Sanguine: Visual Analysis for Patient Blood Management

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Objectives

- List limitations of common patient blood management (PBM) metrics
- Consider how Creativity Workshops glean end user perspectives and insights
- Analyze *Sanguine*, a novel data visualization tool prototype for PBM in complex cardiothoracic surgery
- Evaluate how *Sanguine* can rapidly demonstrate PBM performance in context
- Consider how *Sanguine* can be used to generate "patients like mine"

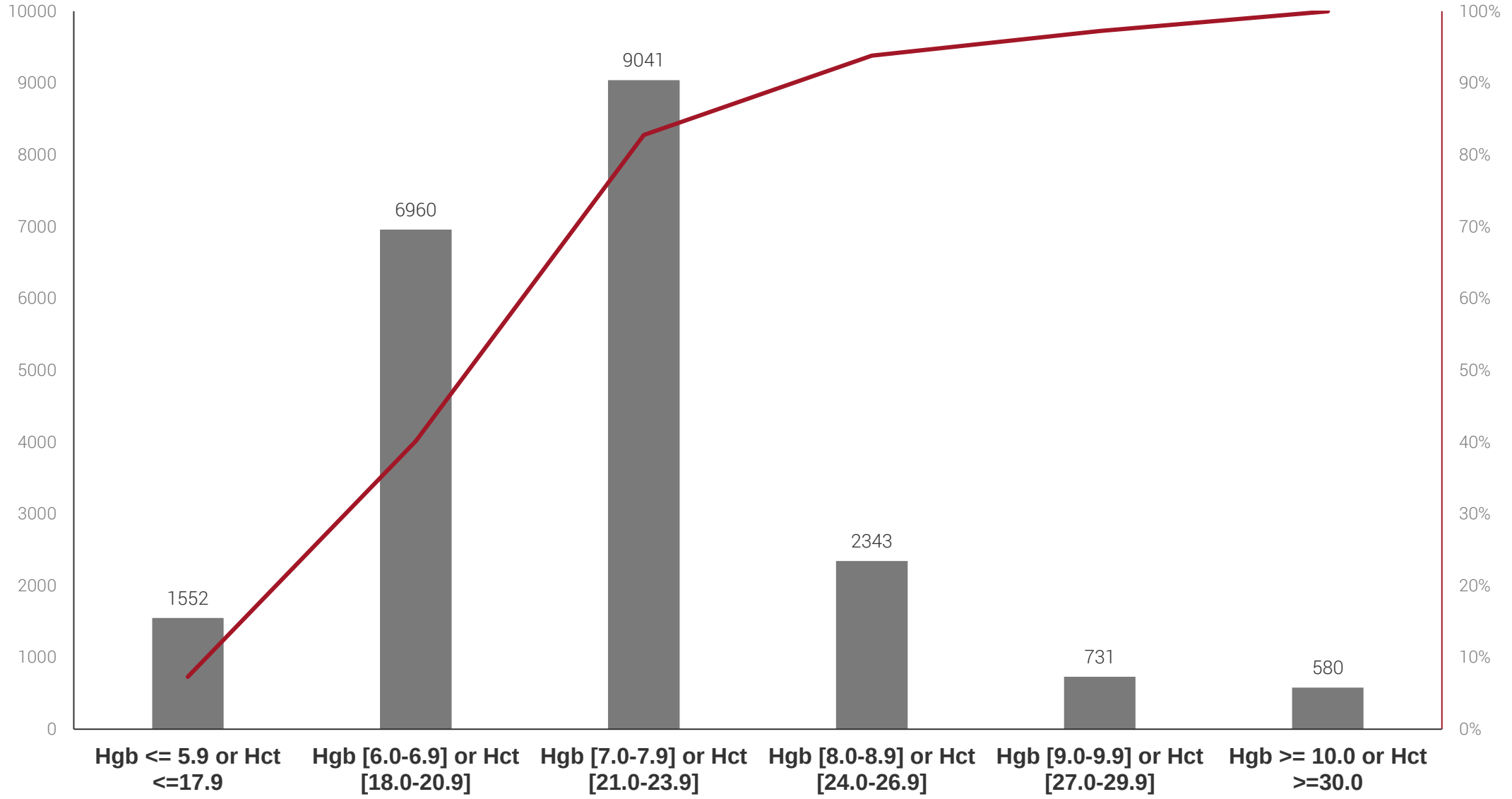
Defining PBM

- Rationally optimizing anemia and hemostasis
- Goal of "restricting" blood utilization
- Improve patient outcomes, efficiency, and value

