

# 2023 Omaha Area Trauma Symposium

## Blood Transfusions in the Rural Setting

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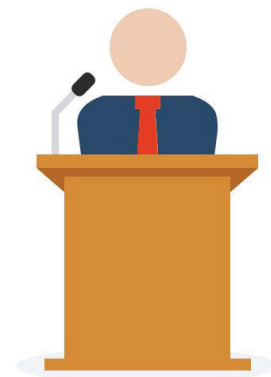
### *Who am I?*

#### **61J Gen Surgeon**

United States Army Reserve  
1999-2011

OEF 2003  
OIF 2005, 2008

No Conflicts of Interest



## *Motor vehicle crash with multiple injuries and two victims.*



## *Rural Definition*

- An open swath of land that has few houses or buildings and not very many people.
- In 2010, 60 million people or 19% of the US population live in a rural setting.

← BACK

### How Does the U.S. Census Bureau Define "Rural?"

urbanized areas with populations of 50,000 or more. Incorporated places and census designated places with populations of at least 2,500 and less than 50,000 located outside of urbanized areas were also included as urban. This definition was used until 2000.

Urban clusters were first introduced in 2000 to replace urban places outside of urbanized areas.

The Census Bureau delineated 3,573 urban areas after the 2010 Census for the United States:

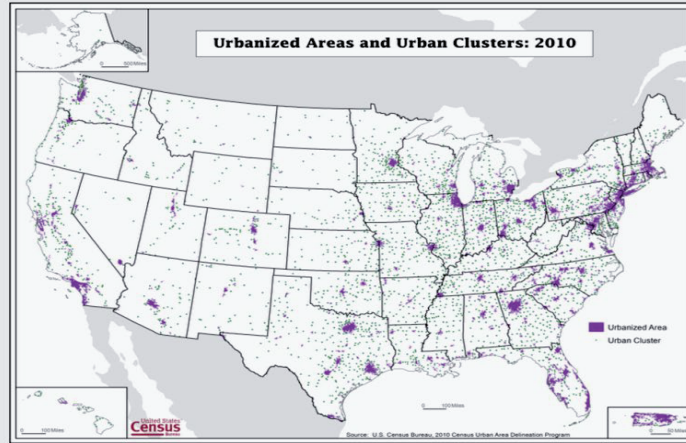
- 486 Urbanized Areas
- 3,087 Urban Clusters

[Click here](#) to see the distribution of urbanized areas and urban clusters in 2010.

Source: U.S. Census Bureau, [Urban and Rural Population: 1900-1990](#); [Census 2000 Summary File 1 Table P002](#); [2010 Census Summary File 1 Table P2](#), [A Century of Delineating a Changing Landscape: The Census Bureau's Urban and Rural Classification, 1910 to 2010](#)

### Dispelling the Nonmetro Myth

"Nonmetro" is not synonymous with rural. Metropolitan Statistical Areas or "metro" areas are defined at the county level, and most counties have a mix of urban and rural areas.



