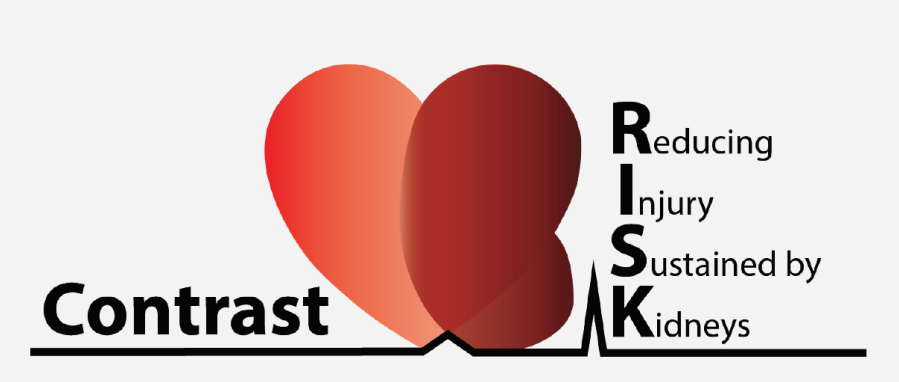


Enhancing Clinical Decision Support for Prevention of Contrast-Induced AKI in Cardiac Catheterization

Faculty/Presenter Disclosure

- **Presenter: Dr. Michelle Graham**
- **No Relationships with financial interests:**

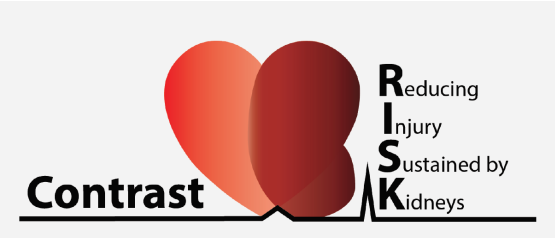
Disclosure of Commercial Support

- **This program has received financial support from Alberta Innovates in the form of a Partnership for Research and Innovation in the Health System Grant**
- **This program has received in-kind support from Alberta Health Services in the form of logistical support for implementation**.

- **<u>Potential for conflict(s) of interest</u>:**
  - Dr. Michelle Graham has not received funding from any organization whose product(s) are being discussed in this program.
  - Data Informed Health Services Ltd. licenses and distributes the electronic clinical information system that will be discussed in this program: APPROACH
  - Health Outcomes Sciences Ltd. Licenses, distributes, and benefits from sales of the risk calculation product that will be discussed in this program: ePRISM

Mitigating Potential Bias

- Sponsor representatives are not members of the Planning Committee of the program
- The Planning Committee carefully developed the material for the program in order to ensure that the principles of scientific integrity, objectivity and balance have been respected
- The Planning Committee chair and members have individual discussions with each speaker regarding expected learning outcomes and teaching formats
- The Planning Committee communicates the course learning objectives and requirement for scientific integrity, as well as instruction on conflict of interest disclosure and managing bias, to each speaker, facilitator and moderator



APPROACH

Alberta Provincial Project for
Outcome Assessment in Coronary Heart Disease

Project Partners

- **Planning Committee:** Dr. Michelle Graham (Co-PI, UAH Site Lead), Dr. Bryan Har (FMC Site Lead), Dr. Ben Tyrrell (RAH Site Lead), Matthew James (Co-PI, APPROACH Research Lead),
- **Funding Agency:** Alberta Innovates – Health Solutions: Partnership for Research & Innovation in the health system (PRIHS)
- **AHS Strategic Clinical Network Partners:** AHS Cardiovascular Health and Stroke Strategic Clinical Network, AHS Kidney Health Strategic Clinical Network
- **Partner Sites and Leads:** Foothills Medical Centre - Libin Cardiovascular Institute of Alberta (Dr. David Goodhart, Tanya Federico), Royal Alexandra Hospital - CK Hui Heart Centre (Dr. Neil Brass, Michael Powell), University of Alberta - Mazankoswski Alberta Heart Institute (Dr. Robert Welsh, Cheryl Loughlin)
- **Collaborating Teams:** Alberta Provincial Project for Outcomes Assessment in Coronary Heart Disease (APPROACH Team), AHS Analytics, AHS Research Facilitation (Peter Faris), Health Outcome Sciences (Dr. John Spertus, Ryan Fox)
- **Project Team:** Eleanor Benterud (Senior Project Coordinator), Pantea Javaheri (Project Coordinator), Denise Kruger (Research Coordinator- Edmonton sites), Tolu Sajobi (Project Biostatistician), Zhi Tan (Senior Analyst)

Self-assessment Case Study 1:

- 75 year old male with diabetes and chronic kidney disease is hospitalized with a NSTEMI complicated by heart failure.
- Baseline creatinine = 300 µmol/L (eGFR = 17 mL/min/1.73m^2)

- Q1: What is this patients risk of CI-AKI?
- Q2: What is this patient's safe contrast limit to reduce his risk of CI-AKI?

Self-assessment Case Study 1:

- 75 year old male with diabetes and chronic kidney disease is hospitalized with a NSTEMI complicated by heart failure.
- Baseline creatinine = 300 µmol/L (eGFR = 17 mL/min/1.73m^2)

- Q3: What procedural tactics can be used to reduce the volume of contrast used during this case?

Self-assessment Case Study 2:

- 60 year old female with NSTEMI, diabetes with eGFR of 50 mL/min/1.73m^2 and anemic with hemoglobin 98 g/L.
- Risk of CI-AKI is 12% (High Risk)
- Weight is 56kg
- LVEDP was 9 mmHg during the procedure

- Q4: What is the most effective post-procedure IV fluid regimen to prevent CI-AKI?

Self-assessment Case Study 2:

- Q4: What is the most effective post-procedure IV fluid regimen to prevent CI-AKI?

A) IV NS 50 mL/hr(1 mL/kg/h) x 4 hours
B) IV NS 100 mL/hr x 4-6 hours
C) IV NS 280 mL/hr (5 mL/kg/h) x 4 hours
D) IV NS 168 mL/hr (3 mL/kg/h) x 6 hours

Self-assessment Case Study 2:

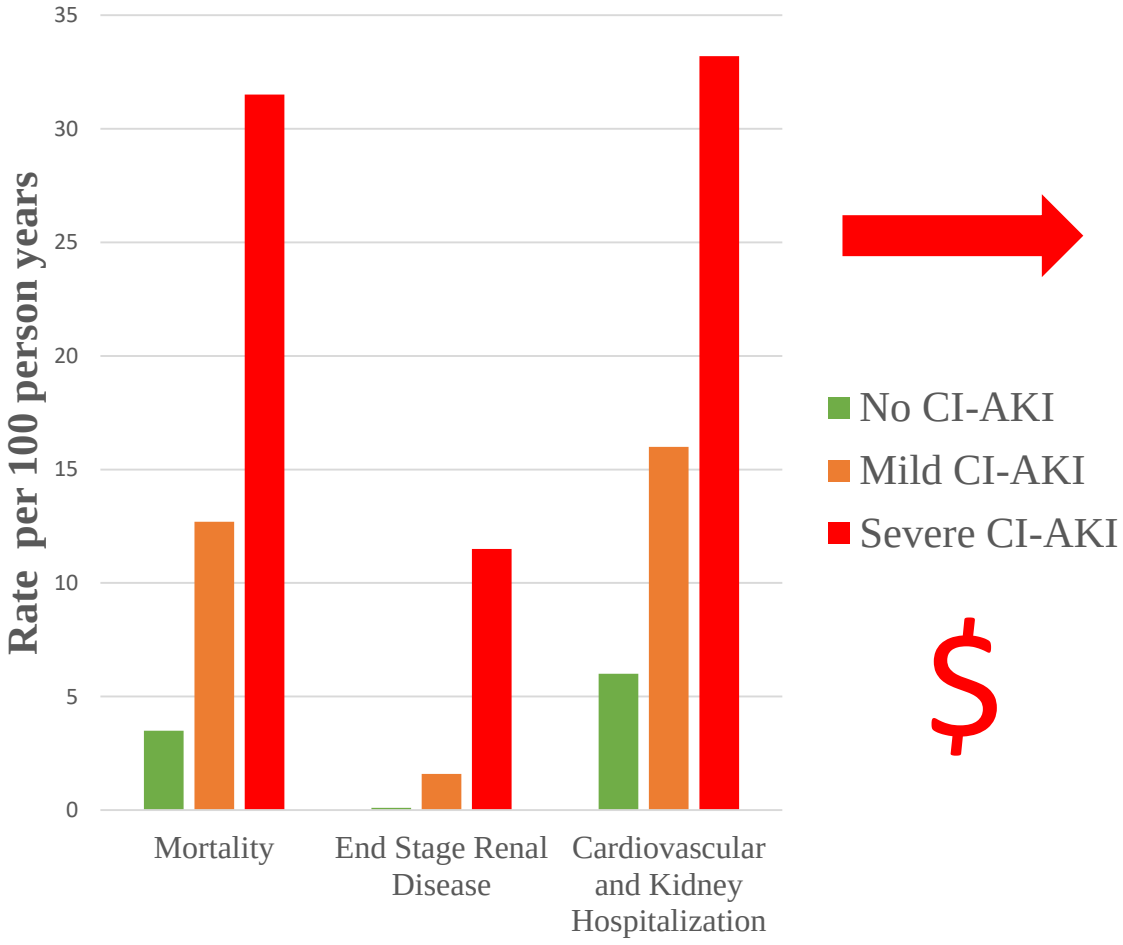
- Q5: When is the recommended time to order a serum creatinine post- procedure to identify patients with CI-AKI?

