Clinical Decision Support for Transfusion Medicine

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Disclosures

- I have no financial disclosures or conflicts of interest related to this presentation.

Learning objectives

- **Define** clinical decision support (CDS)
- **List** examples of CDS applied to transfusion medicine
- **Evaluate** the effectiveness of CDS tools

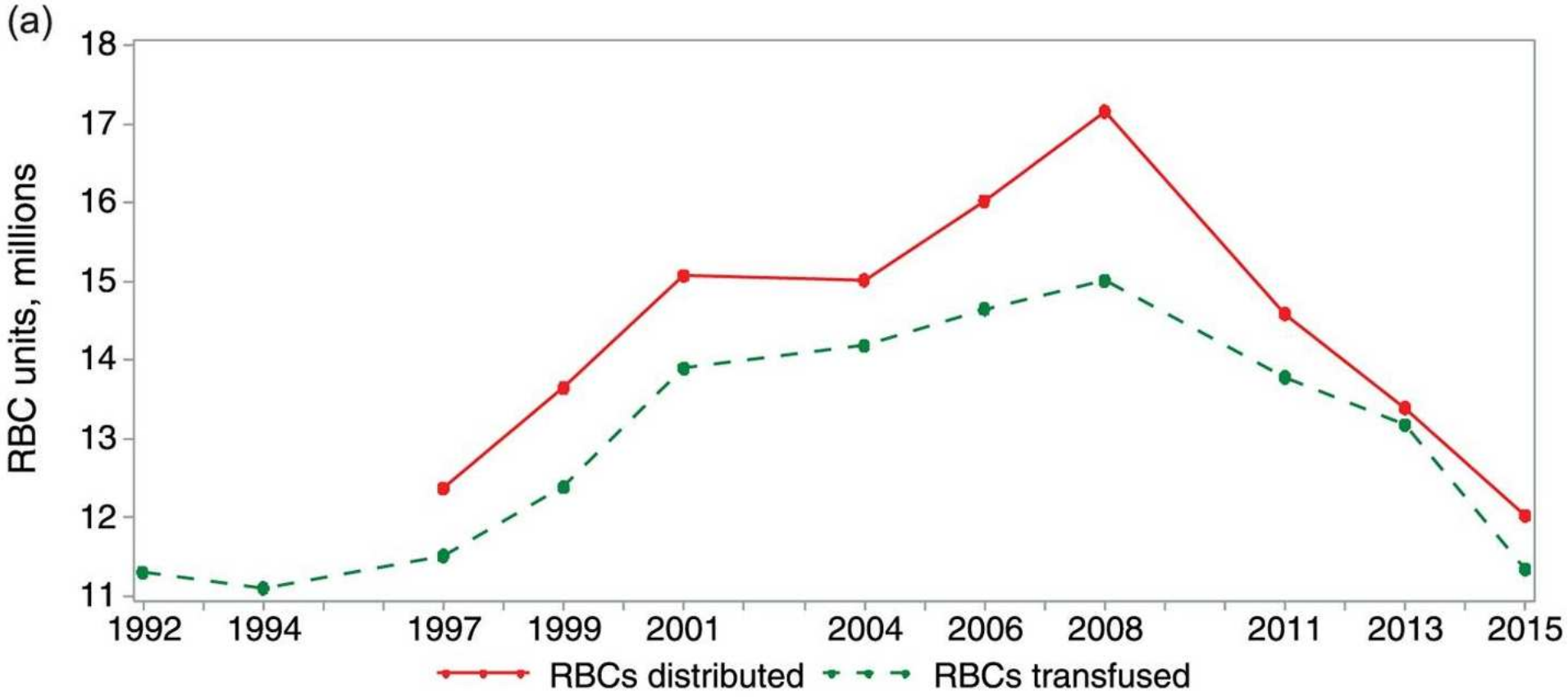
A tale of petrified wood

- Location: Petrified Wood National Park (Arizona)
- Problem: Visitors frequently removed petrified wood for souvenirs.
- Solution: Put up signs reading, “Your heritage is being vandalized every day by theft losses of petrified wood, mostly a small piece at a time.”
- Result: Theft *increased* from 5% to 8%.
- Conclusion: “Stealing petrified wood is a common and socially acceptable behavior.”

Grant A & Sandberg S. *New York Times*. Dec 6, 2014.

Images: nps.gov

RBC transfusion in the United States



Ellington DK et al. *Transfusion* 2017;57:1588

Causes of sustained decrease in RBC transfusion

- Increased awareness of transfusion reactions and poor outcomes (e.g. TACO, TRALI)
- Costs of transfusion (>$200/unit plus blood bank and ancillary costs)
- **Research and changes in medical culture supporting restrictive transfusion practices**

Current research in RBC transfusion utility

- 1999: First randomized controlled trial supporting a restrictive transfusion threshold (Hgb <7 g/dL)
- 2010-: Several more RCTs supporting restrictive transfusion in a variety of complicated patient populations
- 2012-: ABIM Foundation *Choosing Wisely* campaign recommends restrictive transfusion in several patient situations
- Advances in clinical decision support to reduce liberal ordering of blood products

RCTs supporting restrictive transfusion

Trial	Population	Transfusion thresholds (g/dL)	Primary outcome	Results
TRICC[a]	Stable, critically ill	Hb < 7 *vs.* Hb < 10	30-day mortality	18.7% *vs*. 23.3%
FOCUS[b]	Post hip fracture surgery, with cardiovascular disease history/risks	Hb < 8 *vs.* Hb < 10	60-day mortality or inability to walk across a room	35.2% *vs*. 34.7%
Villanueva *et al.*[c]	Severe upper GI bleeding	Hb < 7 *vs.* Hb < 9	45-day mortality	5.2% *vs*. 9.2% ***p* < 0.02**
TRISS[d]	Septic shock	Hb < 7 *vs.* Hb < 9	90-day mortality	43.0% *vs*. 45.0%
TITRe2[e]	Post non-emergent cardiac surgery	Hb < 7.5 *vs.* Hb < 9	Ischemia or sepsis at 3 month	35.1% *vs*. 33.0%

[a]Hebert *et al.*, NEJM 1999;340:409-17
[b]Carson *et al.*, NEJM 2011;365:2453-62
[c]Villanueva *et al.*, NEJM 2013;368:11-21
[d]Holst *et al.*, NEJM 2014;371:1381-91
[e]Murphy *et al.*, NEJM 2015;372:997-1008

Overutilization of tests and procedures

- 2014 American Board of Internal Medicine (ABIM) Foundation survey of physician ordering practices (n = 600, primary care and specialists)

Figure 1: Do you think the frequency of unnecessary tests and procedures in the health care system is a…

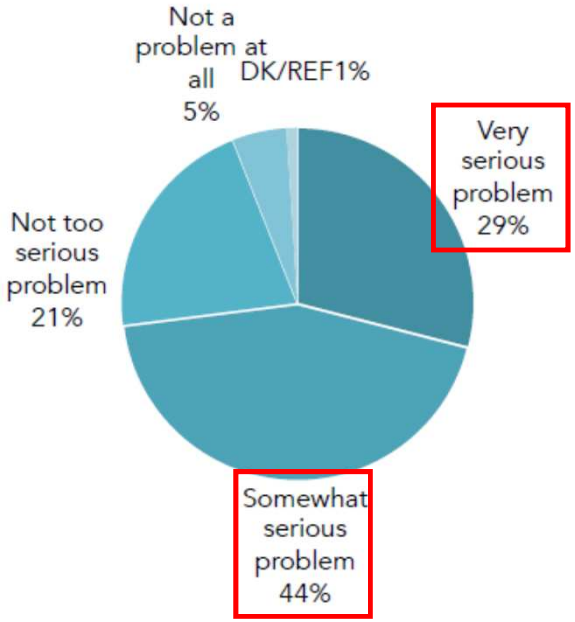


Figure 4: Let's say a patient came to you convinced he or she needed a specific test. You knew the test was unnecessary, but the patient was quite insistent. Would you:

