measured knowledge and to seniority (i.e. medical students vs. attendings). Pediatricians took less time to achieve the correct answer and explore supplements than pathologists. A few learners found gamification in this course to be distracting (n = 1) or uninteresting (n = 8), but most found it to be engaging to fantastic (n = 17) with a few learners asking for additional gamified content (n = 3).

Conclusions: Socratic questioning, in a method termed 'elenchus', is used to challenge mis-conceptions and prompt curiosity (praxis) in learners. We were able to mimic this by providing a question-based learning course with tiered access to additional supplemental information. We demonstrated that clinicians who complete the entire course self-regulate their learning, seeking additional supplemental information when they have incomplete or incorrect knowledge. We further demonstrated that gamification is a valuable tool for improving learner retention. Ultimately, results from this course may be used to design transfusion education that is tailored for specific specialty or learning styles.

NOTES