A) 24 hours
B) 48-72 hours
C) 7 days
D) 30 days

Objectives of the Contrast RISK Project

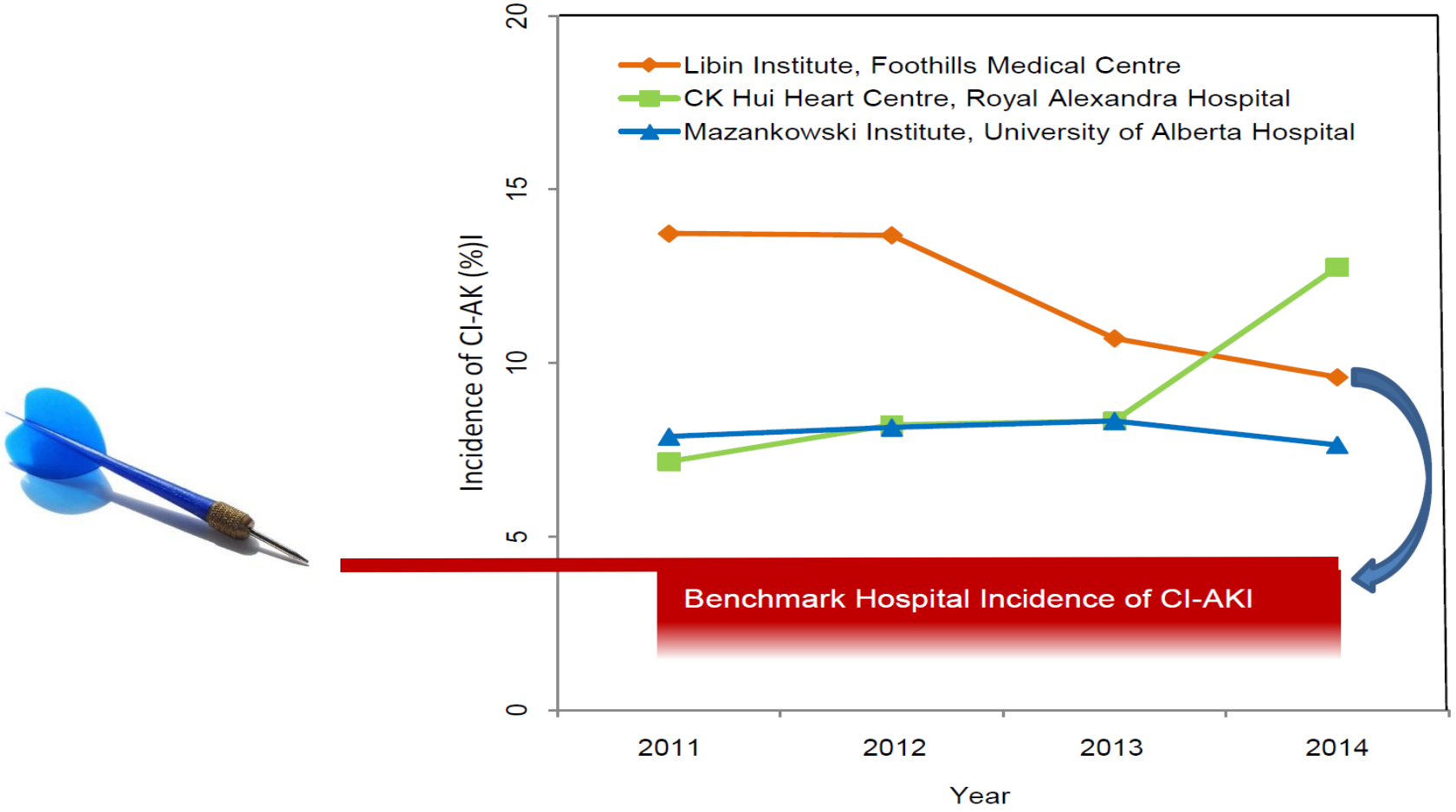
1. Implement automated CI-AKI and dialysis risk assessment in cardiac catheterization / PCI.
2. Provide decision support for CI-AKI prevention, including calculation of safe contrast limits and tailored IV fluid orders according to LVEDP.
3. Support follow-up of high risk patients.
4. Provide audit and feedback of care and outcomes.
5. Evaluate the overall impact of this initiative in Alberta.

Implications of Contrast-Induced AKI in Alberta

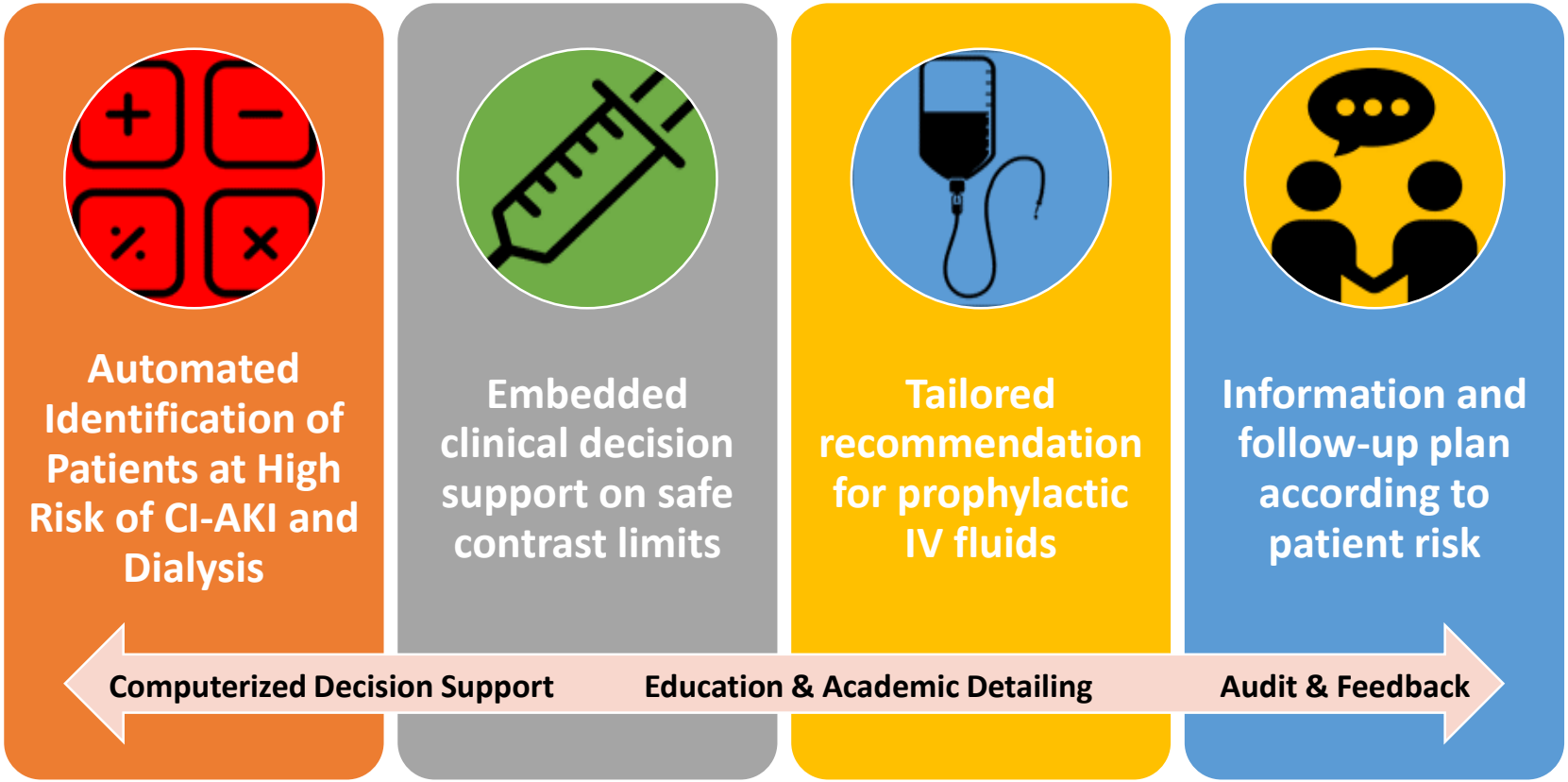


Current state
Annual number of CI-AKI cases after cardiac catheterization in Alberta; n=1,344: Stage 1 (mild) AKI n=1021 Stage 2 (moderate) AKI n=188 Stage 3 (severe) AKI n=94 Dialysis requiring AKI n=40
Annual costs attributable to CI-AKI after cardiac catheterization in Alberta (due to additional time in hospital, consultations, readmissions, and dialysis): Stage 1 (mild) AKI $3.8 million Stage 2 (moderate) AKI $1.1 million Stage 3 (severe) AKI $3.7 million Dialysis requiring AKI $0.9 million
Annual costs attributable to need for ongoing chronic hemodialysis (~30% of all patients who require acute dialysis for CI-AKI don't recovery) n=12 x $80,000 per year = $960,000

Incidence of Contrast-Induced AKI in Alberta



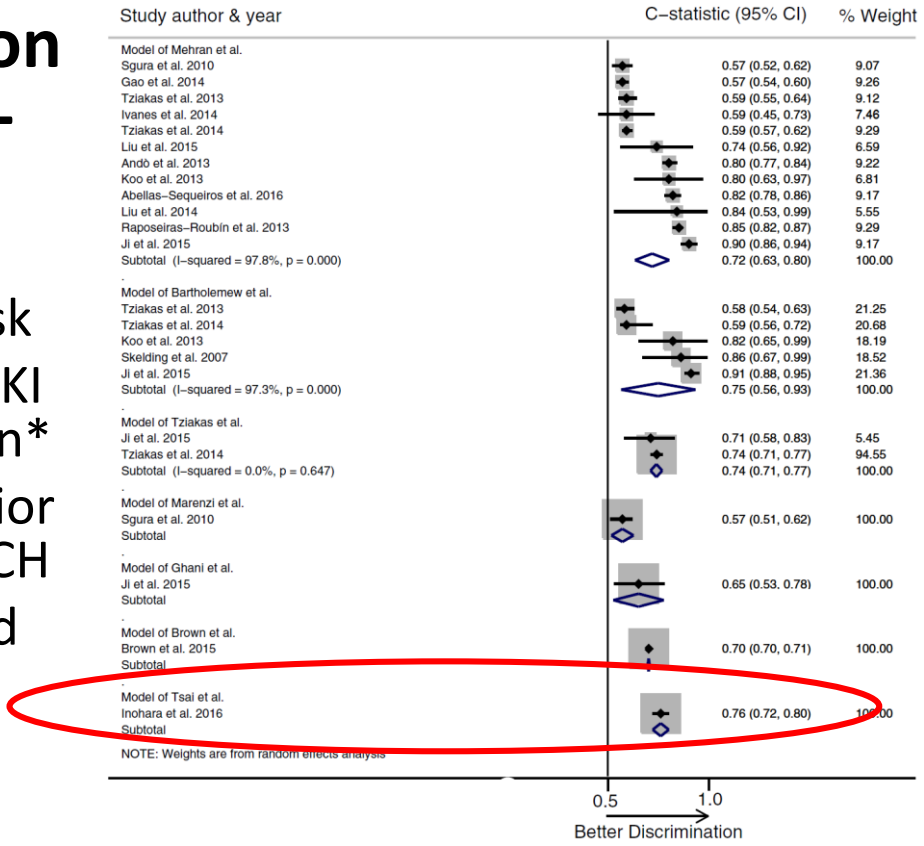
Four Components of the Contrast RISK Project