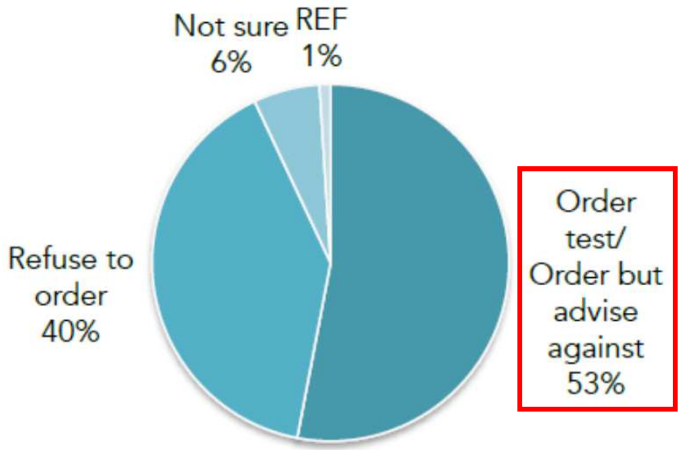
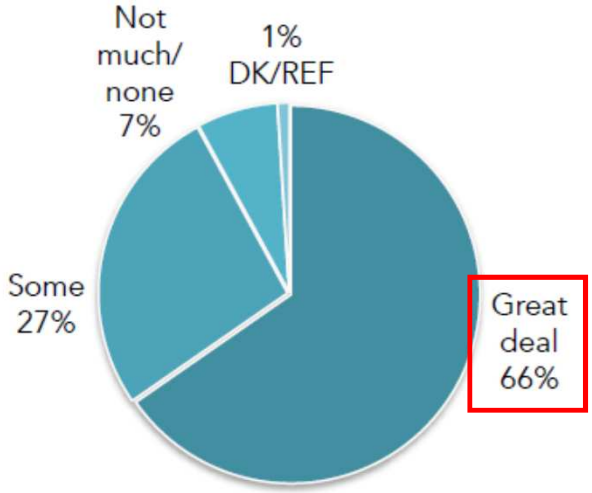


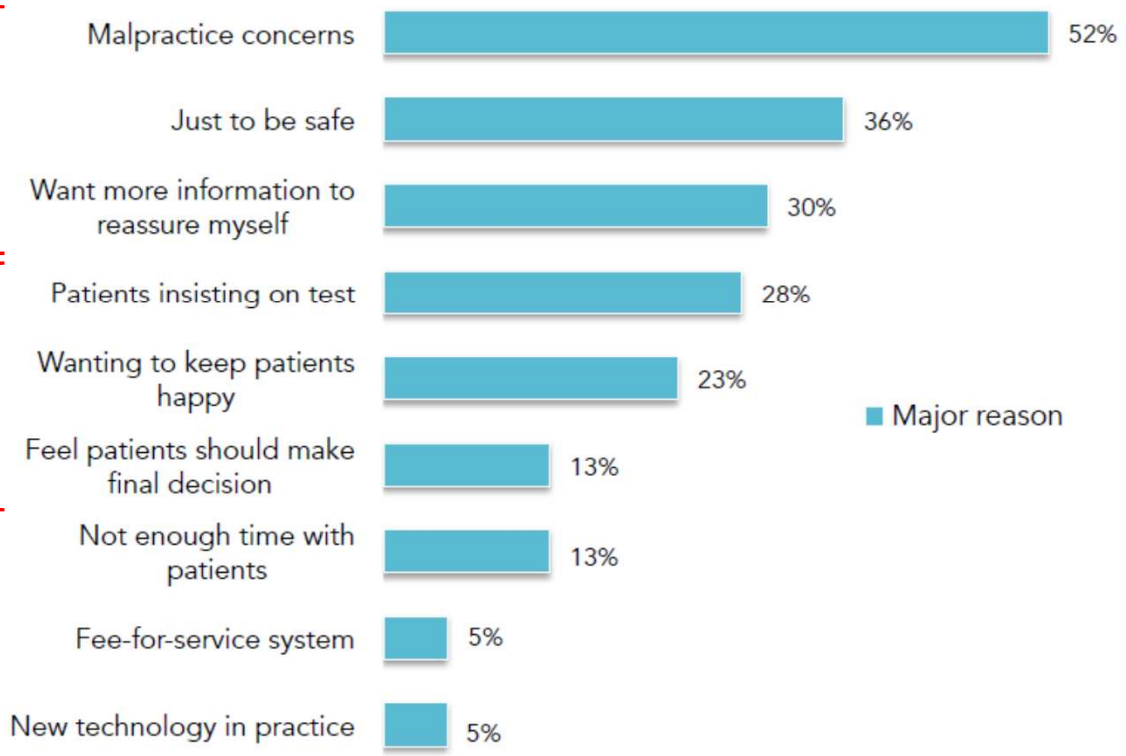
Figure 9: How much responsibility do you feel you have for making sure your patients avoid unnecessary tests and procedures?



choosingwisely.org

Motivations for overutilization

Figure 5: In your own practice, is this a reason you sometimes end up ordering an unnecessary test or procedure? IF YES: Is this a major reason or minor reason?
Total n = 600



Defensive medicine (risk aversion)

Patient autonomy

choosingwisely.org

Choosing Wisely

- ABIM initiative involving >70 medical professional societies
- Recommendations for improved utilization of clinical resources
- Many related to laboratory testing and transfusion

shm
Society of Hospital Medicine

Avoid transfusions of red blood cells for arbitrary hemoglobin or hematocrit thresholds and in the absence of symptoms of active coronary disease, heart failure or stroke.

Don't perform repetitive CBC and chemistry testing in the face of clinical and lab stability.

choosingwisely.org

Choosing Wisely transfusion recommendations

American Association of Blood Banks	Don't transfuse red blood cells for iron deficiency without hemodynamic instability.
Critical Care Societies Collaborative – Critical Care	Don't transfuse red blood cells in hemodynamically stable, non-bleeding ICU patients with a hemoglobin concentration greater than 7 g/dL.
American Society of Hematology	Don't transfuse more than the minimum number of red blood cell (RBC) units necessary to relieve symptoms of anemia or to return a patient to a safe hemoglobin range (7 to 8 g/dL in stable, non-cardiac in-patients).
American Society of Anesthesiologists	Don't administer packed red blood cells (PRBCs) in a young healthy patient without ongoing blood loss and hemoglobin of ≥6 g/dL unless symptomatic or hemodynamically unstable.
Society of Hospital Medicine – Adult Hospital Medicine	Avoid transfusions of red blood cells for arbitrary hemoglobin or hematocrit thresholds and in the absence of symptoms of active coronary disease, heart failure or stroke.

American College of Obstetricians and Gynecologists	Don't routinely transfuse stable, asymptomatic hospitalized patients with a hemoglobin level greater than 7–8 grams.

American Society of Hematology	Don't routinely transfuse patients with sickle cell disease (SCD) for chronic anemia or uncomplicated pain crisis without an appropriate clinical indication.

Choosing Wisely®

An initiative of the ABIM Foundation

choosingwisely.org

Encouraging effective use of transfusion

- Development of evidence-based guidelines
- Education (*e.g.* departmental meetings and conferences)
- Auditing of potentially inappropriate transfusions
- **Electronic clinical decision support**

Clinical decision support (CDS)

- **Definition**: “the use of information and communication technologies to bring relevant knowledge to bear on the health care and well-being of a patient” (Greenes RA ed. Clinical decision support: the road to broad adoption 2014)
- Requires expertise in several aspects of clinical informatics
  - Evidence-based medicine
  - Clinical decision-making
  - Health information technology, *e.g.* computerized provider order entry (CPOE) systems
  - Human-computer interaction
- When implemented properly, CDS is effective in guiding appropriate blood utilization in many clinical scenarios.