Value = Quality / Cost

sabm.org

Last Lab Value Prior to Transfuse Event/Order RBC



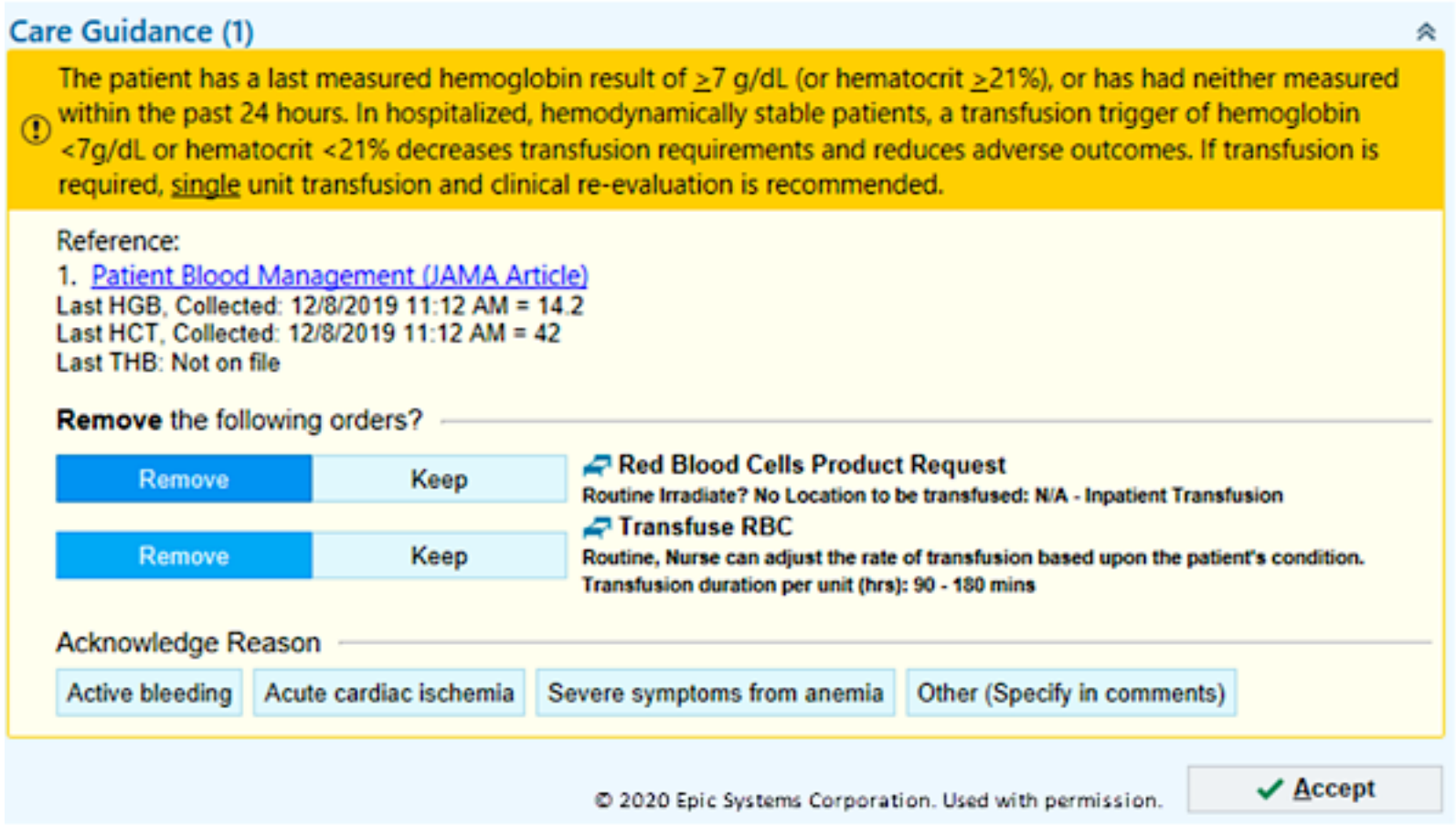
RBC transfusion Best Practice Alerts (BPAs)