Risk Assessment

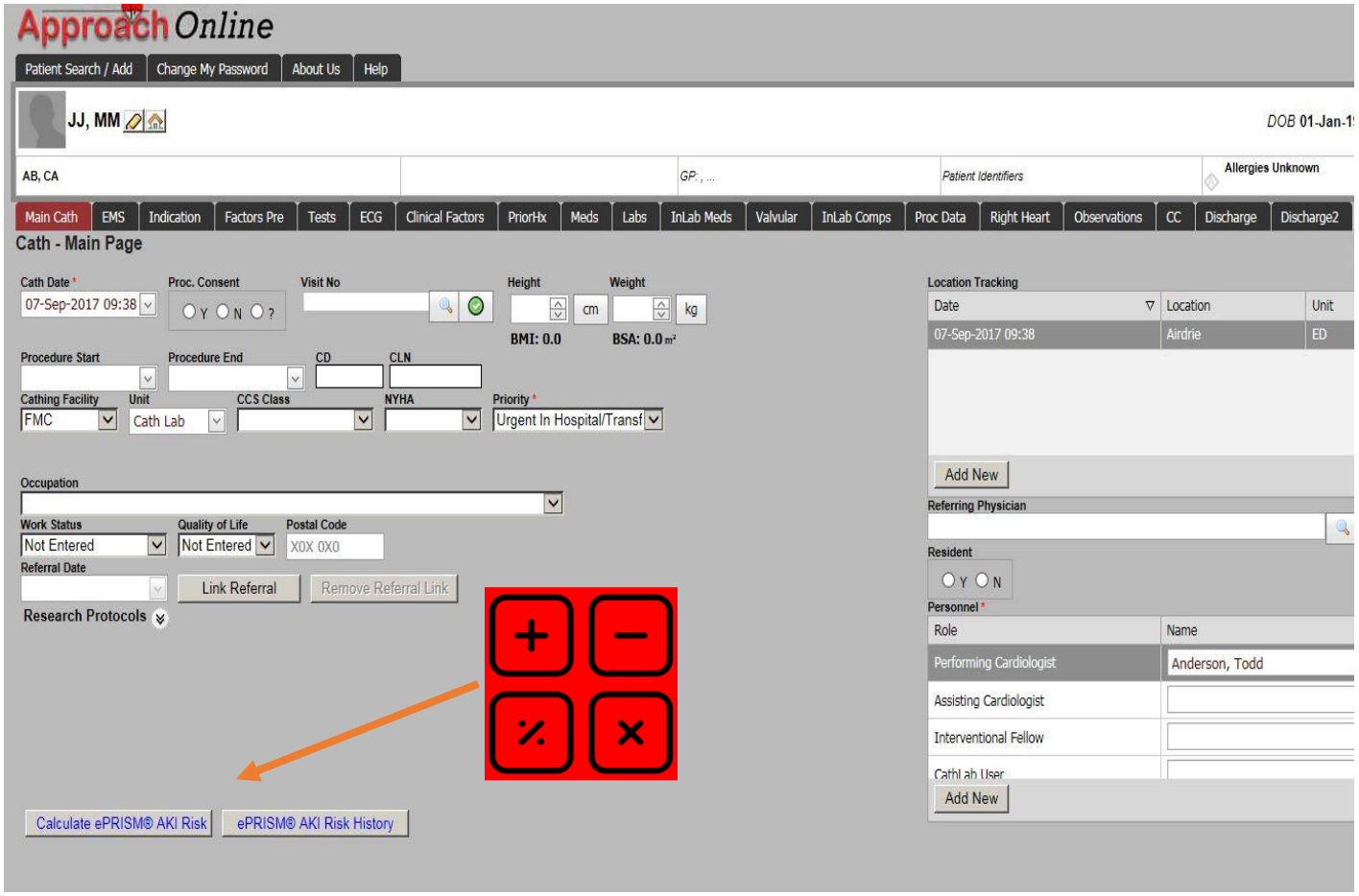
Automated Identification of Patients at Risk of CI-AKI and Dialysis

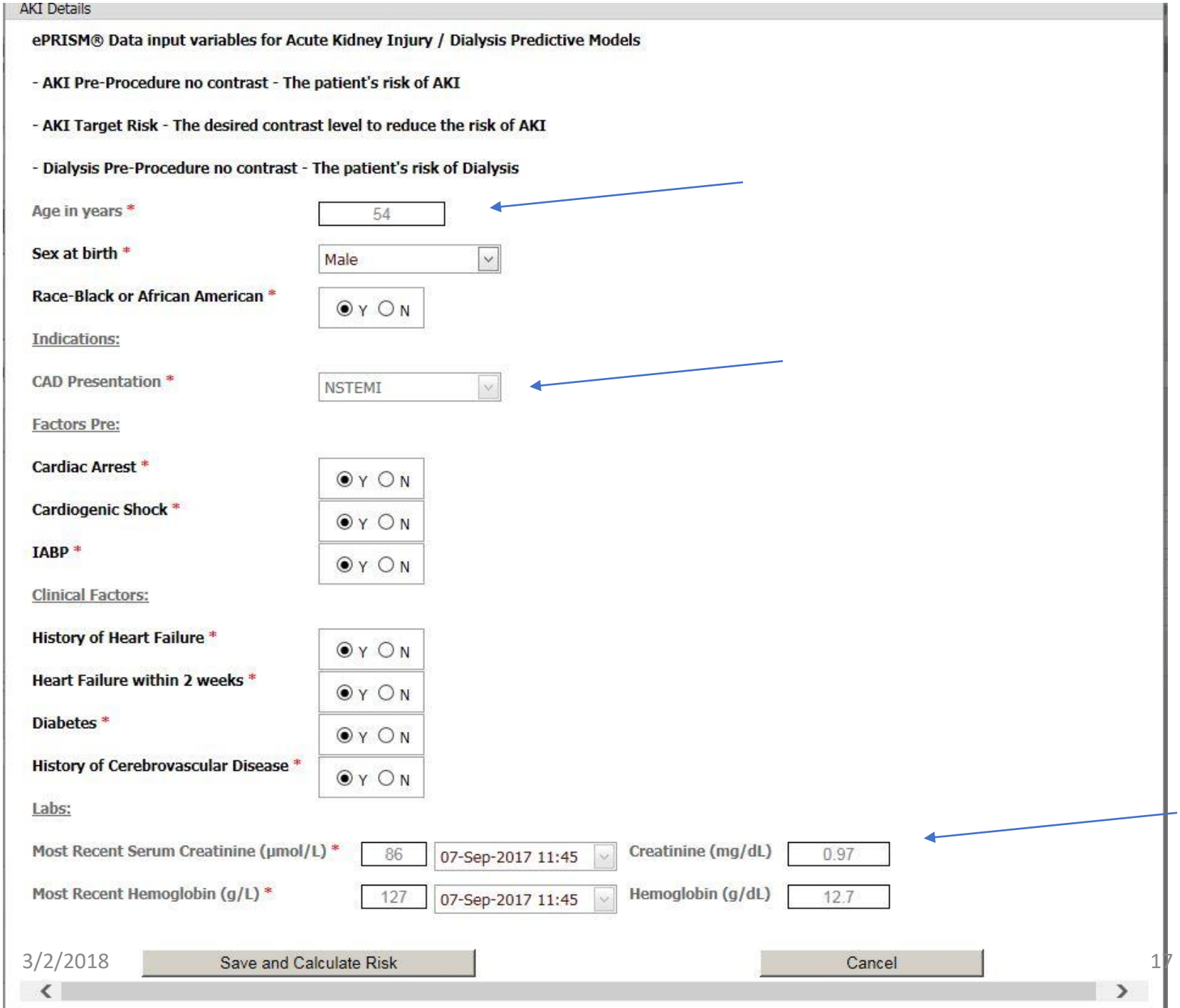
- Accurate and relevant information on patient risk
- Validated models for CI-AKI and dialysis risk prediction*
- Completed immediate prior to cath or PCI in APPROACH
- Primary PCI for STEMI and dialysis patients are excluded

