Acute Kidney Injury (AKI) and Hypotension in Total Elective Joints

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St. Luke's UNIVERSITY HOSPITAL
BETHLEHEM
Total Joint Arthroplasty

- By 2030, total knee replacement surgeries are expected to increase by 673%.

- Across the United States, over 700,000 knee replacements and 400,000 hip replacements are performed every year.

- The incidence of this procedure is projected to increase exponentially -- Aging population and the Affordable Care Act (ACA).

- AKI in Orthopedic patients is associated with increased morbidity and mortality.
Identifying A Problem

- St. Luke’s Orthopedic Care performs 1000 arthroplasty cases per year
- Non-Narcotic pain regimen implemented to decrease post-operative complications
- Acute Kidney Injury (AKI) and Hypotension rates noted to increase
- No protocols in place to prevent or deal with this issue
Orthopedic Acute Kidney Injury (AKI)

<table>
<thead>
<tr>
<th>Publication</th>
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<tbody>
<tr>
<td>Nephrology; 2018</td>
<td>7.5%</td>
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<td>BMC Nephrology; 2015</td>
<td>6.8%</td>
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<tr>
<td>Acta Orthopedica Belgica; 2015</td>
<td>9.7%</td>
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<tr>
<td>Clinical Kidney Journal; 2015</td>
<td>15.0%</td>
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<tr>
<td>British Journal of Anesthesia; 2017</td>
<td>9.4%</td>
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AVERAGE AKI RATE = 9.7%
Orthopedic AKI

Post-Operative AKI Complications

- Increased Mortality (short and long term)
- Increased CV Morbidity
- Increased Costs
- Increased Readmissions
- Decrease rate of discharged home
- Increased LOS
Mortality up to 37%
Defining AKI

- **Diagnosis:** KDIGO criteria
- **Defining Factors:** Serum Creatinine and Urine Output

<table>
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<tr>
<th>Stages of AKI</th>
<th>Hazard Ratio</th>
<th>Creatinine</th>
<th>Urine Output</th>
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<tr>
<td>AKI 1</td>
<td>1.46</td>
<td>1.5-1.9x / &gt;/= 0.3</td>
<td>&lt;0.5ml/kg/h/6h</td>
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<tr>
<td>AKI2</td>
<td>2.08</td>
<td>2.0-2.9x</td>
<td>&lt;0.5ml/kg/h/12h</td>
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<td>AKI 3</td>
<td>2.77</td>
<td>3.0x or Cr &gt;/=4.0 or HD</td>
<td>&lt;0.3ml/kg/h/24h or anuria &gt;24h</td>
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</table>

1 Year Survival: **1.28 Hazard Ratio**

**AKI is associated with DEATH!**
AKI Impact

- LOS
- Mortality
- Discharge to SNF
- Incidence of CKD

- 7-15%
- **Under-reporting**
- **Criteria defining AKI**
- **Lack of routine surveillance**

**AKI Severity**

<table>
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<th>Stage</th>
<th>Cost</th>
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<td>1</td>
<td>$2900</td>
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<td>2</td>
<td>$4900</td>
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<tr>
<td>3</td>
<td>$5300</td>
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<tr>
<td>3+ Dialysis</td>
<td>$11,000</td>
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</table>
AKI – Prevention & Early Detection is Key

Intervening on High Risk patients should occur

Intra-op Hypotension, One dose of NSAID

Failure to recognize first insult can result in progressive CKD or need for RRT
Reducing the incidence of Acute Kidney Injury in the Elective Total Joint Population
Project Scope

- **Population:** Elective Total Hip and Total Knee Arthroplasty
- **Problem:** 12% complication rate for Total Hip and Total Knee Arthroplasty
  - Hypotension 14.54%
  - Acute Renal Failure (AKI) 6.02% versus top decile of 2.03%
- **Evidence:**
  - Increased risk for hospital mortality
  - Increased length of stay
  - Discharge to long term care
  - Increased costs
Identified Causes

**Human**
- Long term use of NSAID’s/ACE’s/ARB’s
- Providers unaware of AKI and Hypotension prevalence
  - Providers unfamiliar with KDIGO criteria
- Patient co-morbidities
  - Hypovolemia after surgery

**Technology**
- No decision support mechanisms for low GFR and NSAID’s when ordered
- No prompt in Epic to order post-operative BMP consistently
- Nursing protocol for post-operative hypotension not available in EPIC
- Lacking nursing post-operative fluid hydration protocol

**Environment**
- Lack GFR report to identify patients at risk for AKI post operatively
- No defined process to order nephrology consults pre-operatively

**Process**
- Lack effective process in PAT for ordering pre-operative IV fluids

**Elective Total Joint (Hip and Knee) patient’s experiencing high Acute Kidney Injury and Hypotension rates compared to the Peer**
Where Do We Begin?