- Alert 1: Hemoglobin (7g/dL), hematocrit (21%) threshold

- Alert 2: Single unit transfusion policy

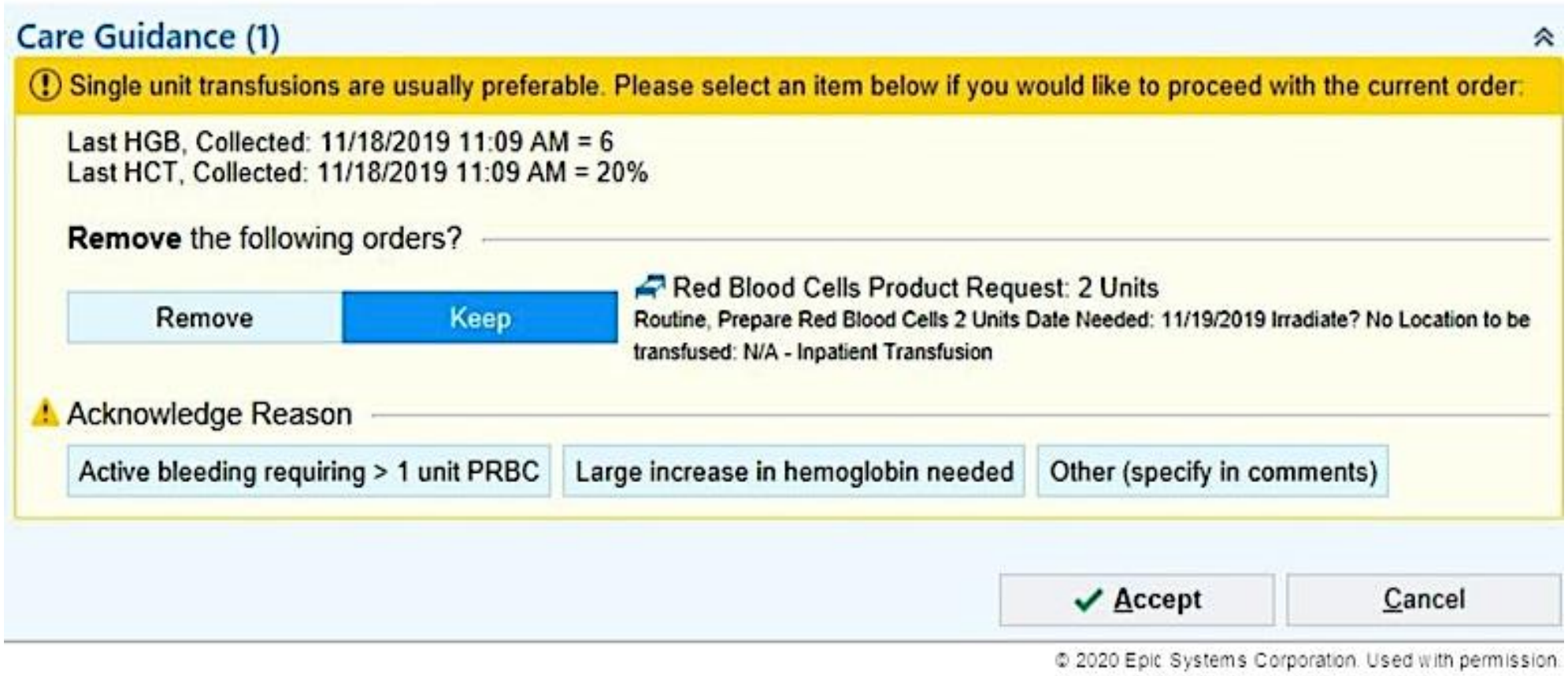
Hemoglobin/hematocrit BPA:

End user action to remove order 30% (very successful)



Single unit transfusion policy BPA

End user action to remove order <1% (not so good!)



An opportunity to further improve

- Changed single unit BPA default action
  - » "Keep" → "remove"
- 4.5 month follow up
  - » End user action to remove increased to 35%
  - » Default action influences end-user behavior

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TRANSFUSION MEDICINE ILLUSTRATED

TRANSFUSION

Electronic clinical decision support: Evidence that default settings influence end-user behavior

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Metcalf et al. Transfusion. 2021.