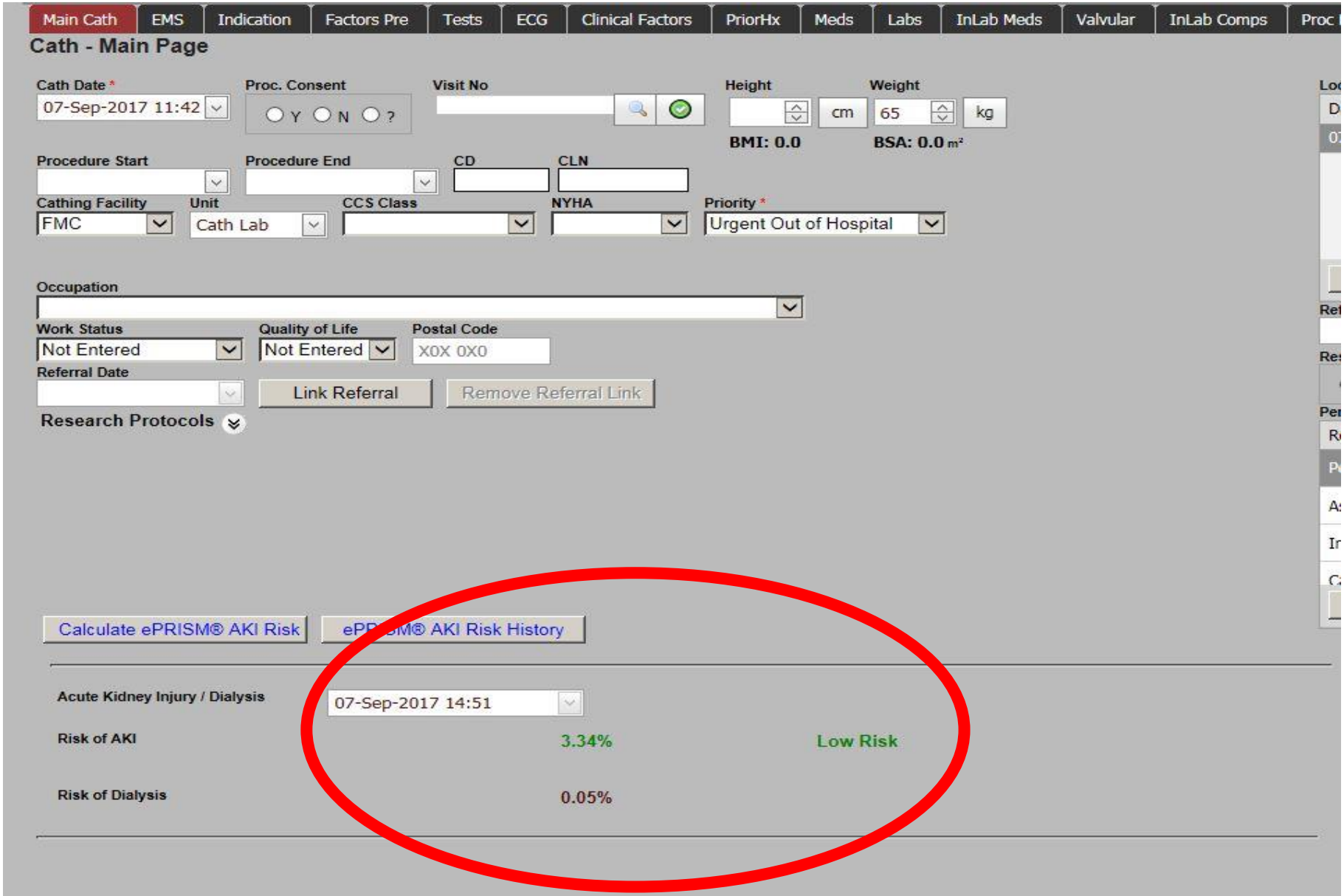


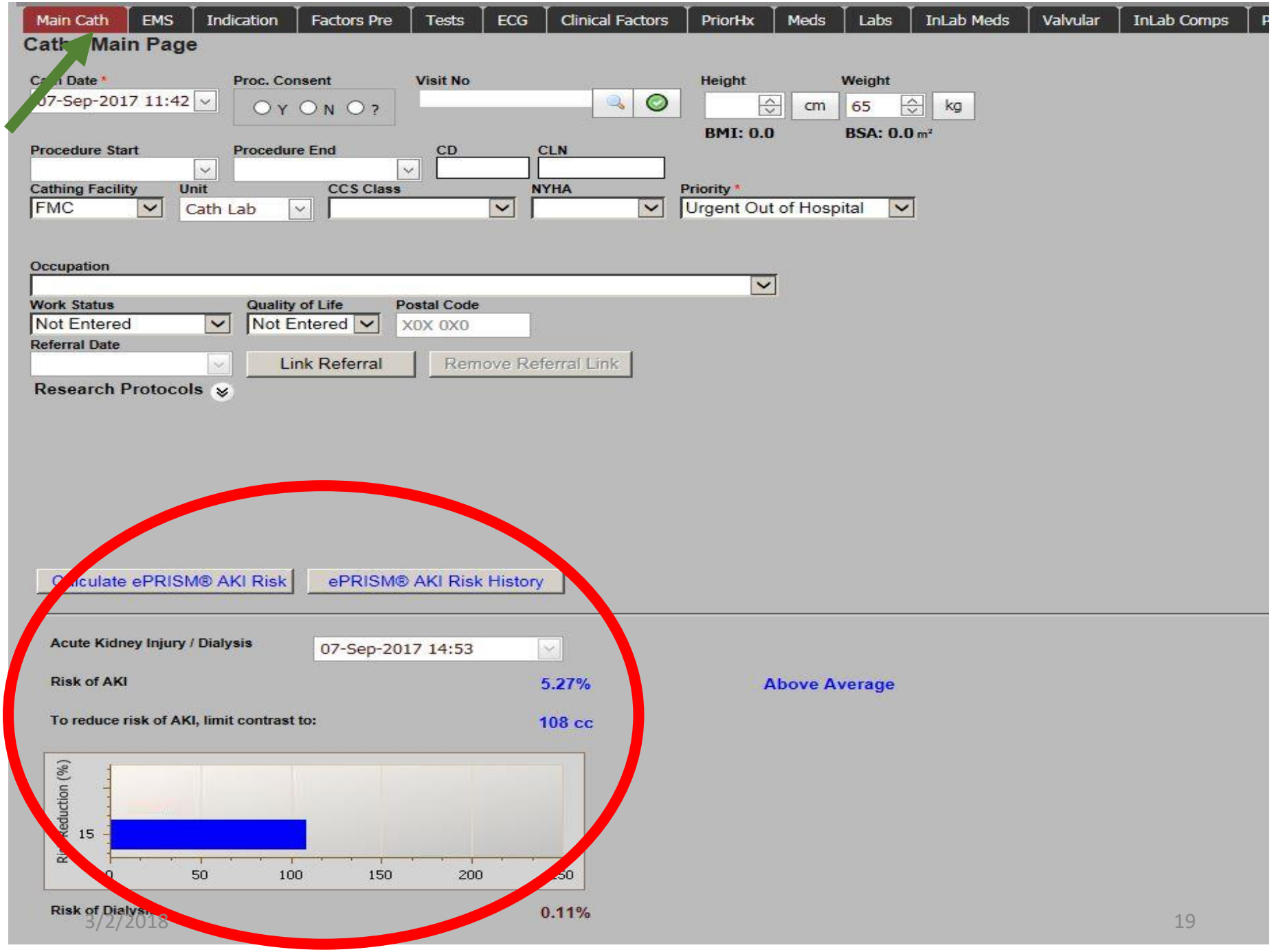
* Tsai T, et al. Validated contemporary risk model of acute kidney injury in patients undergoing percutaneous coronary interventions, JAHA Dec 2014

Risk Assessment




AKI Details
ePRISM® Data input variables for Acute Kidney Injury / Dialysis Predictive Models
- AKI Pre-Procedure no contrast - The patient's risk of AKI
- AKI Target Risk - The desired contrast level to reduce the risk of AKI
- Dialysis Pre-Procedure no contrast - The patient's risk of Dialysis
Age in years *
54
Sex at birth *
Male
Race-Black or African American *
Y N
Indications:
CAD Presentation *
NSTEMI
Factors Pre:
Cardiac Arrest *
Y N
Cardiogenic Shock *
Y N
IABP *
Y N
Clinical Factors:
History of Heart Failure *
Y N
Heart Failure within 2 weeks *
Y N
Diabetes *
Y N
History of Cerebrovascular Disease *
Y N
Labs:
Most Recent Serum Creatinine (µmol/L) *
86
07-Sep-2017 11:45
Creatinine (mg/dL)
0.97
Most Recent Hemoglobin (g/L) *
127
07-Sep-2017 11:45
Hemoglobin (g/dL)
12.7
Save and Calculate Risk
Cancel

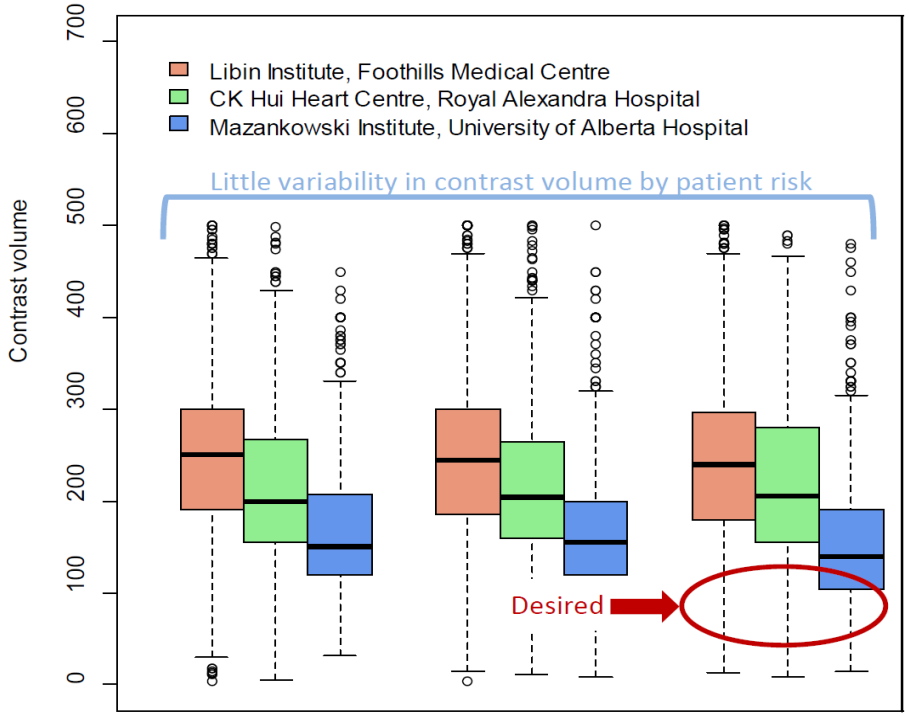

Main Cath
EMS
Indication
Factors Pre
Tests
ECG
Clinical Factors
PriorHx
Meds
Labs
InLab Meds
Valvular
InLab Comps
Cath - Main Page
Cath Date *
07-Sep-2017 11:42
Proc. Consent
Y N ?
Visit No
Height
cm
Weight
65
kg
BMI: 0.0
BSA: 0.0 m²
Procedure Start
Procedure End
CD
CLN
Cathing Facility
FMC
Unit
Cath Lab
CCS Class
NYHA
Priority *
Urgent Out of Hospital
Occupation
Work Status
Not Entered
Quality of Life
Not Entered
Postal Code
X0X 0X0
Referral Date
Link Referral
Remove Referral Link
Research Protocols
Calculate ePRISM® AKI Risk
ePRISM® AKI Risk History
Acute Kidney Injury / Dialysis
07-Sep-2017 14:51
Risk of AKI
3.34%
Low Risk
Risk of Dialysis
0.05%