Common CDS tools to affect provider ordering behavior

	CDS intervention
Ordering	Order search menus
	Order templates and instructions
	Order sets
	Order reflexes and cascades
	Order alerts
	• Interruptive
	• Non-interruptive
Education	Electronic reporting and interpretation
	Electronic references
	Electronic feedback and benchmarking
	• Individualized
	• By department
	• By institution
Diagnostics	Decision algorithms
	• Within electronic health record
	• On handheld/mobile devices
	Predictive analytics/machine learning

Jackups R et al. *Int J Lab Hematol* 2017;39 Suppl 1:128-35

Current state of CDS in the United States

- Pharmacy: widespread use
  - Dosing errors
  - Drug-drug and drug-allergy interactions
- Federal mandates
  - *Meaningful Use*: financial incentives for use of CDS tools
  - *Protecting Access to Medicare Act* (2014): Certified CDS *required* for reimbursement of certain outpatient imaging studies
- Laboratory & blood bank: value only beginning to be realized

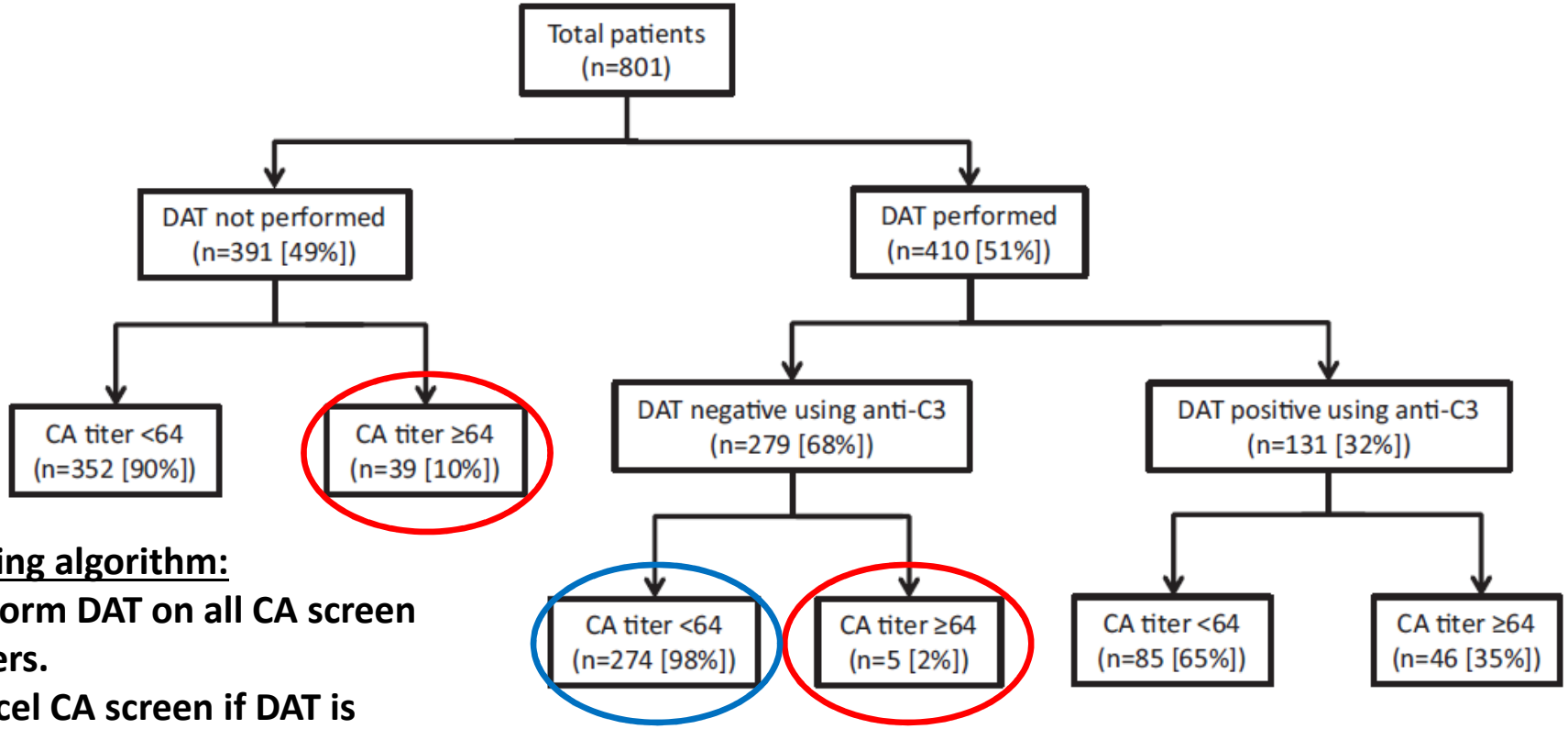
	Stage 1	Stage 2
Objective	Implement one clinical decision support rule relevant to specialty or high clinical priority along with the ability to track compliance that rule	Use clinical decision support to improve performance on high-priority health conditions
Measure	Implement one clinical decision support rule	1. Implement ***5*** clinical decision support interventions ***related to 4 or more clinical quality measures***, if applicable, at a relevant point in patient care for the entire EHR reporting period. 2. The EP, eligible hospital, or CAH has ***enabled the functionality for drug-drug and drug-allergy interaction*** checks for the entire EHR reporting period

Meaningful Use CDS objectives

CDS applications in transfusion medicine

- Blood bank testing algorithms
- Indication menu in blood order
- Dashboards for blood utilization
- Educational initiatives on best practices in transfusion
- Maximum surgical blood order schedule (MSBOS)
- Feedback to providers on personal use of blood
- Alerts for potentially inappropriate transfusion orders

Cold agglutinin (CA) testing – evidence for algorithmic testing

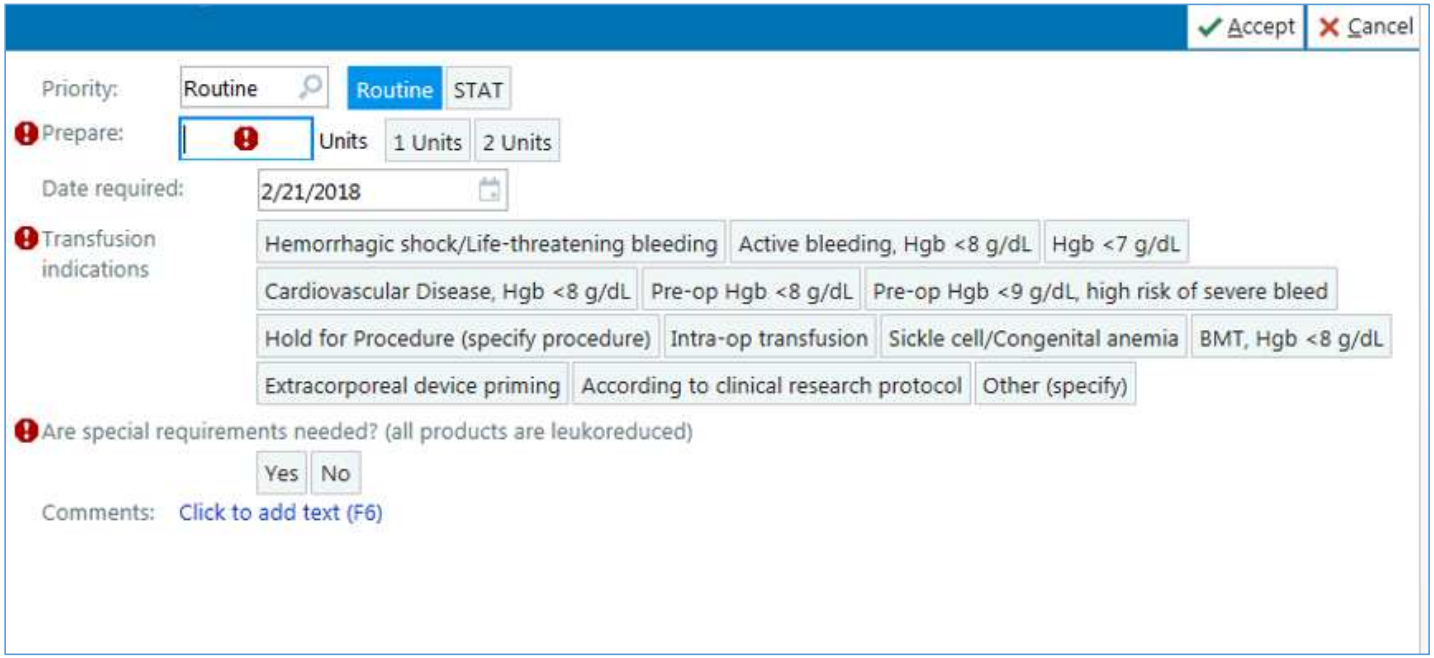


CA testing algorithm:

1. **Perform DAT on all CA screen orders.**
2. **Cancel CA screen if DAT is negative with anti-C3.**