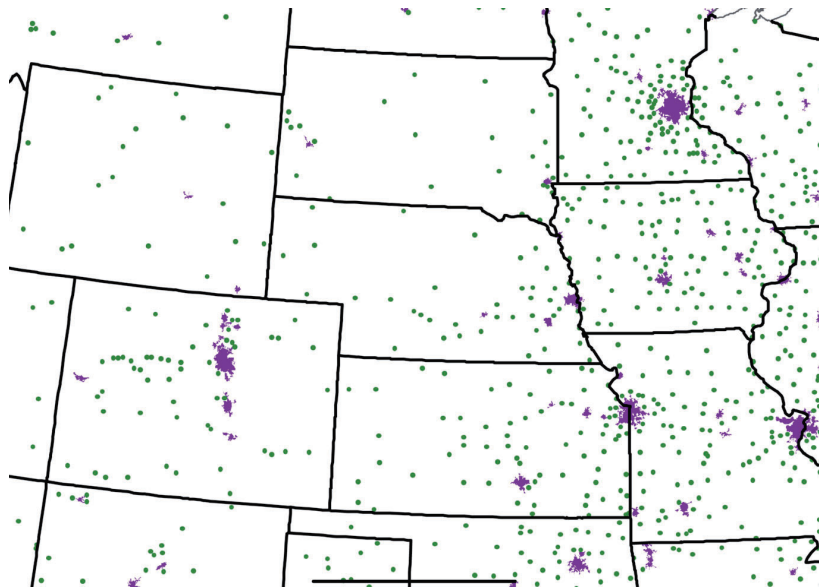
## Urbanized Areas vs Urban Clusters

### Urbanized Areas

-population 50,000 or greater

### Urban Clusters

-population between 2,500 to 50,000



How Does the Census Bureau Define Rural?

Where Can I Find Data for Rural Areas?

Did You Know These Rural Facts?

### How Does the U.S. Census Bureau Define "Rural?"

"Nonmetro" is not synonymous with rural. Metropolitan Statistical Areas or "metro" areas are defined at the county level, and most counties have a mix of urban and rural areas. In fact, according to the latest American Community Survey (ACS), **54.4 percent** of people living in rural areas are within a metro area.

Explore the relationships of the metro and urban areas on the map to understand this concept better.

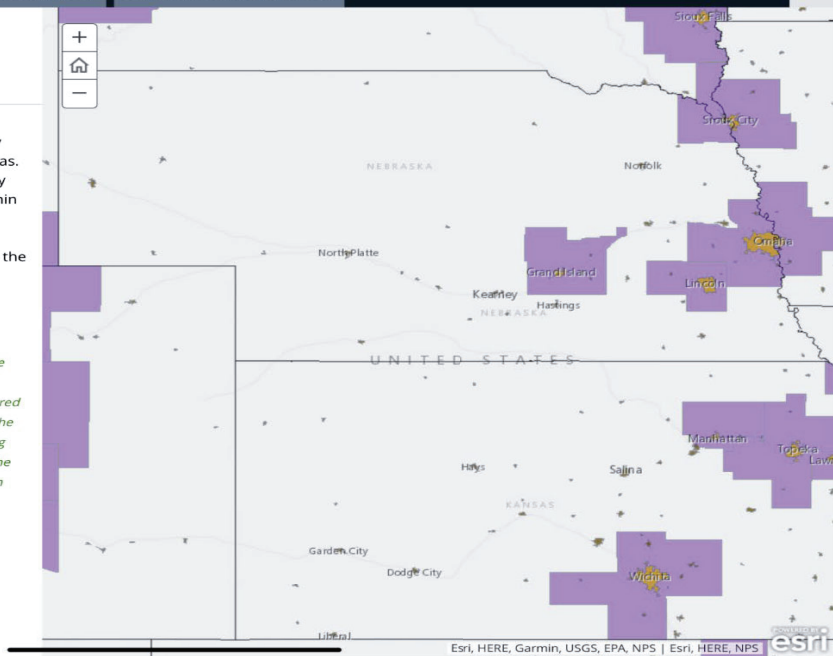


Zoom in and observe how the urban areas appear in relation to the metro areas. Remember anything outside of an urban area is considered rural and everything outside of a metro area is considered nonmetro. You can see rural areas overlap with metro areas. Use the buttons below to turn OFF an individual layer on the map. Selecting another layer will turn the previously selected layer back on. Use the "BACK" button that appears above the map to turn all the layers on again.