Pre-op Optimization

Inpatient

Discharge/Transition of Care
**Perioperative/Inpatient Workflow**

**Elective Ortho AKI Protocol**
- Discontinue ACE/ARBs/NSAIDs/Diuretics
- Consider pre-op IVF hydration.
- Adjust BP hold parameters for SBP < 130 except for beta blockers
- Complete a Nephrology pre-op outpt referral for patients with a GFR < 45
  - Inpt Nephrology consult generated for patient with GFR of 46-59 or any AKI even within the last 3 months.
  - Enter a signed and held order for Nephrology consult post-op
- **Refer to SOC-AKI Risk Evaluation Algorithm for further detailed management**

**Pre-op recommendations will include**

**Order Sets, Tasks, BPA’s**

**Ambulatory**
- Patient is deemed a surgical
  - Case Request is entered and patient is sent to SOC for further optimization
  - CMP is ordered, medications reviewed by Surgeon and SOC MD

**Pre/intra/Post-op**
- Pre-op BMP collected at time of arrival in ASC
  - No NSAID’s will be given throughout the perioperative
  - MAP should be maintained >55 for the duration of the procedure. Notification in EPIC.

**Ortho**
- Ortho will utilize post-op orders sets for hip/hemiarthroplasty and knee arthroplasty
  - *Epic will ask if patient is emergent versus elective in the hip/hemiarthroplasty order set*

**Initiate Nurse Hypotension Protocol order using post op order set for Hip and Knee TIA.
  - If SBP ≤ 100, RN will receive a BPA to initiate the Non-Selective Ortho Hypotension Protocol, notify anesthesia

**Med Reconciliation**
- ACE/ARB’s and Diuretics, will be held for at least 48 hours and re-evaluated after that time by Orthopaedics
  - RN/Providers receive BPA to hold NSAIDs for GFR < 60

**Inpatient/Discharge**
- Daily BMP x3 beginning on POD 1
  - If SBP < 100, RN will initiate the Elective Ortho Hypotension Protocol within first 24 hours after surgery
    - Notify attending at initiation
  - IVF should continue until POD 1. They should not be stopped no earlier, per protocol.

**Patient is discharged home/SNF/ARC/HH**

**Order Sets, BPA’s**

**St. Luke’s University Hospital - Bethlehem**
Pre Operative Phase of Care
Ortho office
- staff can use an order set to enter the case request
- tasks for the Pre-Admission Testing dept
- orders to be carried out Pre Op on the day of surgery
Surgical Optimization Risk Evaluation
Pre-Operative Tasks
AKI Risks – Task Build

- GFR lab results trigger tasks for the SOC
- Procedure Pass:

<table>
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<tr>
<th></th>
<th>Value</th>
<th>Reference Range</th>
<th>Unit</th>
<th>Status</th>
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<td>Alkaline Phosphatase</td>
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<td>55 - 165</td>
<td>U/L</td>
<td>Final</td>
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<tr>
<td>Total Protein</td>
<td>7.1</td>
<td>6.4 - 8.9</td>
<td>g/dL</td>
<td>Final</td>
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<tr>
<td>Albumin</td>
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<td>3.5 - 5.7</td>
<td>g/dL</td>
<td>Final</td>
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<tr>
<td>Total Bilirubin</td>
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<td>0.20 - 1.00</td>
<td>mg/dL</td>
<td>Final</td>
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<td>eGFR</td>
<td>50</td>
<td>ml/min/1.73sq</td>
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Electronic Hard Stops

ROUND 1 HARD STOPS

Results must be:
- Hgb ≥ 11
- HgA1c ≤ 7
- GFR > 60
- BMI ≤ 40

If any parameter not met, patient cannot move forward until referrals / next steps completed.

Referrals/Next Steps
- Hgb<11 Hematology
- HgA1c > 7 PCP/Endocrine
  *Case postponed up to 90 days for repeat HgA1c
- GFR < 45 Nephrology
- GFR 45-60 PCP or SOC
- BMI > 40 Weight Management

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# AKI Risks – Medication Education

**Home Medications**

- **Med List Status**: RN Complete
- **Set By**: Diane Hoffman, RN at 06/10/2019 10:15 AM

<table>
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<tr>
<th>Medication</th>
<th>Formulation</th>
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<tr>
<td>albuterol (VENTOLIN HFA) 90 mcg/act inhaler</td>
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<tr>
<td>amlodipine (NORVASC) 10 mg tablet</td>
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<tr>
<td>atenolol (TENORMIN) 50 mg tablet</td>
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<tr>
<td>atorvastatin (LIPITOR) 20 mg tablet</td>
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<tr>
<td>fluticasone-vilanterol (BREO ELLIPTA) 200-25 MCG/INH inhaler</td>
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<tr>
<td>ipratropium-albuterol (DUO-NEB) 0.5-2.5 mg/3 mL nebulizer solution</td>
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<tr>
<td>levothyroxine 100 mcg tablet</td>
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<tr>
<td>lisinopril (ZESTRIL) 40 mg tablet</td>
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<tr>
<td>Magnesium Gluconate 550 MG TABS</td>
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<tr>
<td>naproxen (NAPRELAN) 375 MG TB24</td>
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**Flag for Review**