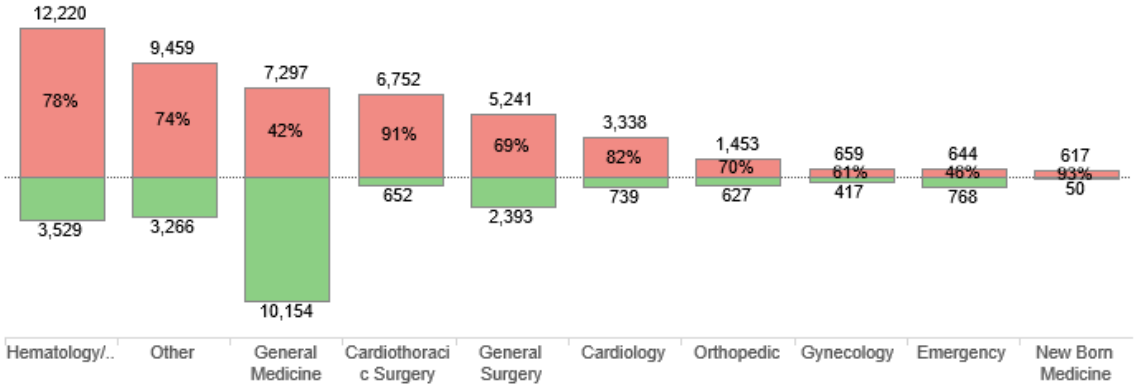
Wilen CB et al. *Transfusion* 2017;57:1480-4

Indication menu in blood order



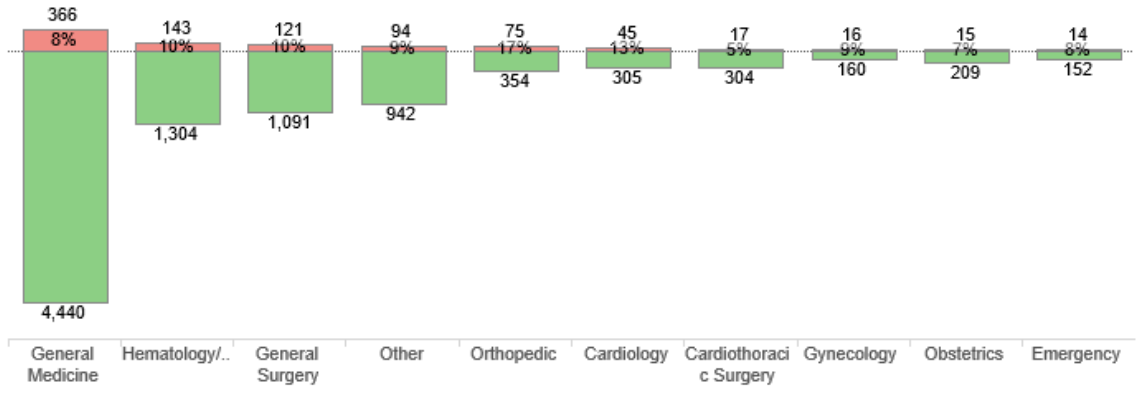
A valid indication must be selected.
Requests outside indications must be justified.

Dashboards for blood utilization



RBC transfusions with Hgb > 7

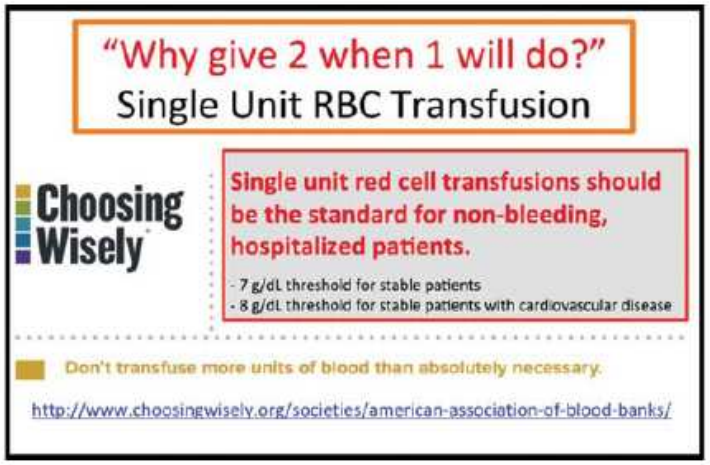
RBC transfusions with Hgb < 7



RBC transfusions with "Hgb < 7" indication selected on order

Educational initiatives on best practices (Johns Hopkins)

A.



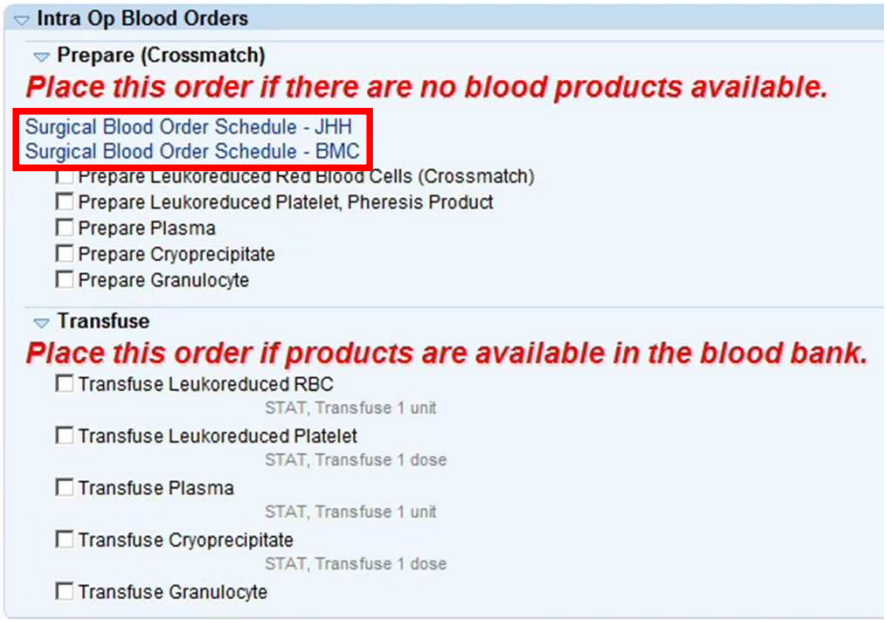
B.

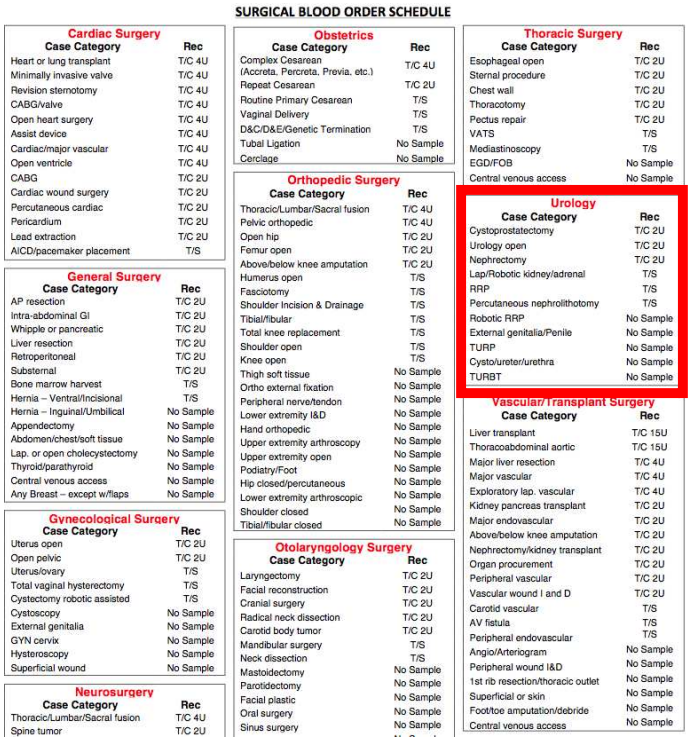
Message appeared in newsletters and on computer screensavers.

Multi-unit transfusion orders decreased from 68% to 31%.