**Urbanized Areas** **Urban Clusters** **Metro Areas**

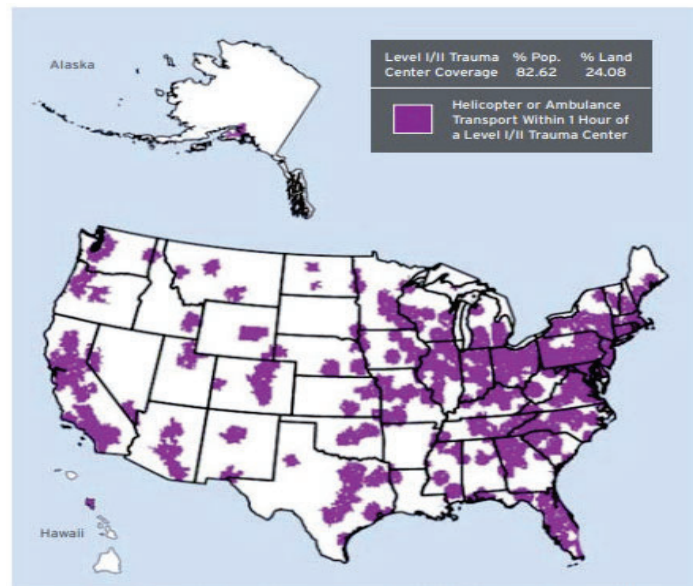
**Map Legend**

Urban Areas (no rural component)



## Access to Trauma Centers In the United States

- Injuries are the leading cause of death for children and adults ages 1-44.
- While most injuries can be treated at a local emergency department, if you are **severely injured**, getting care at a Level I trauma center can lower your risk of death by 25 percent.
- Nearly 45 million Americans **DO NOT** have access to a Level I or II trauma center within one hour of being injured. That is equal to the populations of Arizona, New Mexico, Texas, Louisiana, Mississippi, and Alabama combined!



Map provided by the American Trauma Society's Trauma Information Exchange Program with support from CDC.



## *Rural Mechanisms*

- Farm equipment
- MVC
- ATV/UTV
- Falls



## *Unusual Trauma in Rural Environment*



## *WW1 Surgeon W. Cannon*

- Identified that giving anything to increase blood pressure prior to surgery could cause mortality.
- This was reiterated in WW2 by Beecher.
- Transfusion of whole blood man to man occurred in WWI. Main Resuscitation fluid in WW2 was Dried plasma. The military conflicts helped us to learn these lessons again with each new event.
- Invention of IVF , animal studies made us forget what we had Learned.
- Improvement in blood banking and viscoelastography are allowing new more directed treatments

## *Hypotensive Resuscitation*

- William Bickell in 1994 published study demonstrating survival benefit with minimal Iv Fluid in penetrating chest trauma