Best Practice Alert Results

- Pre-intervention: 4/2018 to 3/2019
- Post-intervention: 4/2019 to 3/2020

- Overall 11% reduction in RBCs transfused

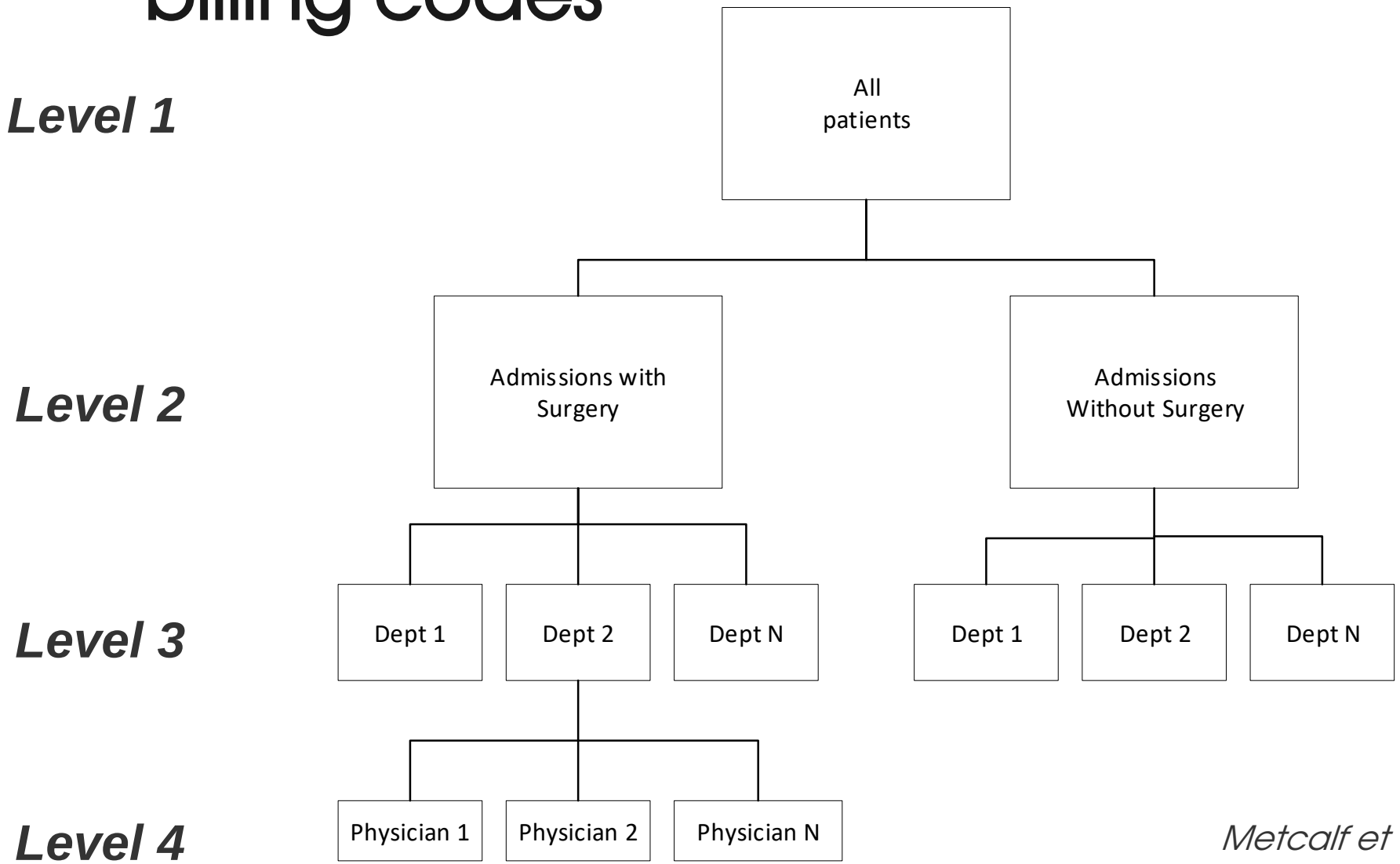
- Projected acquisition cost savings ~$400k/year

Limitations of threshold approaches

- PBM is multifaceted
  - » Perioperative anemia management
  - » Blood conservation
  - » Surgical technique
  - » Antifibrinolytic agents

- Evaluate blood use beyond lab values?
  - » For example: high blood loss surgeries

Risk-adjustment by organizational unit using billing codes



Metcalf et al. Transfusion. 2019.