Podlasek SJ et al. *Transfusion* 2016;56:2164

Maximum surgical blood order schedule (MSBOS)





SURGICAL BLOOD ORDER SCHEDULE

Cardiac Surgery

Case Category	Rec
Heart or lung transplant	T/C 4U
Minimally invasive valve	T/C 4U
Revision sternotomy	T/C 4U
CABG/valve	T/C 4U
Open heart surgery	T/C 4U
Assist device	T/C 4U
Cardiac/major vascular	T/C 4U
Open ventricle	T/C 4U
CABG	T/C 2U
Cardiac wound surgery	T/C 2U
Percutaneous cardiac	T/C 2U
Pericardium	T/C 2U
Lead extraction	T/C 2U
AICD/pacemaker placement	T/S

General Surgery

Case Category	Rec
AP resection	T/C 2U
Intra-abdominal GI	T/C 2U
Whipple or pancreatic	T/C 2U
Liver resection	T/C 2U
Retroperitoneal	T/C 2U
Substernal	T/C 2U
Bone marrow harvest	T/S
Hernia – Ventral/Incisional	T/S
Hernia – Inguinal/Umbilical	No Sample
Appendectomy	No Sample
Abdomen/chest/soft tissue	No Sample
Lap. or open cholecystectomy	No Sample
Thyroid/parathyroid	No Sample
Central venous access	No Sample
Any Breast – except w/flaps	No Sample

Gynecological Surgery

Case Category	Rec
Uterus open	T/C 2U
Open pelvic	T/C 2U
Uterus/ovary	T/S
Total vaginal hysterectomy	T/S
Cystectomy robotic assisted	T/S
Cystoscopy	No Sample
External genitalia	No Sample
GYN cervix	No Sample
Hysteroscopy	No Sample
Superficial wound	No Sample

Neurosurgery

Case Category	Rec
Thoracic/Lumbar/Sacral fusion	T/C 4U
Spine tumor	T/C 2U

Obstetrics

Case Category	Rec
Complex Cesarean (Accreta, Percreta, Previa, etc.)	T/C 4U
Repeat Cesarean	T/C 2U
Routine Primary Cesarean	T/S
Vaginal Delivery	T/S
D&C/D&E/Genetic Termination	T/S
Tubal Ligation	No Sample
Cerclage	No Sample

Orthopedic Surgery

Case Category	Rec
Thoracic/Lumbar/Sacral fusion	T/C 4U
Pelvic orthopedic	T/C 4U
Open hip	T/C 2U
Femur open	T/C 2U
Above/below knee amputation	T/C 2U
Humerus open	T/S
Fasciotomy	T/S
Shoulder Incision & Drainage	T/S
Tibial/fibular	T/S
Total knee replacement	T/S
Shoulder open	T/S
Knee open	T/S
Thigh soft tissue	No Sample
Ortho external fixation	No Sample
Peripheral nerve/tendon	No Sample
Lower extremity I&D	No Sample
Hand orthopedic	No Sample
Upper extremity arthroscopy	No Sample
Upper extremity open	No Sample
Podiatry/Foot	No Sample
Hip closed/percutaneous	No Sample
Lower extremity arthroscopic	No Sample
Shoulder closed	No Sample
Tibial/fibular closed	No Sample

Otolaryngology Surgery

Case Category	Rec
Laryngectomy	T/C 2U
Facial reconstruction	T/C 2U
Cranial surgery	T/C 2U
Radical neck dissection	T/C 2U
Carotid body tumor	T/C 2U
Mandibular surgery	T/S
Neck dissection	T/S
Mastoidectomy	No Sample
Parotidectomy	No Sample
Facial plastic	No Sample
Oral surgery	No Sample
Sinus surgery	No Sample

Thoracic Surgery

Case Category	Rec
Esophageal open	T/C 2U
Sternal procedure	T/C 2U
Chest wall	T/C 2U
Thoracotomy	T/C 2U
Pectus repair	T/C 2U
VATS	T/S
Mediastinoscopy	T/S
EGD/FOB	No Sample
Central venous access	No Sample

Urology

Case Category	Rec
Cystoprostatectomy	T/C 2U
Urology open	T/C 2U
Nephrectomy	T/C 2U
Lap/Robotic kidney/adrenal	T/S
RRP	T/S
Percutaneous nephrolithotomy	T/S
Robotic RRP	No Sample
External genitalia/Penile	No Sample
TURP	No Sample
Cysto/ureter/urethra	No Sample
TURBT	No Sample

Vascular/Transplant Surgery

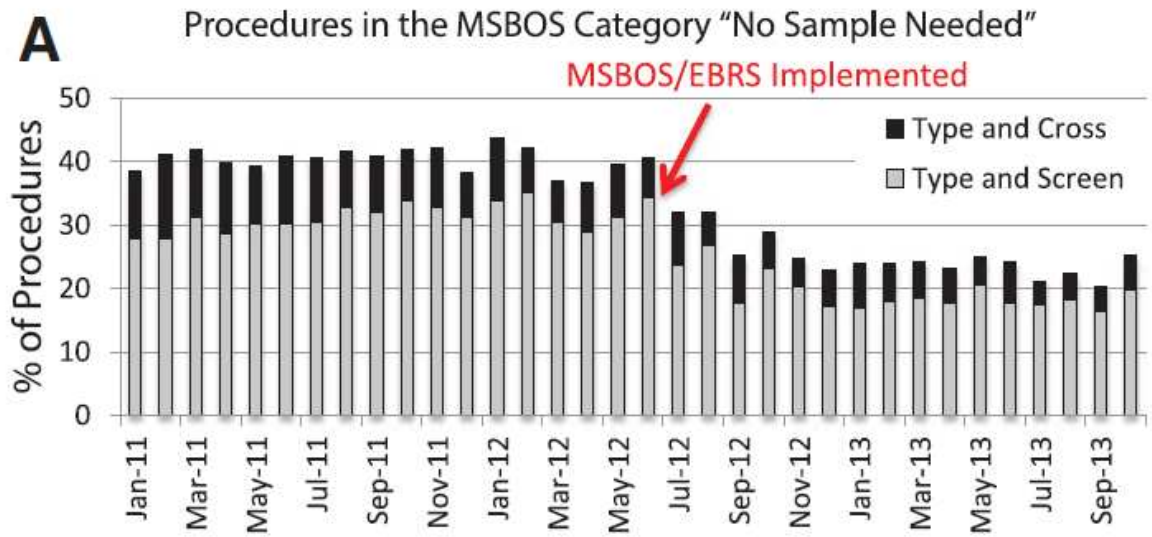
Case Category	Rec
Liver transplant	T/C 15U
Thoracoabdominal aortic	T/C 15U
Major liver resection	T/C 4U
Major vascular	T/C 4U
Exploratory lap. vascular	T/C 4U
Kidney pancreas transplant	T/C 2U
Major endovascular	T/C 2U
Above/below knee amputation	T/C 2U
Nephrectomy/kidney transplant	T/C 2U
Organ procurement	T/C 2U
Peripheral vascular	T/C 2U
Vascular wound I and D	T/C 2U
Carotid vascular	T/S
AV fistula	T/S
Peripheral endovascular	T/S
Angio/Arteriogram	No Sample
Peripheral wound I&D	No Sample
1st rib resection/thoracic outlet	No Sample
Superficial or skin	No Sample
Foot/toe amputation/debride	No Sample
Central venous access	No Sample

Urology

Case Category	Rec
Cystoprostatectomy	T/C 2U
Urology open	T/C 2U
Nephrectomy	T/C 2U
Lap/Robotic kidney/adrenal	T/S
RRP	T/S
Percutaneous nephrolithotomy	T/S
Robotic RRP	No Sample
External genitalia/Penile	No Sample
TURP	No Sample
Cysto/ureter/urethra	No Sample
TURBT	No Sample

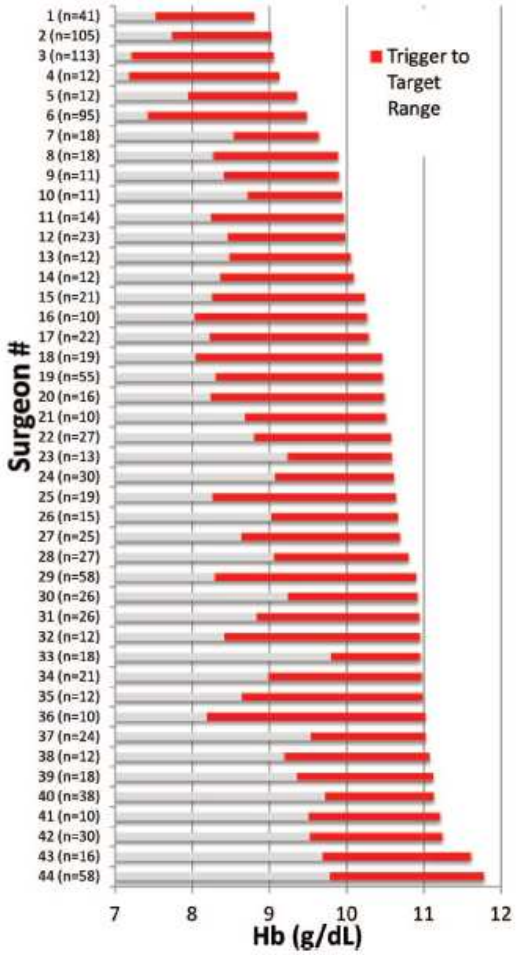
Frank SM et al. *Anesthesiology* 2013;118:1286-97