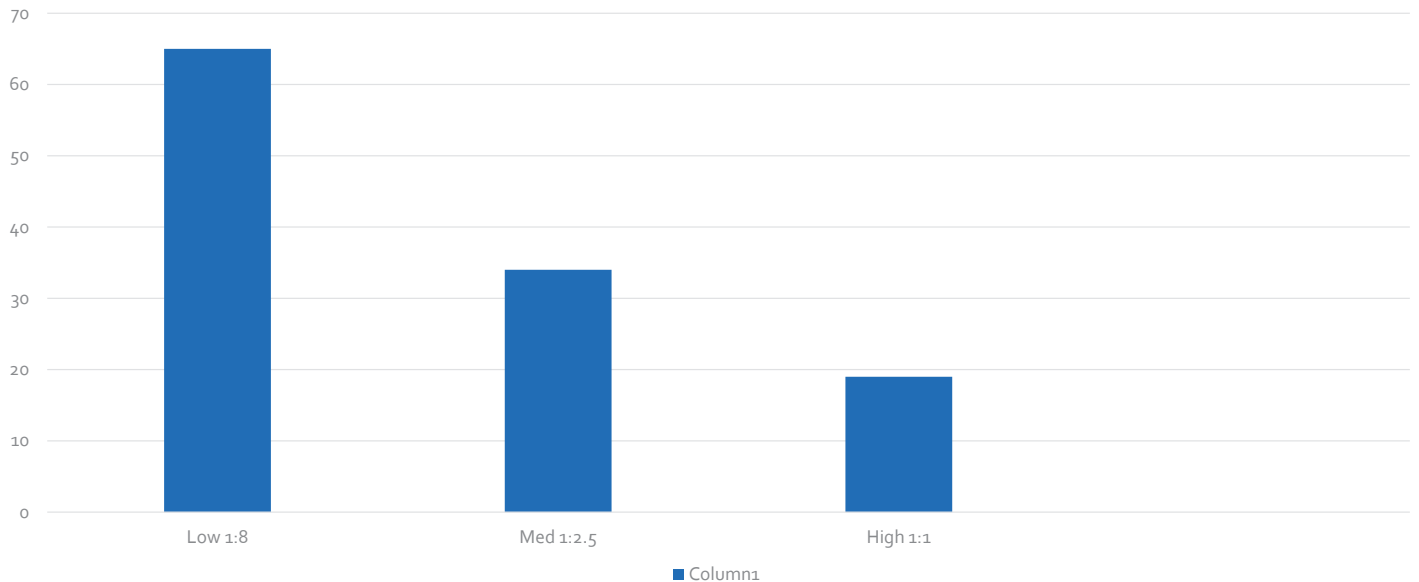
# Hemorrhagic Shock due to Trauma

- Leading cause of death for ages 1-44
- 5<sup>th</sup> overall
- > 5 million deaths per year
- 30% of trauma deaths that occur within 24hrs of injury are due to hemorrhagic shock

## Classes of Hemorrhagic Shock (ATLS)

- **Class I: Blood Loss < 15%**
  - HR: nl to slight increase
  - BP: nl
  - PP: nl
  - RR: nl
- **Class II (Mild): Blood Loss 16-30%**
  - HR: tachy (100-120)
  - BP: nl
  - PP: decreased
  - RR: tachypnea (24-30)
  - Cap Refill: delayed
  - Urine Output: decreased
- **Class III (Moderate): Blood Loss 31-40%**
  - HR: tachy (> 120)
  - BP: low or 20-30% ↓ in HTN pt
  - PP: decreased
  - RR: tachypnea
  - Cap Refill: delayed
  - Urine Output: decreased
- **Class IV (Severe): Blood Loss 41% +**
  - HR: > 120
  - BP: < 90
  - PP: < 25
  - Urine Output: minimal
  - Decreased mental status
  - Skin: cool and clammy

# *PRBC: Plasma Transfusion Ratio Correlated to Mortality*



## *IV Fluids for trauma patients*

- The best fluid for the patient does not always equal the best fluid available.
- Normal Saline
  - fluid of choice with head injuries, hyponatremia, and metabolic alkalosis.
  - can be used with blood products. LR cannot.
- Lactated Ringers
  - Balanced salt solutions are better choices when we aren't thinking transfusion is imminent as they can not be used with blood products.
  - They have been associated with less acidemia and less kidney failure
- Colloids (Albumin or Hydroxyethyl Starch) and Hypertonic Saline are not associated with improved survival of the trauma patient.
- The physiologic impact of the volume of fluid is likely more important than the type initially chosen. Until blood is available, clear fluids should be limited to only that which maintains adequate organ perfusion.

# *Dilutional Coagulopathy*

Volume of fluid resuscitation is proportional to the incidence of coagulopathy

- 2 Liters = 20%
- 3 Liters = 30%
- 4 Liters = 70%

## *Balanced Resuscitation is Best for all patients*

- In the setting of hemorrhagic shock, early administration of blood products given in a 1:1:1 ratio with minimizing crystalloids and correcting coagulopathy will lead to improved outcomes.
- Coagulopathy may be present in 25% of trauma patients on admission.
- Large volume of IV Fluid for resuscitation results in:
  - Increased abdominal compartment pressure
  - Increased mortality
  - ARDS
  - Multi-organ dysfunction
  - Surgical site infections
  - Increased length of stay
  - Increased ventilator days

# Massive Transfusion

- Traditional definition: 10 or more units of PRBC's given within a 24-hour period.
- New definition: 3 units of PRBC's given in less than 1 hour in the first 24 hours of admit
  
- Only 1-3% of trauma patients at major medical centers require massive transfusion.
- The incidence of massive transfusion is low but mortality of patients who require massive transfusion is high.