Statistical vs Clinical Significance

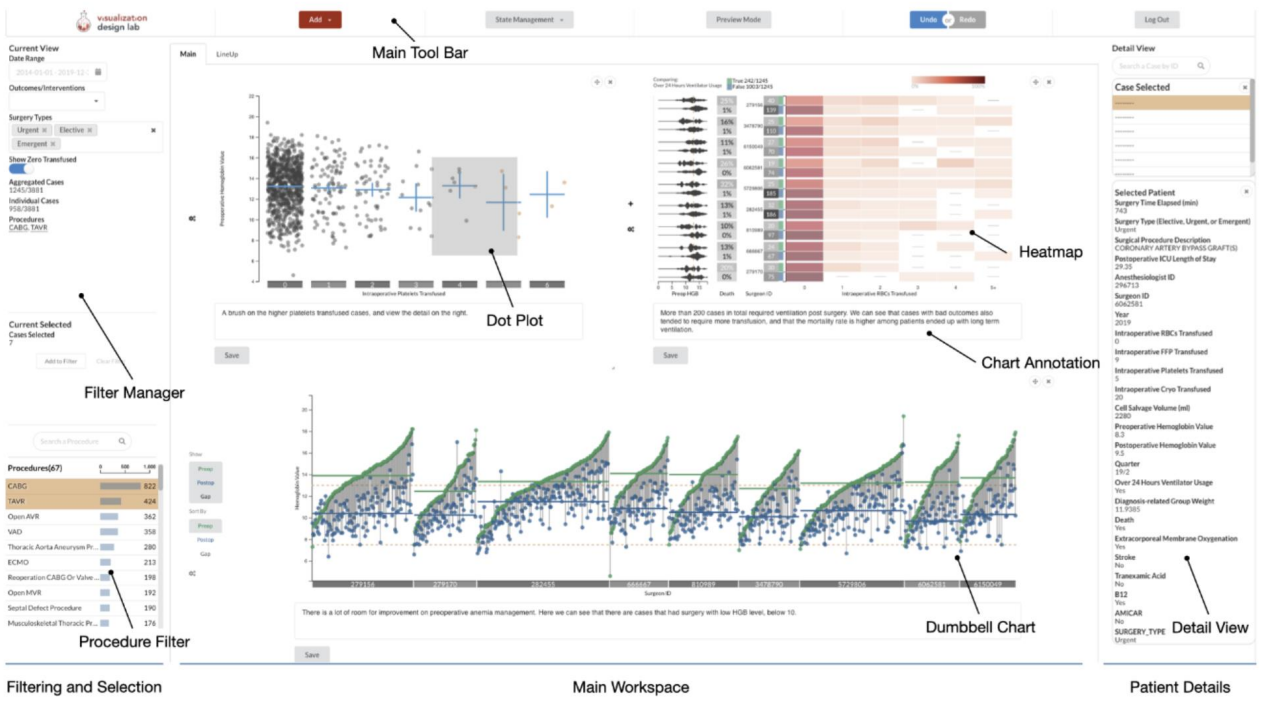
Model	DRG weight IRR	p-value	Clinical LOS IRR	p-value
Overall	1.22	<0.001	1.03	<0.001
Surgical	1.26	<0.001	1.03	<0.001
Medical	1.05	<0.001	1.04	<0.001