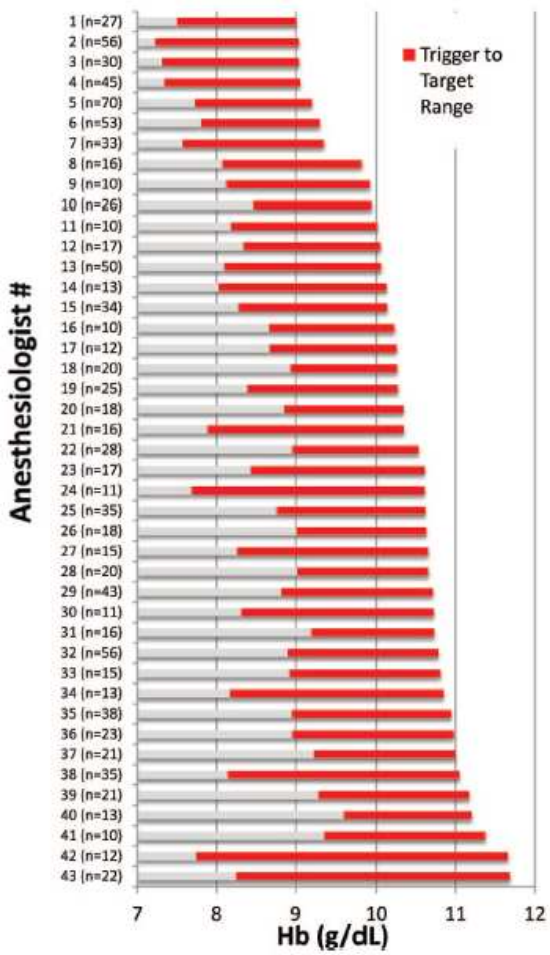
Effect of MSBOS on pre-transfusion testing and cross-matching