## ABC Score for Massive Transfusion

Predicts the need for massive transfusion in trauma patients.

Penetrating Mechanism	Yes +1
Systolic BP $\leq$ 90 in ED	Yes +1
Heart Rate $\geq$ 120 in ED	Yes +1
Positive FAST	Yes +1

Score of 2, 3, or 4: Patient is likely to require massive transfusion.

## *Trigger to MTP 1+*

- ABC score of 2 +
- Persistent hemodynamic instability
- Active bleeding requiring IR embolization
- Blood transfusion in Trauma Bay

## *Fresh Whole Blood*

- 8-hr shelf life at room temp or 48-hours if kept in temps  $< 6^{\circ}\text{C}$
- Single donor
- Delivers clotting factors and no excess fluid
- New blood is lowest risk of morbidity and mortality
- Logistically it is simpler
- Commonly used in military environments
- Shows better survival compared to component in 2008 combat data, but in USA use is difficult.
- Group O whole blood is the best universal donor.

## Calculated FWB vs Component therapy

	Hematocrit	Platelet x 10g/l	Coagulation factor activity
Fresh Whole Blood	38-50%	150-400	100%
1:1:1 Component therapy	29%	88	65%

## Red Blood Cells

- Prepared from whole blood by removing the plasma.
- Must be ABO Compatible with the recipient.
- Do not provide any coagulation factors or viable platelets.

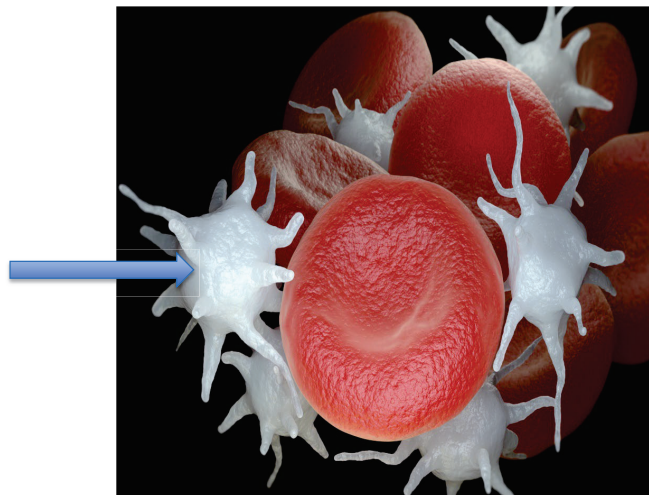


# Plasma

- Contains clotting factors 1, 2, 3, 4, 5, 7, & 8
- Fresh Frozen Plasma
  - 12-month shelf life at -18°C and 7 years at -65°C
  - 30 min to thaw, once thawed stable for 5 days
  - 65% of factor V and VIII
- Fresh plasma (Never Frozen)
  - Shelf life of 26 days
  - 88% of clotting factors present
- Plasma is A- may be universal donor plasma because of anti bodies with AB plasma
  - AB blood type is only 4% of population
  - A and O patients make up 85 % of us population

# Platelets

- Pooled- multiple donors
- Pheresed- single donor
- Goal platelet count of greater than 50k