DRG = diagnosis related group; IRR = incidence rate ratio

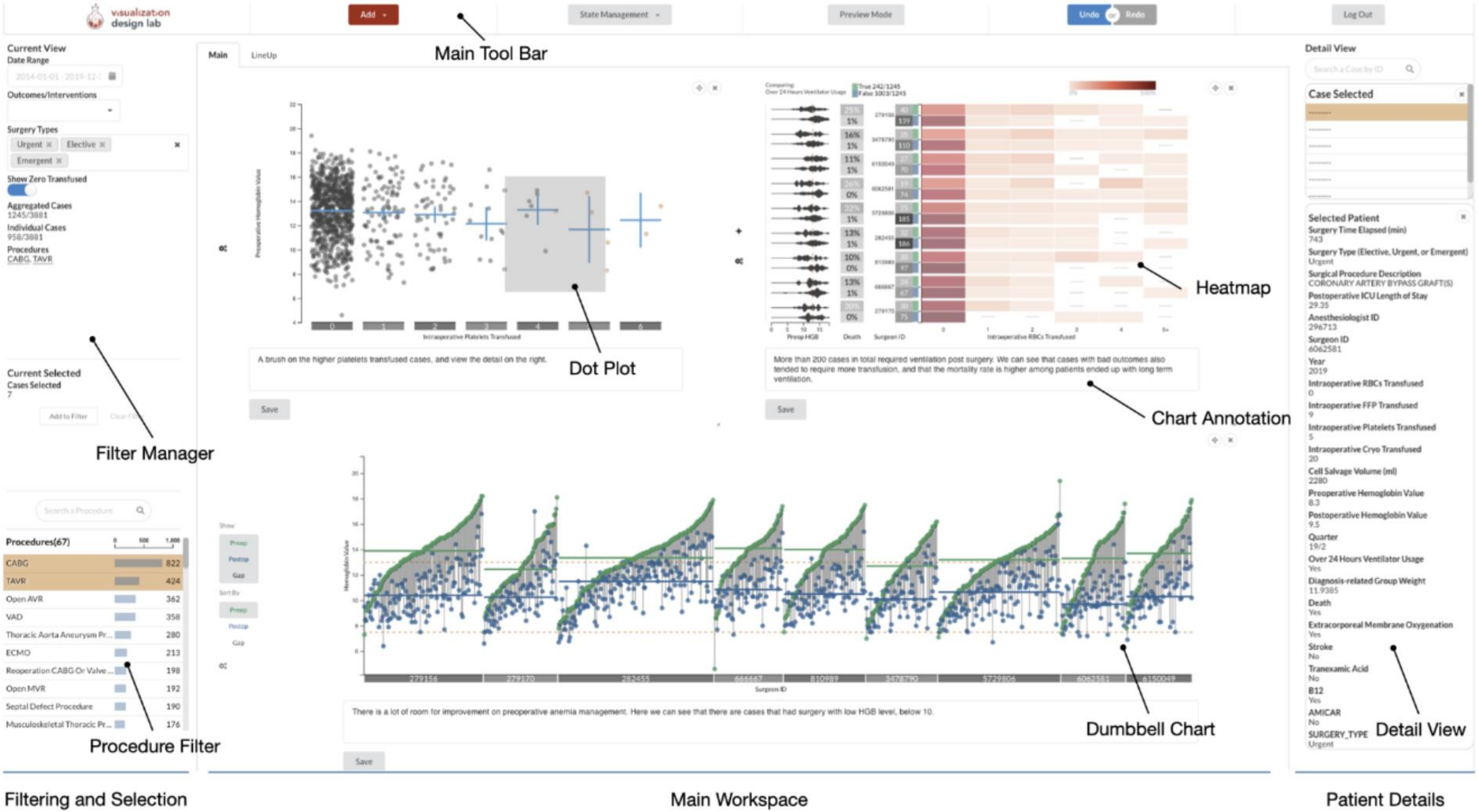
Application & next steps

- Data visualization: graphical representations of data to facilitate understanding and insights into the data

- *Sanguine*: a novel tool with rapid, flexible data visualizations in relevant PBM contexts
  - Institutional review board approval
  - Data use agreement



Lin et al. Info Vis. In press.