Frank SM et al. *Anesthesiology* 2014;121:501-9

Feedback to providers on personal use of blood



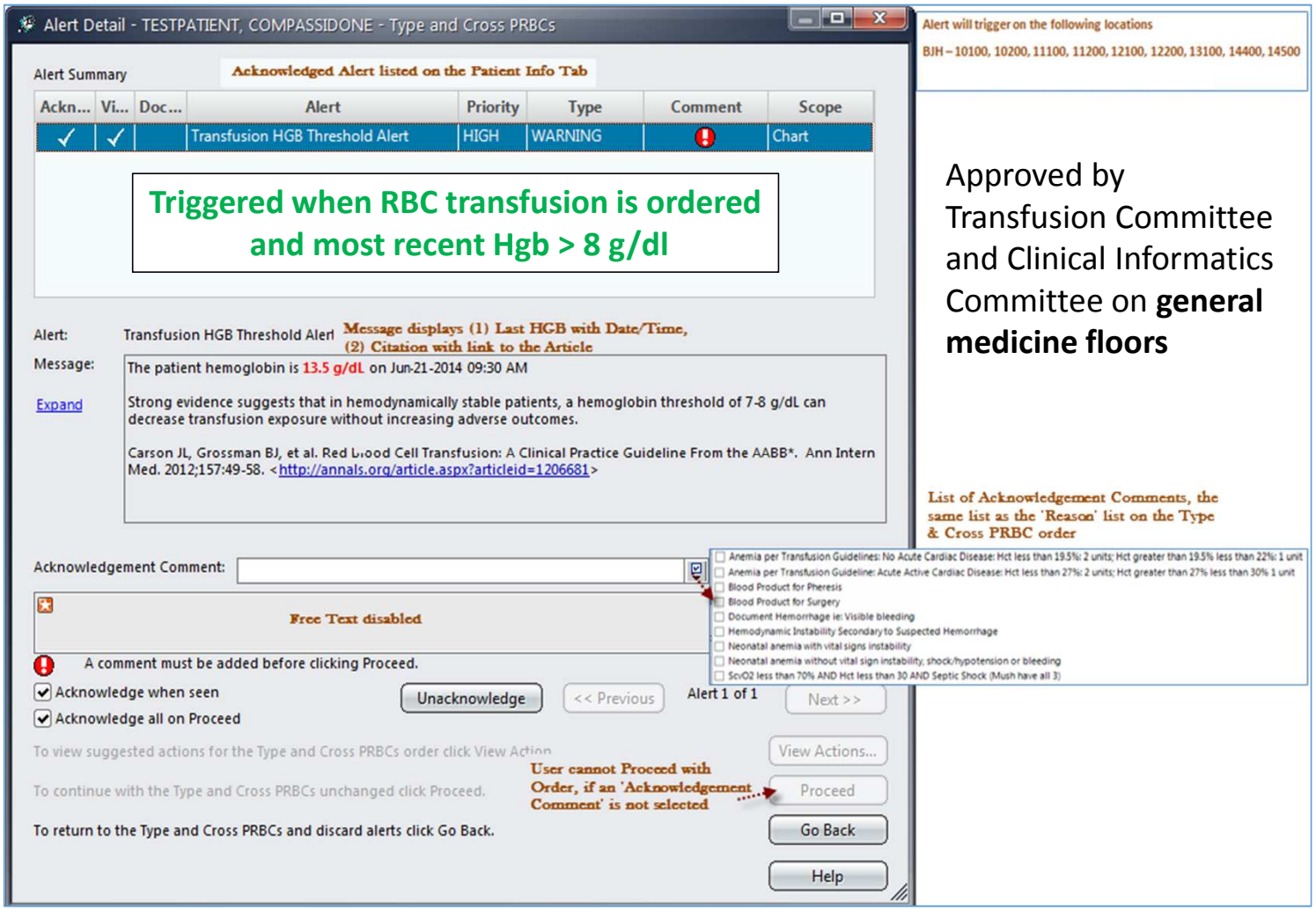


<u>Trigger</u>: Hgb before first intra-op transfusion

<u>Target</u>: Hgb after last intra-op transfusion

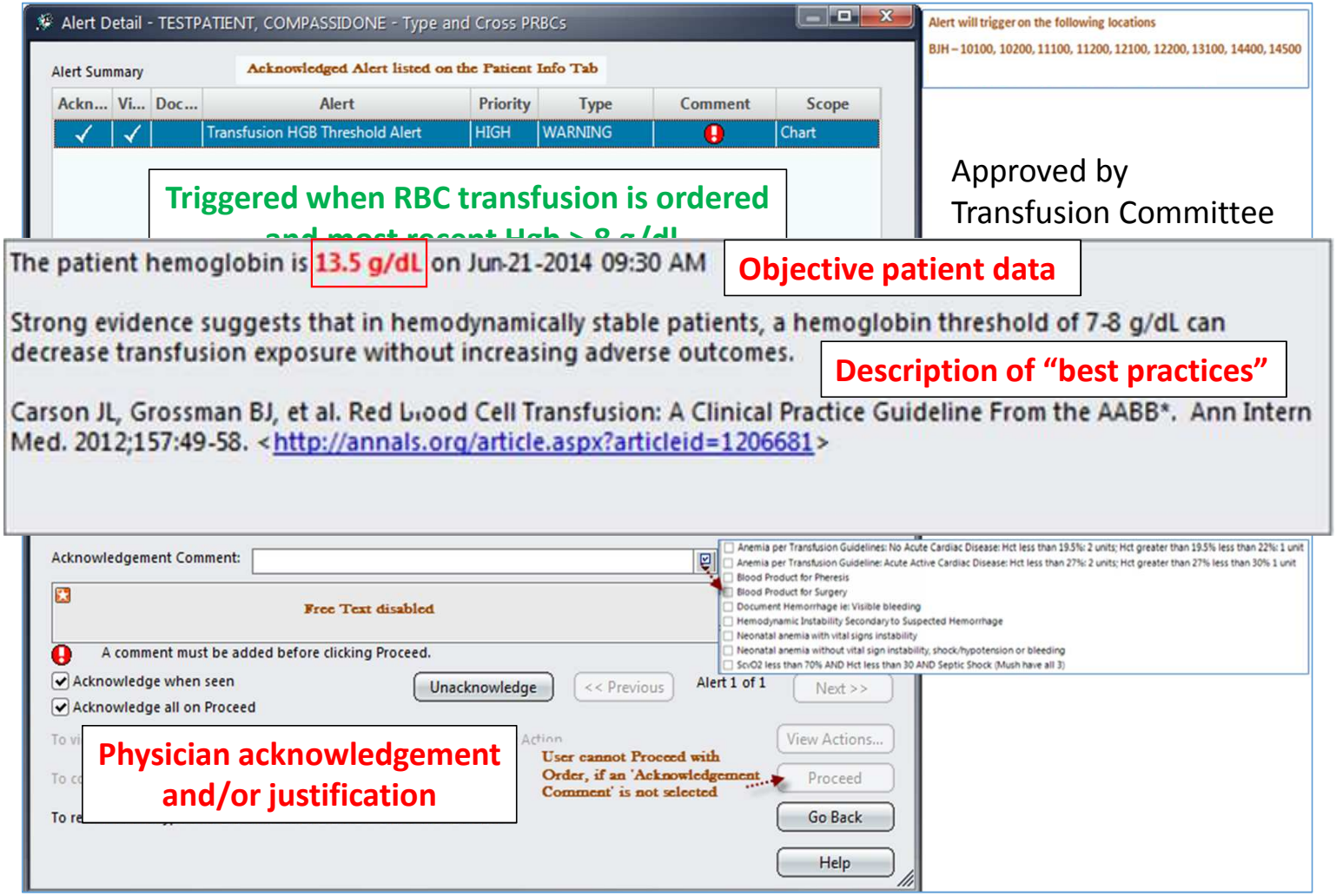
Frank SM et al. *Anesthesiology* 2012;117:99-106

Interruptive transfusion alert, Barne-Jewish Hospital

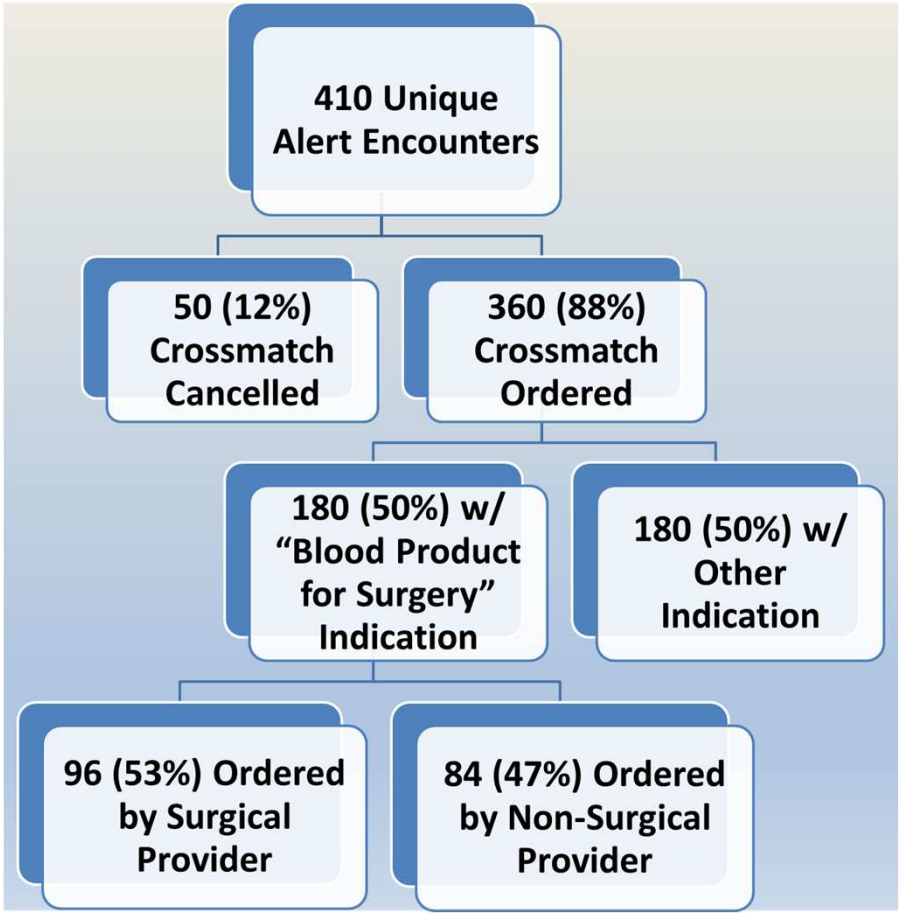


Approved by Transfusion Committee and Clinical Informatics Committee on **general medicine floors**

Interruptive transfusion alert, Barne-Jewish Hospital



Transfusion alert responses (Apr – Oct 2015)



- Lessons learned:
  - Almost half of blood ordered on medicine floors was in advance of a procedure.
  - The provider placing the order was often not the provider who desired the transfusion.

Papiernik J & Jackups R (*Unpublished*)

Guidelines for effective CDS

The Five Rights of CDS
The right information
To the right person
In the right CDS intervention format
Through the right channel
At the right time in the workflow

Sirajuddin AM et al. *J Healthc Inf Manag* 2009

The Ten Commandments for Effective CDS
Speed is everything.
Anticipate needs and deliver in real time.
Fit into the user's workflow.
Little things can make a big difference.
Recognize that physicians will strongly resist stopping.
Changing direction is easier than stopping.
Simple interventions work best.
Ask for additional information only when you really need it.
Monitor impact, get feedback, and respond.
Manage and maintain your knowledge-based systems.

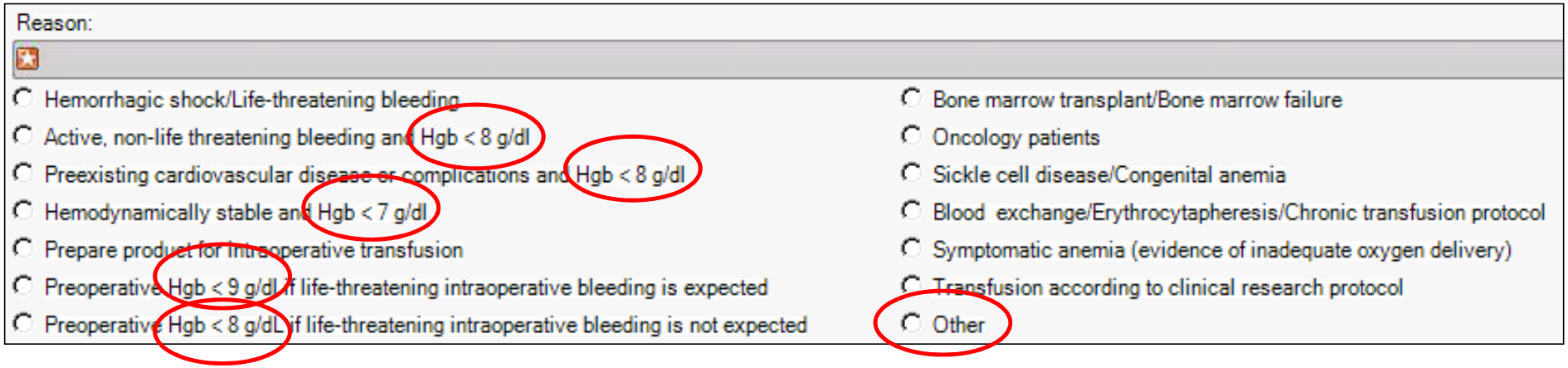
Bates DW et al. *J Am Med Inform Assoc* 2003