Main Cath
EMS
Indication
Factors Pre
Tests
ECG
Clinical Factors
PriorHx
Meds
Labs
InLab Meds
Valvular
InLab Comps
Main Page
Proc. Consent
Y N ?
Visit No
Height
Weight
cm
65
kg
BMI: 0.0
BSA: 0.0 m²
Procedure Start
Procedure End
CD
CLN
Cathing Facility
FMC
Unit
Cath Lab
CCS Class
NYHA
Priority *
Urgent Out of Hospital
Occupation
Work Status
Not Entered
Quality of Life
Not Entered
Postal Code
X0X 0X0
Referral Date
Link Referral
Remove Referral Link
Research Protocols
ePRISM® AKI Risk History
Acute Kidney Injury / Dialysis
07-Sep-2017 14:53
Risk of AKI
5.27%
Above Average
To reduce risk of AKI, limit contrast to:
108 cc
Risk reduction (%)
15
50
100
150
200
0.11%

Safe Contrast Volumes

Embedded clinical decision support on safe contrast limits

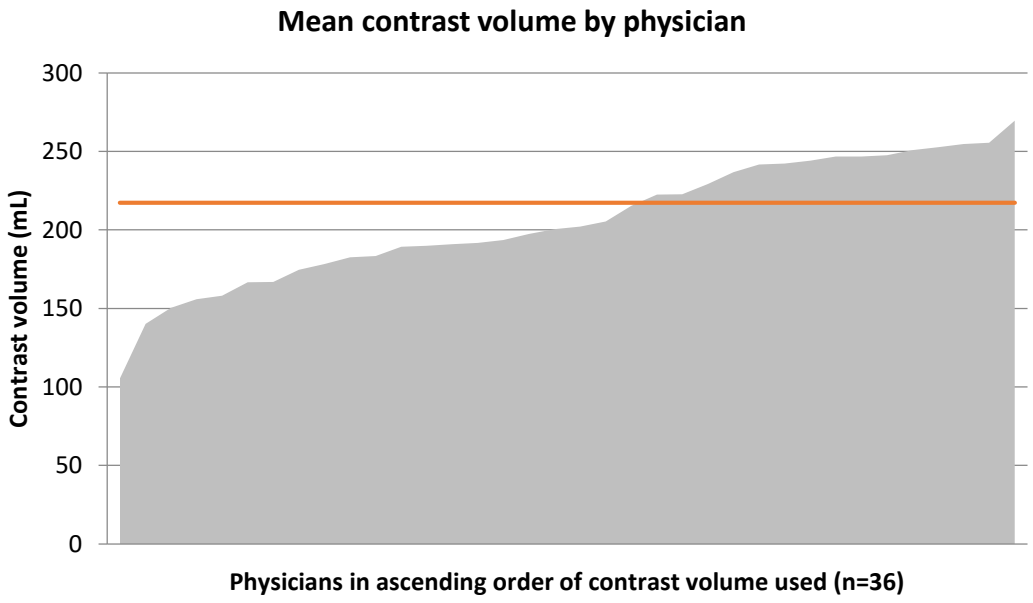
- An additional 45 cc of dye increases the risk of AKI by 15%
- Reducing volume of contrast dye reduce the risk of AKI



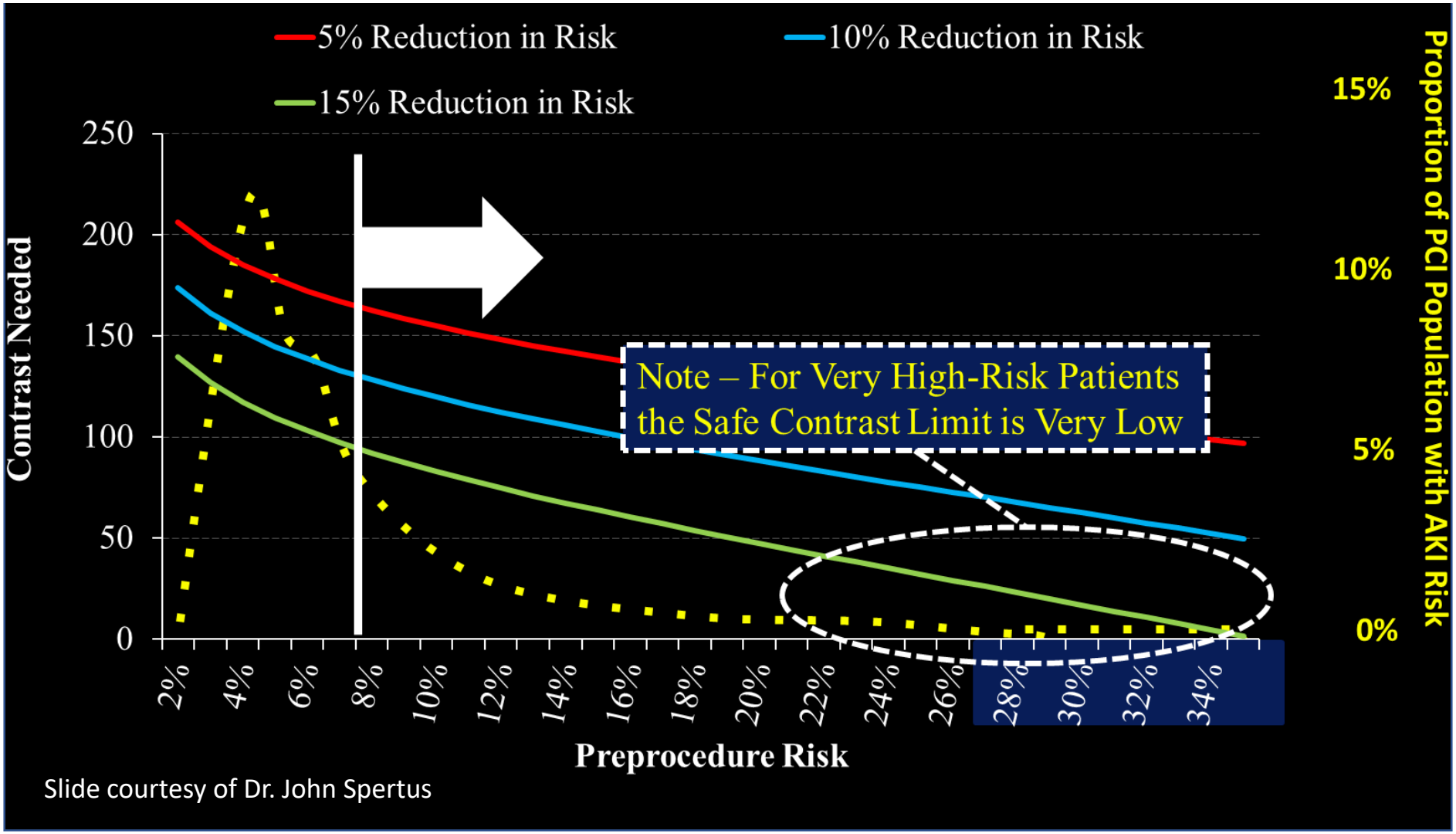
Safe Contrast Volumes

Embedded clinical decision support on safe contrast limits

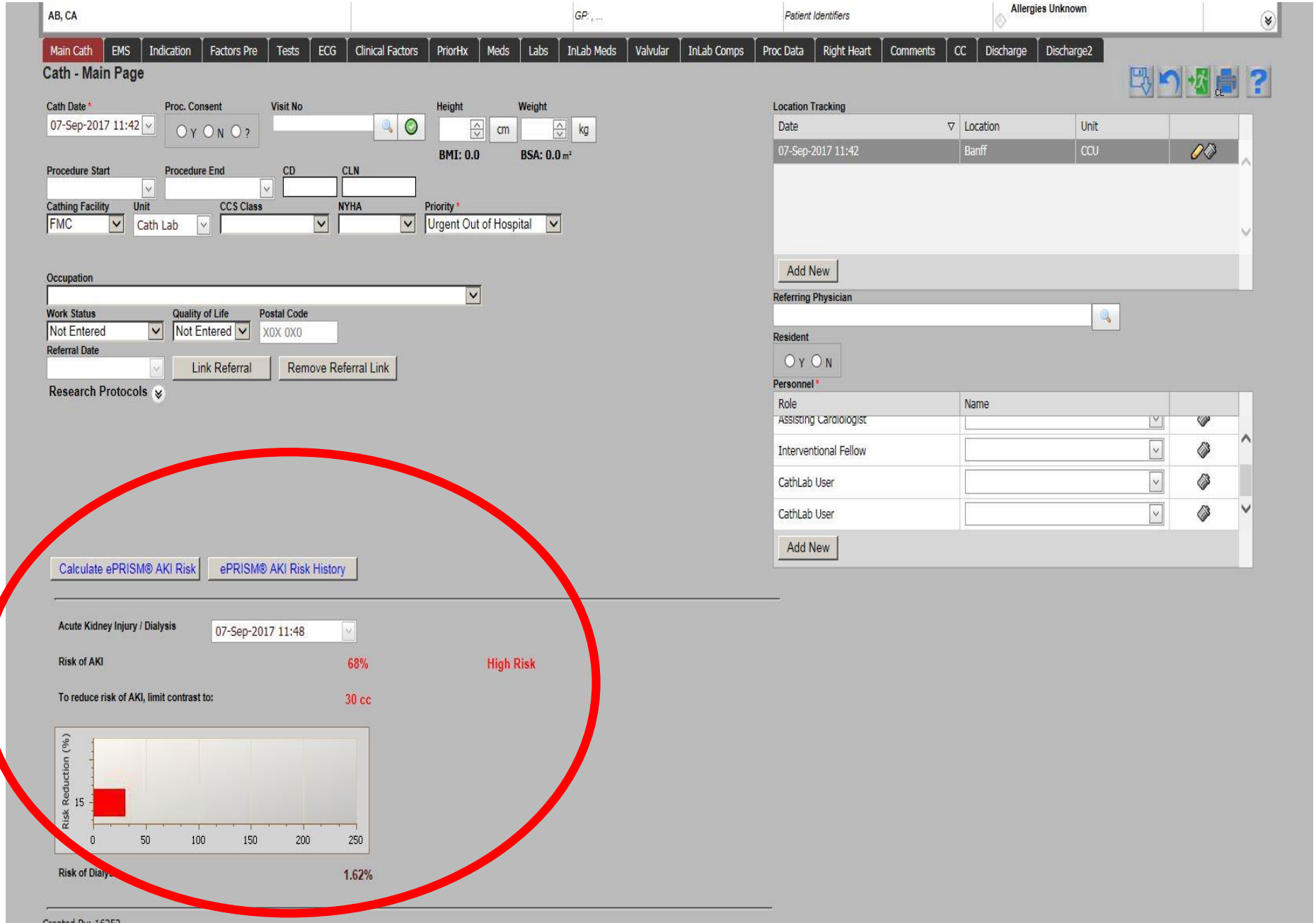
- 23% of variation in contrast volume is attributable to physicians rather than patient characteristics