# Cryoprecipitate

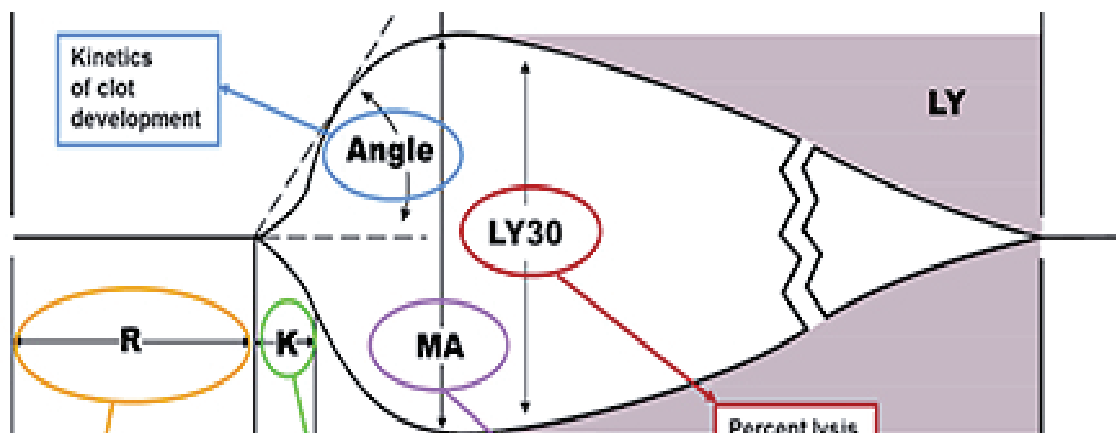
- Precipitate of thawed FFP
- Rich in clotting factors
- Pooled 5-10 u
- Lasts up to one year frozen
- Each unit increases fibrinogen by 7-10 in a 70kg person
- Goal is greater than 180

# Trauma induced Coagulopathy

- Ptt > 60, INR > 1.5, PT > 15, D-dimer ↑ , Fibrinogen ↓
- Viscoelastic testing
  - TEG (thromboelastography) can be done on fresh blood sample and takes less time
  - Done on a TEG 5000 machine and displays a graph
  - Gives information of clot initiation, progression, strength, and lysis from whole blood sample
    - Run at 37 degrees C
    - In teg the cup rotates around a central pin
    - Time is on x axis and resistance to oscillation is on the Y
    - Have to reverse citrate with calcium or add kaolin and TF for rapid tEG