visualization design lab
Add
Main Tool Bar
State Management
Preview Mode
Undo
Redo
Log Out
Current View
Date Range
Outcomes/Interventions
Surgery Types
Urgent
Elective
Emergent
Show Zero Transfused
Aggregated Cases
1245/3881
Individual Cases
958/3881
Procedures
CABG, TAVR
Main
LineUp
Dot Plot
A brush on the higher platelets transfused cases, and view the detail on the right.
Save
Heatmap
More than 200 cases in total required ventilation post surgery. We can see that cases with bad outcomes also tended to require more transfusion, and that the mortality rate is higher among patients ended up with long term ventilation.
Chart Annotation
Detail View
Case Selected
Selected Patient
Surgery Time Elapsed (min)
743
Surgery Type (Elective, Urgent, or Emergent)
Urgent
Surgical Procedure Description
CORONARY ARTERY BYPASS GRAFT(S)
Postoperative ICU Length of Stay
29.35
Anesthesiologist ID
296713
Surgeon ID
6062581
Year
2019
Intraoperative RBCs Transfused
0
Intraoperative FFP Transfused
9
Intraoperative Platelets Transfused
5
Intraoperative Cryo Transfused
20
Cell Salvage Volume (ml)
2280
Preoperative Hemoglobin Value
8.3
Postoperative Hemoglobin Value
9.5
Quarter
19/2
Over 24 Hours Ventilator Usage
Yes
Diagnosis-related Group Weight
11.9385
Death
Yes
Extracorporeal Membrane Oxygenation
Yes
Stroke
No
Tranexamic Acid
No
B12
Yes
AMICAR
No
SURGERY_TYPE
Urgent
Detail View
Current Selected
Cases Selected
7
Add to Filter
Filter Manager
Procedures(67)
CABG 822
TAVR 424
Open AVR 362
VAD 358
Thoracic Aorta Aneurysm Pr... 280
ECMO 213
Reoperation CABG Or Valve ... 198
Open MVR 192
Septal Defect Procedure 190
Musculoskeletal Thoracic Pr... 176
Procedure Filter
Dumbbell Chart
There is a lot of room for improvement on preoperative anemia management. Here we can see that there are cases that had surgery with low HGB level, below 10.
Save
Filtering and Selection
Main Workspace
Patient Details

Cardiothoracic (CT) Surgery Database

- Worked closely with Enterprise Data Warehouse (EDW)

- CT surgery database core elements:
  - » Patient demographic data
  - » Encounter data
  - » Billing codes (ICD, CPT, DRG)
  - » Surgery case
  - » Vital signs
  - » Medications
  - » Labs
  - » Blood transfusions

Why CT Surgery?

- Highly complex patients that frequently require blood transfusions

- Several possible PBM modalities exist
  - » Perioperative anemia management
  - » "Restrictive" transfusion strategy
  - » Antifibrinolytic agents
  - » Intraoperative blood recovery

- Quality-oriented, collaborative culture

Data Visualization: What is possible?

- Cohort filter/zoom to any organizational unit
  - » Department, procedure type, physician, patient, etc
- Create meaningful context:
  - » Blood utilization
  - » Surgeon and anesthesiologist
  - » Procedures
  - » Risk adjustment
  - » Laboratory values
  - » Use of PBM modalities
  - » Time/intervention
  - » Outcomes: mortality, complications, etc.
  - » Cost

Creativity Workshop

- End user stakeholders (participants): CT surgeons, CT anesthesiologists, IT decision support
- Facilitators: Visualization expert*, PBM expert
- Three hour session
  - » Opening/background, tool demo (20min)
  - » Current workflow (30min)
  - » Wishful thinking (50min)
  - » Visualization analogies (30min)
  - » Barrier removal (40min)
  - » Reflection and next steps (10min)

What would you like to know?
What would you like to do?
What would you like to see?

*Scientific Computing and Imaging (SCI) Institute: sci.utah.edu

vdl.sci.utah.edu/CVOWorkshops


Activity 2: Wishful Thinking: Grouping / Prioritizing
Now we would like you to:
Group your ideas by topics
Rank them by importance.

Creativity Workshop: Findings/Themes

- Transfusion can feel like an emotional decision, bias to transfuse if not sure
- My practice compared to a standard?
- Benchmarking my utilization with risk-adjustment would be useful
- Want info at hierarchical levels
- Incorporate patient outcomes
- Retrospective quality application
  - » Beyond blood: include other quality measures?

Sanguine: Selected Use Cases

- Preoperative anemia management
- Transfusion appropriateness
- Antifibrinolytic agents
- Cell salvage
- "Patients like mine"
- General quality
- Financial impact

Switching Gears: Live Demo

Sanguine: Visual Analysis Tool for Patient Blood Management

Lin et al. Info Vis. In press.

Conclusions

- Limitations of static PBM metrics
- Risk-adjusted blood use for comparisons
- Creativity workshops for stakeholder input
- *Sanguine* identifies PBM patterns in context; examples:
  - » Preop anemia management
  - » Transfusion appropriateness
  - » Antifibrinolytic use
  - » Cell salvage use
  - » "Patients like mine"

visualization design lab

Future directions and next steps for *Sanguine*

- Deployed locally
- Beta site deployment
- Iterative refinement
  - » State sharing, annotation, line up, etc.
- Generalization
- Beyond PBM?

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