Safe Contrast Volumes



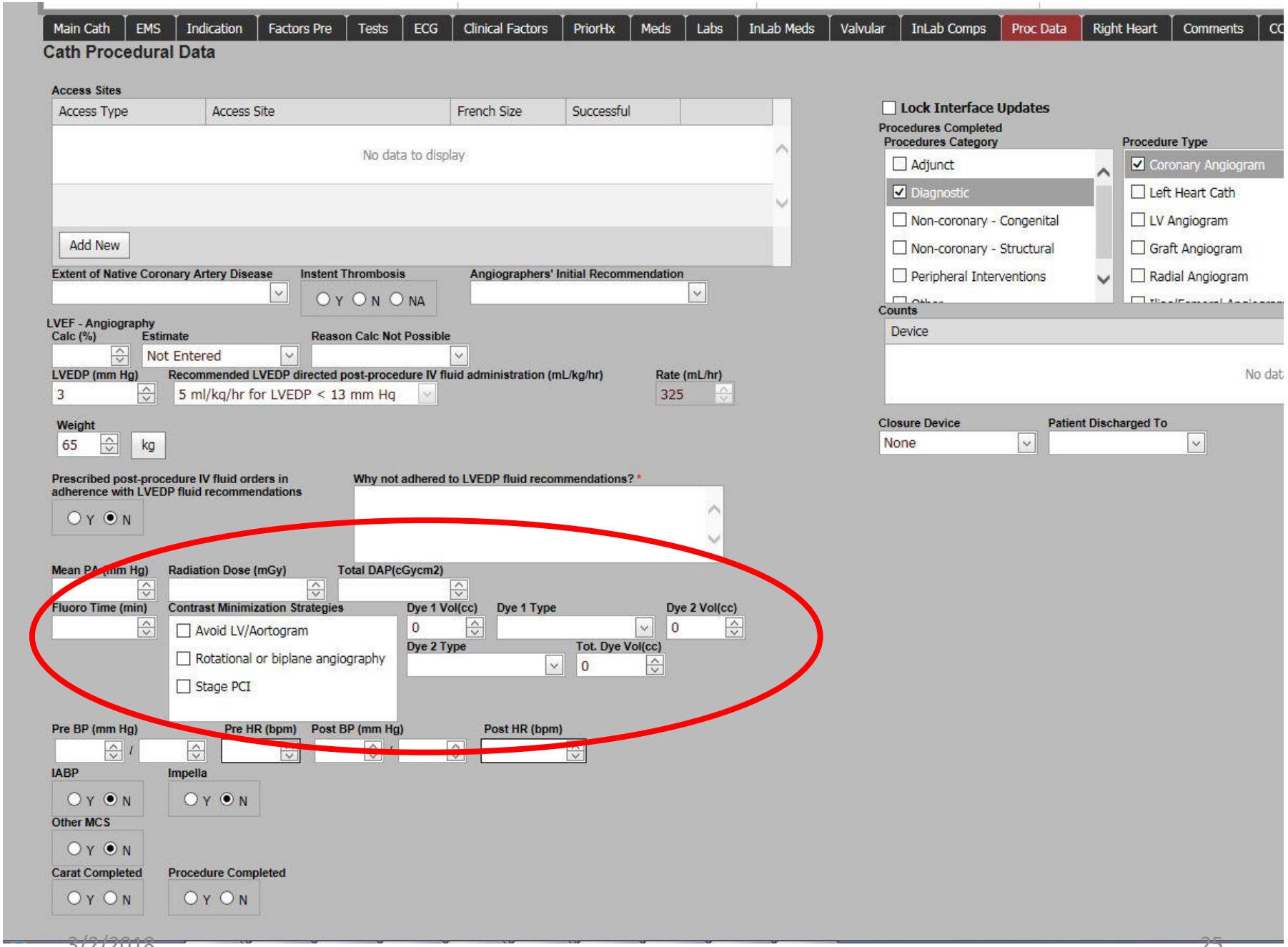
Slide courtesy of Dr. John Spertus


AB, CA
GP: , ...
Patient Identifiers
Allergies Unknown
Main Cath
EMS
Indication
Factors Pre
Tests
ECG
Clinical Factors
PriorHx
Meds
Labs
InLab Meds
Valvular
InLab Comps
Proc Data
Right Heart
Comments
CC
Discharge
Discharge2
Cath - Main Page
Cath Date *
07-Sep-2017 11:42
Proc. Consent
Y N ?
Visit No
Height
cm
Weight
kg
BMI: 0.0
BSA: 0.0 m²
Procedure Start
Procedure End
CD
CLN
Cathing Facility
FMC
Unit
Cath Lab
CCS Class
NYHA
Priority *
Urgent Out of Hospital
Occupation
Work Status
Not Entered
Quality of Life
Not Entered
Postal Code
X0X 0X0
Referral Date
Link Referral
Remove Referral Link
Research Protocols
Location Tracking
Date
Location
Unit
07-Sep-2017 11:42
Banff
CCU
Add New
Referring Physician
Resident
Y N
Personnel *
Role
Name
Assisting Cardiologist
Interventional Fellow
CathLab User
CathLab User
Add New
Calculate ePRISM® AKI Risk
ePRISM® AKI Risk History
Acute Kidney Injury / Dialysis
07-Sep-2017 11:48
Risk of AKI
68%
High Risk
To reduce risk of AKI, limit contrast to:
30 cc
Risk Reduction (%)
15
0
50
100
150
200
250
Risk of Dialy
1.62%
Created By: 16353

Safe Contrast Volumes

Tactics to reduce contrast volume:

- Avoid left ventriculogram
- Use of rotational/biplane angiography
- Consider staging the PCI if contrast limits approached
- Diluting the contrast agent
- Use of a smaller syringe if there is no assistance device
- Avoiding unnecessary test puffs
- Avoiding intracoronary nitroglycerine flush with contrast (or unnecessary ic NTG)


Main Cath
EMS
Indication
Factors Pre
Tests
ECG
Clinical Factors
PriorHx
Meds
Labs
InLab Meds
Valvular
InLab Comps
Proc Data
Right Heart
Comments
Cath Procedural Data
Access Sites
Access Type
Access Site
French Size
Successful
No data to display
Add New
Extent of Native Coronary Artery Disease
Instent Thrombosis
Y N NA
Angiographers' Initial Recommendation
LVEF - Angiography
Calc (%)
Estimate
Not Entered
Reason Calc Not Possible
LVEDP (mm Hg)
3
Recommended LVEDP directed post-procedure IV fluid administration (mL/kg/hr)
5 ml/kg/hr for LVEDP < 13 mm Hg
Rate (mL/hr)
325
Weight
65
kg
Prescribed post-procedure IV fluid orders in adherence with LVEDP fluid recommendations
Y N
Why not adhered to LVEDP fluid recommendations? *
Mean PA (mm Hg)
Radiation Dose (mGy)
Total DAP(cGycm2)
Fluoro Time (min)
Contrast Minimization Strategies
Avoid LV/Aortogram
Rotational or biplane angiography
Stage PCI
Dye 1 Vol(cc)
0
Dye 1 Type
Dye 2 Vol(cc)
0
Dye 2 Type
Tot. Dye Vol(cc)
0
Pre BP (mm Hg)
Pre HR (bpm)
Post BP (mm Hg)
Post HR (bpm)
IABP
Y N
Impella
Y N
Other MCS
Y N
Carat Completed
Y N
Procedure Completed
Y N
Lock Interface Updates
Procedures Completed
Procedures Category
Adjunct
Diagnostic
Non-coronary - Congenital
Non-coronary - Structural
Peripheral Interventions
Procedure Type
Coronary Angiogram
Left Heart Cath
LV Angiogram
Graft Angiogram
Radial Angiogram
Counts
Device
No dat
Closure Device
None
Patient Discharged To

Tailored IV Fluids

3. Tailored recommendations for prophylactic IV fluids

- Administering IV fluids during and after cardiac catheterization according to LVEDP and weight-based strategy reduced the risk of CI-AKI*