Focus group study on blood utilization and CDS alert

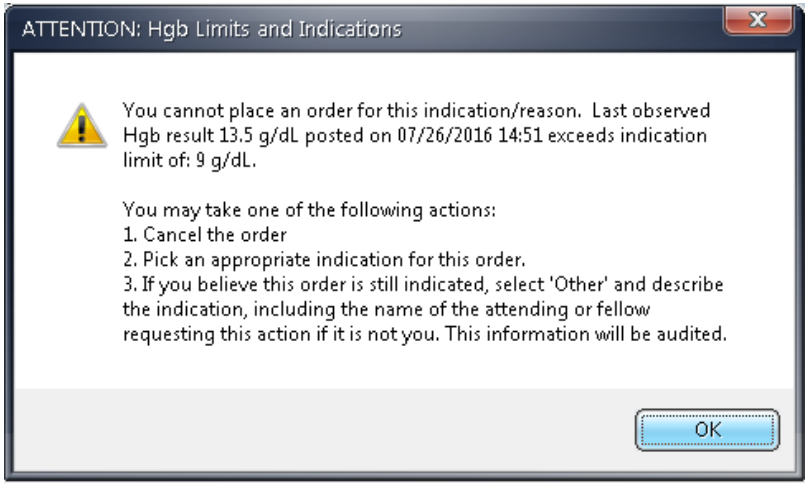
- 4 focus groups comprising 26 medicine residents and 14 attending hospitalists
- Resulting themes included:
  - Practice variation: attending & subspecialist preference, lack of evidence for appropriate indications
  - Challenges to improvement: education/remediation, transfusion transparency, prospective auditing

Halford B et al. (*Unpublished*)

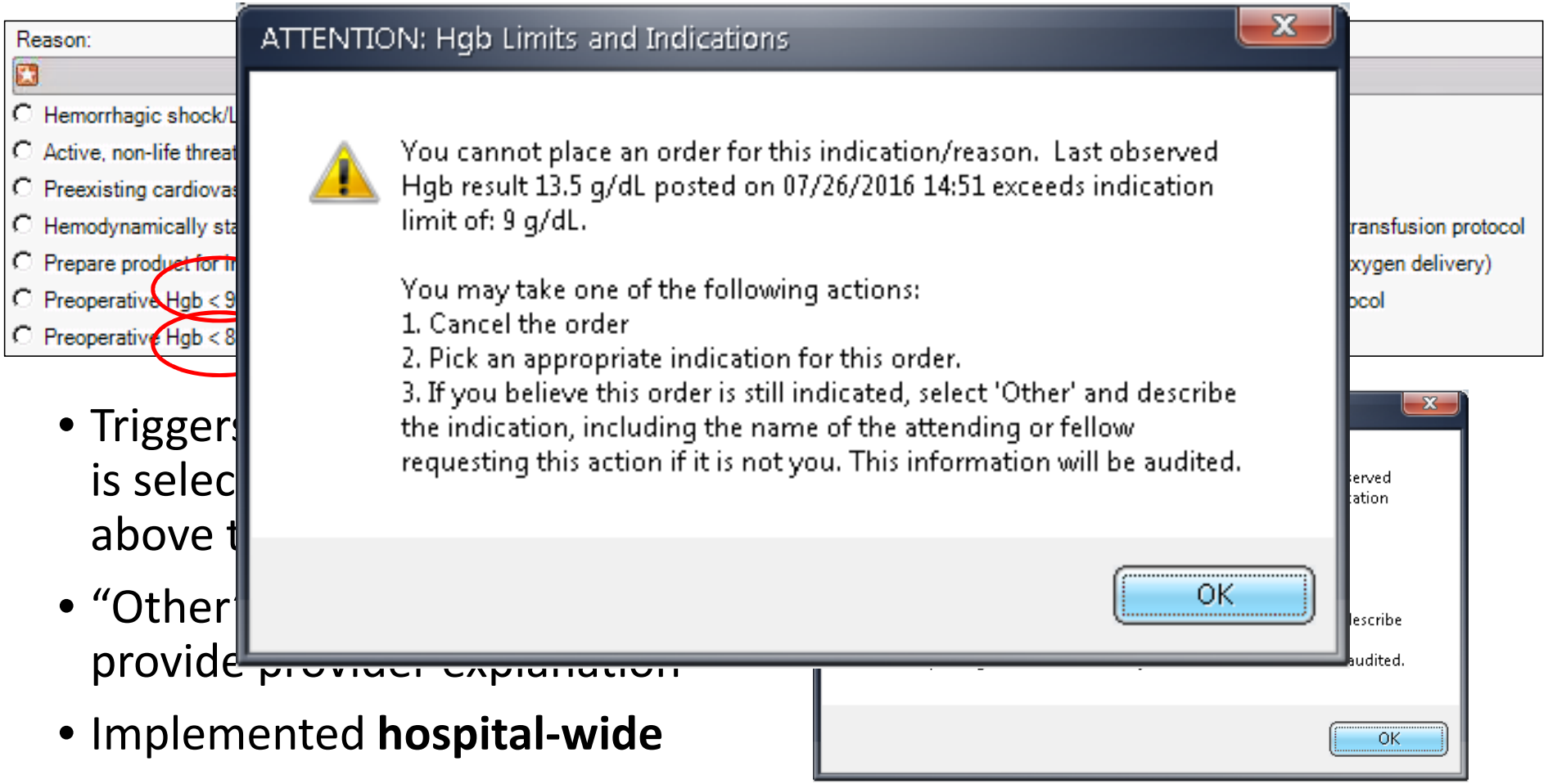
Updated transfusion alert



- Triggers when a Hgb threshold is selected, but the Hgb is above the threshold.
- "Other" indication added to provide provider explanation
- Implemented **hospital-wide**



Updated transfusion alert



- Trigger
  is selec
  above t
- "Other
  provide provider explanation
- Implemented **hospital-wide**

Response to new alert (Aug 2016 – Feb 2017)

Indication	#Alerts	%Canceled	Proceed Hgb	Cancel Hgb
Hemodynamically stable and Hgb < 7 g/dL	527	14.7	7.1	7.4
Active, non-life threatening bleeding and Hgb < 8 g/dL	468	11.5	8.6	8.9
Preexisting cardiovascular disease and Hgb < 8 g/dL	220	8.7	8.4	8.4
Preoperative Hgb < 9 g/dL if life-threatening bleeding is expected	65	5.8	9.2	10.7
Preoperative Hgb < 9 g/dL if life-threatening bleeding is not expected	133	8.9	10.4	9.6
Total	**1413**	**11.9**	**8.2**	**8.3**

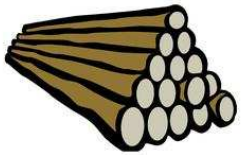
168 (new alert) vs. **50** (old alert) crossmatches cancelled.

Papiernik J & Jackups R (*Unpublished*)

Conclusions

- Transfusions have decreased in use with the increased popularity of restrictive transfusion practices.
- Several methods exist to encourage appropriate use of transfusion.
- **Clinical decision support** is a promising tool to reduce unnecessary transfusions and inform future quality improvement efforts.

Back to petrified wood…

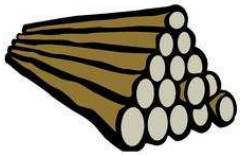


- Behavioral time-course study of 2655 visitors to PWNP
- Signage was randomized, locations baited with loose pieces of wood

Message type	Message text
Negative command	"Please don't remove the petrified wood from the park."
Positive command	"Please leave petrified wood in the park."
Negative descriptive	"Many past visitors have removed the petrified wood from the park, changing the state of the Petrified Forest."
Positive descriptive	"The vast majority of past visitors have left the petrified wood in the park, preserving the natural state of the Petrified Forest."

Cialdini et al. *Social Influence* 2006

Back to petrified wood…



- Behavioral time-course study of 2655 visitors to PWNP
- Signage was randomized, locations baited with loose pieces of wood

Message type	Message text	Theft (%)
Negative command	"Please don't remove the petrified wood from the park."	**1.67**
Positive command	"Please leave petrified wood in the park."	**5.33**
Negative descriptive	"Many past visitors have removed the petrified wood from the park, changing the state of the Petrified Forest."	**7.92**
Positive descriptive	"The vast majority of past visitors have left the petrified wood in the park, preserving the natural state of the Petrified Forest."	**5.00**

Conclusion: Short, direct messages work best (just like *Choosing Wisely!)*

Cialdini et al. *Social Influence* 2006

Questions?

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