# TEG



How Fast R, How Long K, How strong MA, and Breakdown LY<sub>30</sub>

## TEG shortcomings

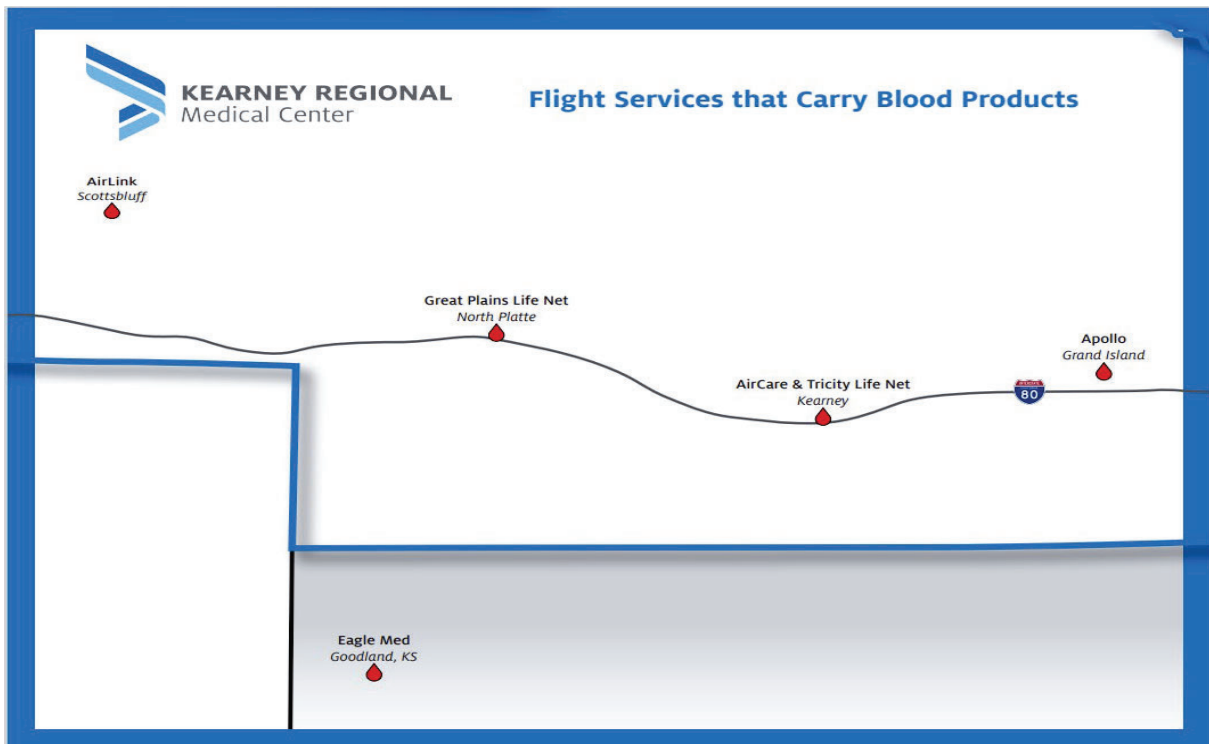
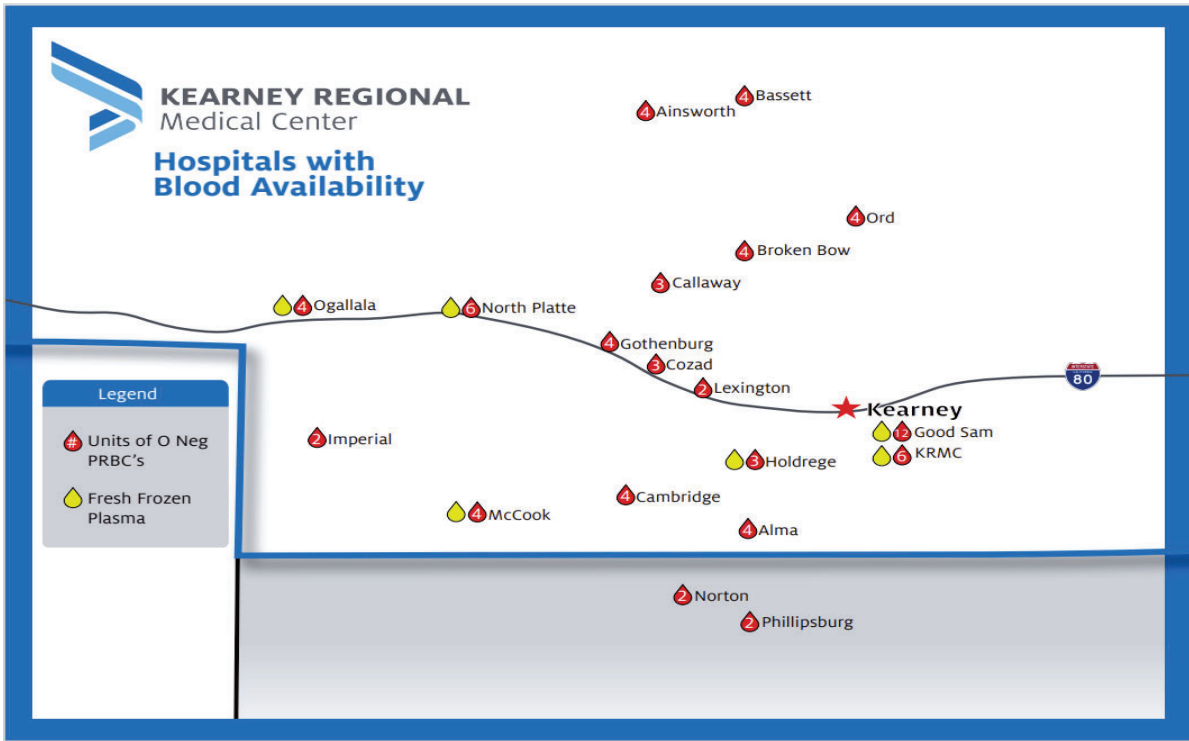
- Un-citrated sample must be run in 4 min
- People are often colder than 37°C so invivo and invitro don't match
- Precision with reagents and reversal and inter-tech and inter-facility could be an issue