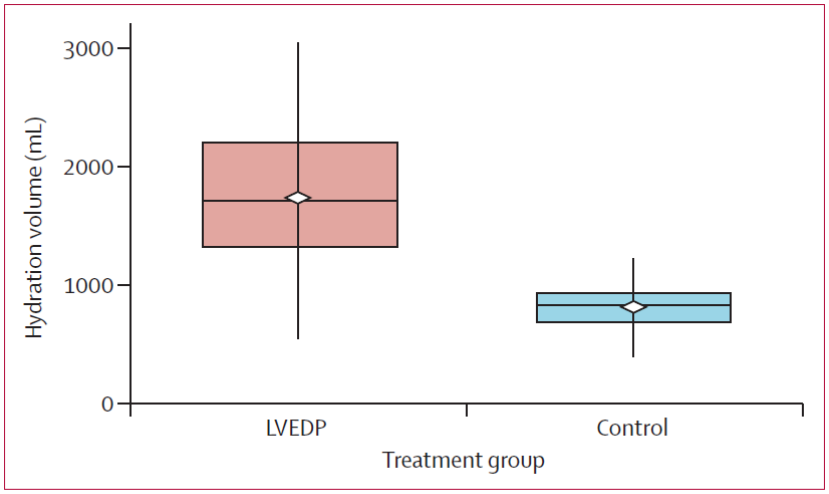


Figure 2: Hydration volumes of normal saline administered in each group

* Brar S, et al. Haemodynamic-guided fluid administration for the prevention of CI-AKI: the POSEIDON randomised controlled trial, Lancet May 2014

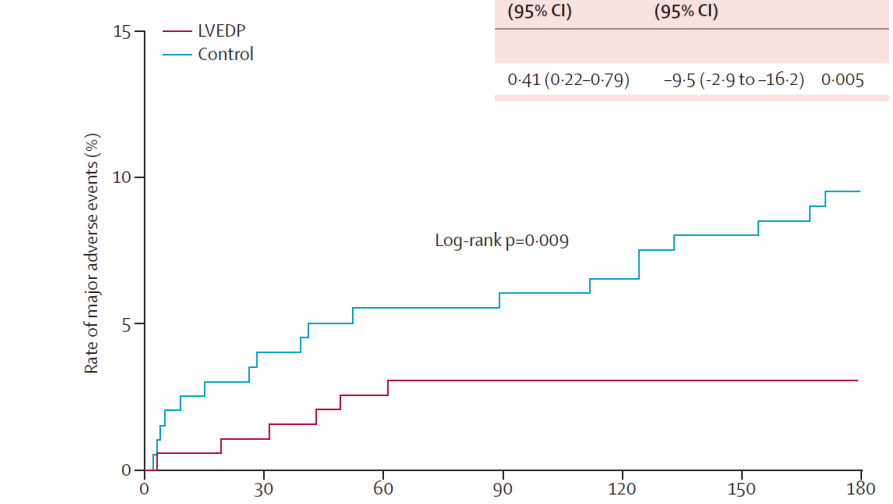
Tailored IV Fluids

3. Tailored recommendations for prophylactic IV fluids

- Administering IV fluids during and after cardiac catheterization according to LVEDP and weight-based strategy reduced the risk of CI-AKI*

	LVEDP hydration-guided group	Control group
Primary endpoint		
>25% or 0·5 mg/dL increase in serum creatinine	12/178 (6·7%)	28/172 (16·3%)

Relative risk (95% CI)	Risk difference (95% CI)	p value
0·41 (0·22–0·79)	−9·5 (-2·9 to −16·2)	0·005



Number at risk							
LVEDP	196	194	191	190	190	190	190
Control	200	192	189	188	187	184	181

* Brar S, et al. Haemodynamic-guided fluid administration for the prevention of CI-AKI: the POSEIDON randomised controlled trial, Lancet May 2014

Main Cath | EMS | Indication | Factors Pre | Tests | ECG | Clinical Factors | PriorHx | Meds | Labs | InLab Meds

Cath Procedural Data

Access Sites

Access Type	Access Site	French Size	Successful
No data to display			

Add New

Extent of Native Coronary Artery Disease

Instent Thrombosis ○ Y ○ N ○ NA

Angiographers' Initial Recommendation

LVEF - Angiography

Calc (%)

Estimate Not Entered

Reason Calc Not Possible

LVEDP (mm Hg) 3

Recommended LVEDP directed post-procedure IV fluid administration (mL/kg/hr) 5 ml/kg/hr for LVEDP < 13 mm Hg

Rate (mL/hr) 325

Weight 65 kg

Prescribed post-procedure IV fluid orders in adherence with LVEDP fluid recommendations ○ Y ◉ N

Why not adhered to LVEDP fluid recommendations? *

Mean PA (mm Hg)

Radiation Dose (mGy)

Total DAP(cGycm2)

Fluoro Time (min) 3/2/2018

Contrast Minimization Strategies ☐ Avoid LV/Aortogram

Dye 1 Vol(cc) 0

Dye 1 Type

Dye 2 Vol(cc) 0

Dye 2 Type

Tot. Dye Vol(cc)

Follow-up & Monitoring

Information and follow-up plan for patients at increased CI-AKI risk

- Instructions for patients to ensure adequate hydration
- Follow up laboratory test order / requisition for serum creatinine and electrolytes at 48-72 hours after procedure
- Link to Alberta Chronic Kidney Disease clinical pathway for follow-up of patients with persistent reduction in kidney function

Follow-up & Monitoring

Alberta Health Services

Contrast RISK Reducing Injury Sustained by Kidneys

Patient Information After X-Ray Contrast Administration

Date: _____

Dear Patient:

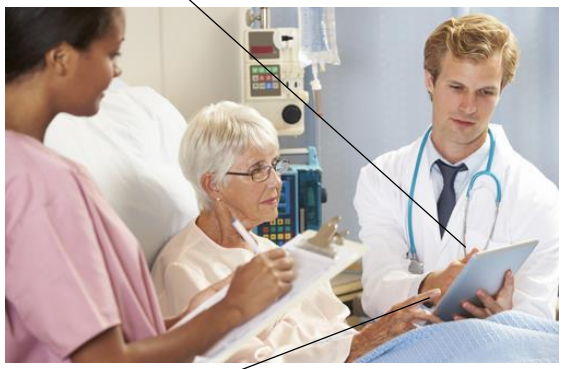
Today you received an x-ray contrast media (dye) during your heart procedure.

You are at risk for a drop in your kidney function due to this dye.

For this reason, you have been given a laboratory requisition to have a blood test in 2-3 days from today to check your kidney function. The results of this test will be sent to your doctor (usually your family doctor).

You can take the following steps to minimize the effects of the dye on your kidneys:

1. Drink plenty of clear fluids (6-8 glasses of water per day) on the day of and 2 days following your procedure, unless otherwise directed by your doctor who did your procedure.
2. Please take the laboratory requisition to a laboratory of your choice in 2 to 3 days from today to have blood work drawn to check your kidney function
3. Follow-up with your family doctor to review your blood work to determine whether there has been any changes to your kidney function.
4. If you have any concerns or are feeling unwell in any way, please contact your family doctor.



Follow-up & Monitoring

Contrast RISK Reducing Injury Sustained by Kidneys

Alberta Health Services

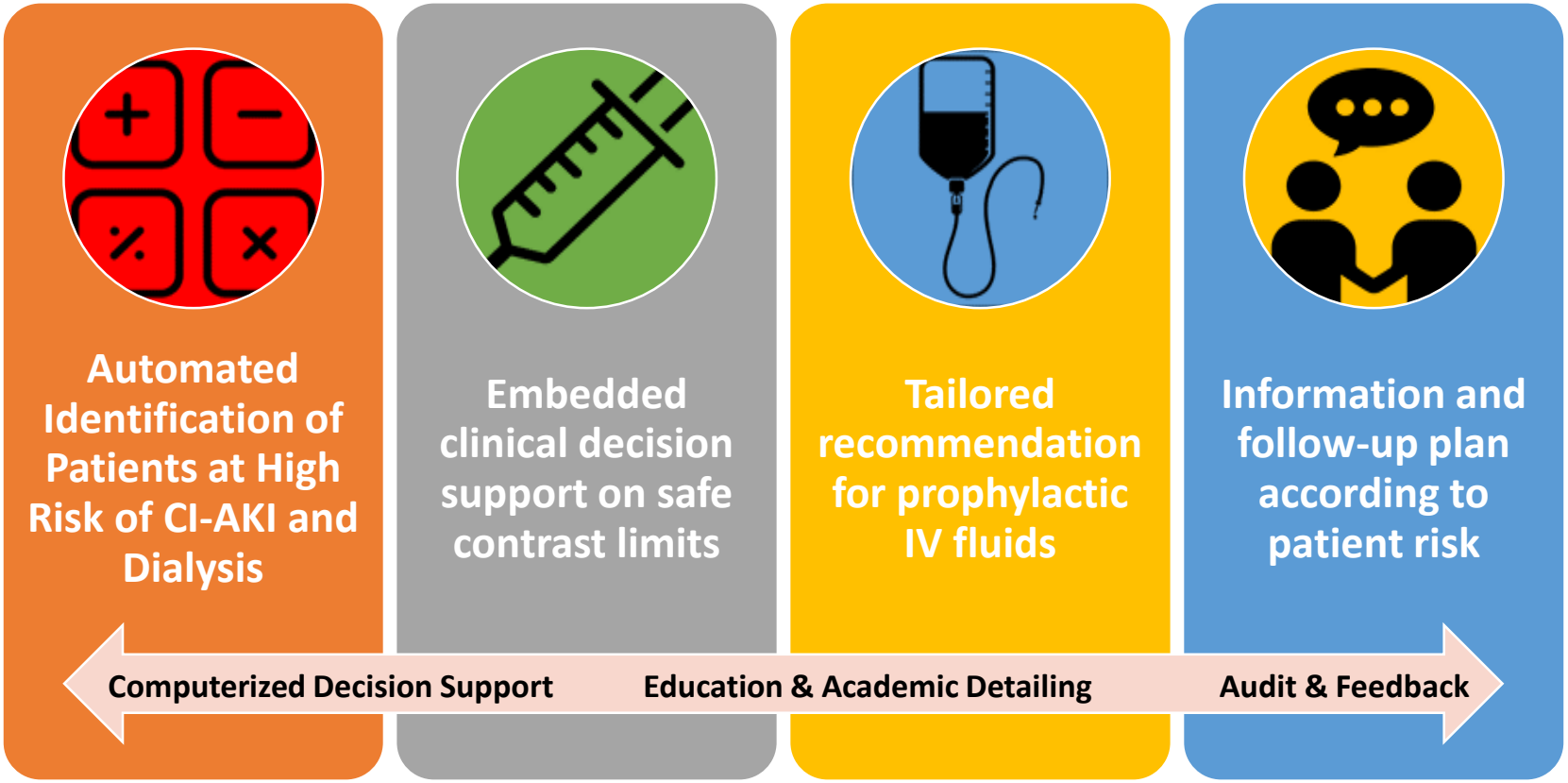
Patient Identifier

Physician Name: _____
Physician Phone: _____ Fax: _____

Your patient received cardiac catheterization on _____ (date) and was identified as being at risk of contrast-induced acute kidney injury.