## *TEG treatments*

- Treatment of Patient with TEG is an evolving adjunct
- ACT >128: Transfuse FFP, reverse anticoagulant
- K>2.5 min: Transfuse FFP, Cryo if angle is less than 65 degrees
- MA<55mm: FFP, Cryo, and consider Plts
- LY<sub>30</sub> >3%: Administer Tranexamic Acid

## *Transfusion in rural setting*

- Local hospital only has 2 units O- PRBCs , no Plts, FFP, or Cryoprecipitate available.
- Has 600 residents in town
- Often has blood expire
- Nearest larger hospital is level 3 an hour away.



## *Transfusion at KRMC, Level 3 Trauma Center*

- Order placed for crossmatched blood.
- Patient blood draw (or if done pt has blood band)
- ABO and AB testing done
- Mix donor and patient plasma to evaluate for reaction
- Release unit
- Takes at best 60 min, avg 90 min
- Release of uncrossmatched blood takes 5-10 min
- Thank you to Trudy Connors, MT (ASCP) BB
  - Blood Bank Specialist for KRMC

## *Transfusion with no ability to fix problem*

- Permissive hypotension
  - Maintaining a lower blood pressure may prevent additional bleeding.
  - Well documented in thoracic penetrating trauma.
- Raising blood pressure beyond normal organ function may cause further hemorrhage.
- If head injury present, should try to maintain a MAP of 80.
- Use of IV fluids could worsen coagulopathy, acidemia, and hypothermia.

## *Rural (austere) settings*

- Hemorrhagic shock
  - Use Fluid you have available
  - Normal Saline, warmed, if possible
  - 250 – 500 cc boluses and evaluate response
    - If responds, then watch BP and follow with need for further intervention
    - If persistent hypotension, tachycardia, or organ dysfunction, then give bigger bolus and call for (uncrossmatched) blood and arrange for transfer
- Have a plan for anticoagulants
  - K centra (4 factor), Andexa, FFP, Profil 9 (3factor)
- Maintain normothermia
  - Control temperature of resuscitation room and fluids
  - Keep pt covered, use warm blankets and/or forced Air
  - Large volume fluid warmer such as a Level One Infuser

## *New Frontiers*

- Walking donor pool in everyone's small town.
- Willingness to be screened and in a database.
- Hospital becoming better oriented to transfusion.
- Transport of Blood/Plasma from receiving Facility (done in some places now.)
- Completely synthetic Oxygen carrying molecules.

## *Rural Fresh Whole Blood*

- 8hr shelf life at room temp and 48 @ 6 deg C
- Single donor that could be called when notified of patient
- New blood is the lowest risk of morbidity and mortality
- Logistically these donors could be relatively close to most of our rural centers
- Low titer anti A, anti B group O whole blood is the universal donor

## *Hemoglobin Solutions*

- Not substitutes for blood
- Act as oxygen carriers
- They help native hemoglobin release oxygen in tissue.
- Example: Hemopure
  - the most stable of these, is used in other countries but currently under study in the US
  - Compatible with all blood types, type and cross-match is unnecessary.



## Takeaways

- Blood is the best medicine for trauma patients in need of resuscitation due to hemorrhagic shock.
- It is not ideal to transfuse PRBC's alone, but it could be the best way in some cases.
- Artificially increasing blood pressure can result in significant patient harm or death.
- Transport to a Trauma Center equipped to take care of the source of hemorrhage is the mainstay of treatment for patients with ongoing blood loss.
- Stop The Bleed is a course sponsored by ACS that can really save a life as it provides hemorrhage control training to the public.

## Thank you

- I think the way blood and plasma are managed, allocated, and used in the future will be crucial for improving survival rates for trauma patients.

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- Feel free to email with questions and if you would like the slides.