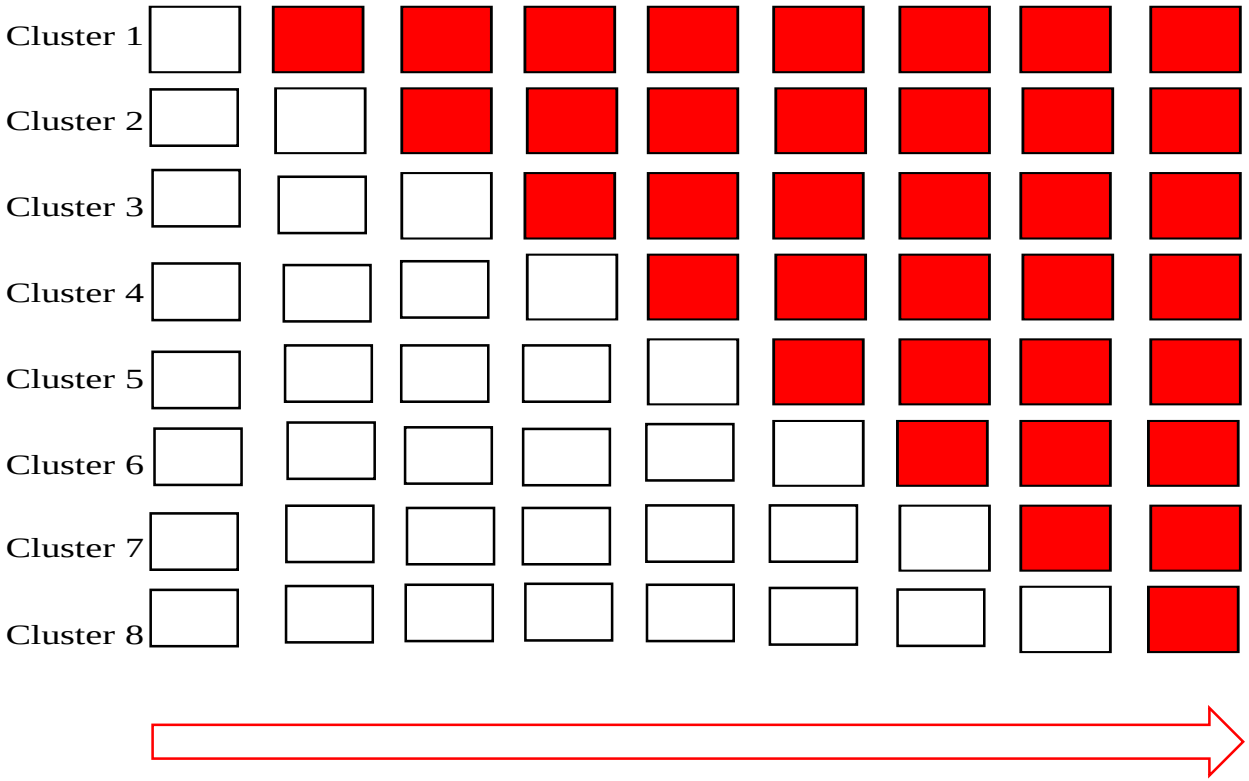
Your patient has been given a requisition for a serum creatinine level to be checked 2 to 3 days after the procedure and these results will be sent to you. It has been recommended to your patient that they see you within a week after their procedure, including follow-up of their kidney function.

Information and the management and referral of patients identified with kidney disease can be found on the Alberta online chronic kidney disease clinical pathway at:
www.diagnoseckd.ca


Automated Identification of Patients at High Risk of CI-AKI and Dialysis
Embedded clinical decision support on safe contrast limits
Tailored recommendation for prophylactic IV fluids
Information and follow-up plan according to patient risk
Computerized Decision Support
Education & Academic Detailing
Audit & Feedback

Electronic Decision Support Tool Integration with the Time and Place of Decision Making

Physician Clusters Stepped In Over Time



Audit and Feedback Report

Report process measures and outcomes to physicians and catheterization lab for patients at risk of CI-AKI:

- Contrast volume
- IV fluid use
- AKI incidence

Self-assessment Case Study 1:

- 75 year old male with diabetes and chronic kidney disease is hospitalized with a NSTEMI complicated by heart failure.
- Baseline creatinine = 300 µmol/L (eGFR = 17 mL/min/1.73m^2)

- Q1: What is this patients risk of CI-AKI?
- Q2: What is this patient's safe contrast limit to reduce his risk of CI-AKI?

Self-assessment Case Study 1:

- This patient's estimated risk of AKI is 28% (High Risk).

- Completing the case within this patient's safe contrast limit of 52 cc will reduce this patients risk of AKI by 15%.

Self-assessment Case Study 1:

- 75 year old male with diabetes and chronic kidney disease is hospitalized with a NSTEMI complicated by heart failure.
- Baseline creatinine = 300 µmol/L (eGFR = 17 mL/min/1.73m^2)
- CI-AKI risk 28%
- Safe contrast limit 52cc

- Q3: What procedural tactics can be used to reduce the volume of contrast used during this case?

Self-assessment Case Study 1:

- Biplane or rotational angiography conducted
- LV angiogram was not conducted (hypokinetic anterior wall was identified by echocardiogram)
- Staged PCI of non-culprit lesion performed
- Unnecessary contrast puffs and flushes avoided
- Diluted the contrast agent

Self-assessment Case Study 2:

- 60 year old female with NSTEMI, diabetes with eGFR of 50 mL/min/1.73m^2 and anemic with hemoglobin 98 g/L.
- Risk of CI-AKI is 12% (High Risk)
- Weight is 56kg
- LVEDP was 9 mmHg during the procedure

- Q4: What is the most effective post-procedure IV fluid regimen to prevent CI-AKI?

Self-assessment Case Study 2:

- Q4: What is the most effective post-procedure IV fluid regimen to prevent CI-AKI?

A) IV NS 50 mL/hr(1 mL/kg/h) x 4 hours
B) IV NS 100 mL/hr x 4-6 hours
C) IV NS 280 mL/hr (5 mL/kg/h) x 4 hours
D) IV NS 168 mL/hr (3 mL/kg/h) x 6 hours

Self-assessment Case Study 2:

- Q4: What is the most effective post-procedure IV fluid regimen to prevent CI-AKI?

A) IV NS 50 mL/hr(1 mL/kg/h) x 4 hours

B) IV NS 100 mL/hr x 4-6 hours

C) IV NS 280 mL/hr (5 mL/kg/h) x 4 hours ⬅

D) IV NS 168 mL/hr (3 mL/kg/h) x 6 hours

Self-assessment Case Study 2:

- Q5: When is the recommended time to order a serum creatinine post- procedure to identify patients with CI-AKI?

A) 24 hours
B) 48-72 hours
C) 7 days
D) 30 days

Self-assessment Case Study 2:

- Q5: When is the recommended time to order a serum creatinine post- procedure to identify patients with CI-AKI?

A) 24 hours

B) 48-72 hours ⬅

C) 7 days

D) 30 days

References

1. James MT, Ghali WA, Knudtson ML, Ravani P, Tonelli M, Faris P, Pannu N, Manns BJ, Klarenbach SW, Hemmelgarn BR. Associations between acute kidney injury and cardiovascular and renal outcomes after coronary angiography. Circulation 2011;123:409-416.
2. Allen DW, Ma B, Leung KC, et al. Risk Prediction Models for Contrast-Induced Acute Kidney Injury Accompanying Cardiac Catheterization: Systematic Review and Meta-analysis. *Canadian Journal of Cardiology*. 2017. doi:10.1016/j.cjca.2017.01.018.
3. Tsai TT, Patel UD, Chang TI, et al. Validated Contemporary Risk Model of Acute Kidney Injury in Patients Undergoing Percutaneous Coronary Interventions: Insights From the National Cardiovascular Data Registry Cath-PCI Registry. *Journal of the American Heart Association*. 2014;3(6). doi:10.1161/jaha.114.001380.
4. Brown JR, Solomon RJ, Sarnak MJ, et al; Northern New England Cardiovascular Disease Study Group. Reducing contrast-induced acute kidney injury using a regional multicenter quality improvement intervention. *Circ Cardiovasc Qual Outcomes*. 2014;7(5):693-700.
5. Shafiq A, Pokarel Y, Qintar M, Kennedy K, Spertus JA, Amin AP. A novel method for estimating the optimal contrast amount needed to minimize acute kidney injury after percutaneous coronary intervention [abstract 110]. *Circ Cardiovasc Qual Outcomes*. 2016;9:A110.
6. Minsinger KD, Kassis HM, Block CA, Sidhu M, Brown JR. Meta-analysis of the Effect of Automated Contrast Injection Devices versus Manual Injection and Contrast Volume on Risk of Contrast Induced Nephropathy. *The American journal of cardiology*. 2014;113(1):49-53. doi:10.1016/j.amjcard.2013.08.040.
7. Brar SS, Aharonian V, Mansukhani P, Moore N, Shen AYJ, Jorgensen M, Dua A, Short L, Kane, K. Haemodynamic-guided fluid administration for the prevention of contrast-induced acute kidney injury: the POSEIDON randomised controlled trial. *The Lancet*. 2014;383(9931):1814-1823. doi:10.1016/S0140-6736(14)60689-9.
8. Kidney Disease: Improving Global Outcomes (KDIGO). Acute kidney injury work group. KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl 2012; 2: 1–138.

Contact us:

Need Help after today?

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Do you have any questions or comments?

- If you have questions or comments regarding APPROACH, please email them at support@approach.org and in the subject line put: *AHS QA for AKI*