- **Taking?**
- **Last Reviewed by Diane Hoffman, RN on 09/10/2019 at 10:15 AM**

**Outside Medication Reconciliation**

- **offoxacin (OCUFLOX) 0.3 % ophthalic solution**
- **pantoprazole (PROTONIX) 40 mg tablet**
- **sucralfate (CARAFATE) 1 g/10 mL suspension**

**Notes**: Takes 4 x 4 daily

**Mark as Reviewed**

- **Last Reviewed by Diane Hoffman, RN on 09/10/2019 at 10:15 AM**

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Intra Operative
Phase of Care
Intra Op MAP Notification

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<th>MRN: 50069002871</th>
<th>Ht: At: None. None</th>
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<tr>
<td>CSN: 1096299683</td>
<td>Allergies: No Known Allergies</td>
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<td></td>
<td>Active FYIs: None</td>
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</table>

Infection: None
Code: inactive
Isolation: None
Attending: Mark Schadt, MD
Outpatient Surgery

APPENDECTOMY (N/A Adenoma), 5/9/19
Surgeons: Mark Schadt, MD
An Room ID, Case #: 91995, 6:325
MyChart: Inactive

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<tr>
<th>Column Interval: 5 minutes</th>
<th>2019</th>
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ASA Status
ASA Status: Not documented
Emergent Status: Not documented

<table>
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<tr>
<th>Allergies</th>
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</thead>
<tbody>
<tr>
<td>No Known Allergies</td>
</tr>
</tbody>
</table>

Best Practice Advisory - Anesthesia, Screen Four

Patient Safety (1)

The Mean BP is Less than 55mmHg

Acknowledge Reason

Trauma

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Inpatient Phase of Care
Order Set Decision Support Mechanisms

How do you know you do not have a problem if you are not looking??

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Nurse Hypotension Protocol
New BPA

Who?: Inpatient Nurses
What?: New BPA for Systolic BP <=100

When a patient with a systolic blood pressure ≤100 has an order set used for a total hip replacement post-op or a total knee post-op, and does NOT also have an order for "Ortho Total Joint Hypotension protocol for nursing", a BPA will fire to prompt the nurse to open order set and accept the protocol, or give a reason as to why they are not initiating the protocol.

The BPA will look like this, giving the nurse the option to open the order set to order the protocol, or choose “do not open”, and an acknowledgement reason must be charted. If the protocol is chosen not to be ordered and documented in this BPA, the BPA will not fire again for one hour. When a choice is made, click Accept. Sign the order with an order mode of “Per Protocol, No Cosign required”.
Modifying BP Parameters

Network change in collaboration with Cardiology, Pharmacy, and Medicine to decrease risk of AKI by modifying SBP parameters for antihypertensive medications

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Physician GFR BPA

- GFR is a laboratory value that reflects kidney function.
- A GFR less than 60 will generate the BPA.
Nursing BPA

Patient Safety (Advisory: 1)

Patient has GFR less than 60. Collaborate with provider before administering NSAID.

Acknowledge Reason

Administration approved by provider (ent...

Enter comment

Accept

Cancel

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# Monitoring Effectiveness

### 3PA's by Specialty

*Click on a specialty and alert desc to see detail data (Grand totals do not provide detailed data)*

<table>
<thead>
<tr>
<th>Specialty</th>
<th>GFR &lt; 60 AND ON NSAID</th>
<th>MORPHINE WITH GFR&lt;30</th>
<th>KDIGO</th>
<th>NSAIDS WITH GFR &lt;60</th>
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### BPA's by Provider

*Click on a provider and alert desc to see detail data (Grand totals do not provide detailed data)*

<table>
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<tr>
<th>Prov Name</th>
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<th>GFR &lt; 60 AND ON NSAID</th>
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<th>KDIGO</th>
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Tweaking our Process
Updated Hypotension Protocol Order Set

- Surgery General Post-op Order set

**General Surgery Hypotension Protocol for Nurses**

"Use only for patients at St Luke’s Bethlehem Campus"

- Follow General Surgery Hypotension Nursing Protocol

**Order Sets**

- General Surgery Hypotension Protocol for Nurses
  "Use only for patients at St Luke’s Bethlehem Campus"

- Follow General Surgery Hypotension Nursing Protocol

- Note: Each specialty has their own Protocol. However, the functionality is the same across all order sets.

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NURSE HYPOTENSION PROTOCOL ORDER SET UTILIZATION

Qtr1  Qtr2  Qtr3  Qtr4  Qtr1  Qtr2  Qtr3
2018   41%  37%  39%  41%  41%  64%  68%
2019   0%   10%  20%  30%  40%  50%  60%

Hypotension Protocol Build Revised 4/9/19
Check

Bethlehem:
- Hypotension rate decreased from 14.54% to 5.97%
- AKI pre-pilot rate of 6.02% → FY19 0.24%

Network:

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Hypotension Rate</th>
<th>AKI Rate</th>
<th>ALOS Index</th>
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<tbody>
<tr>
<td>2016</td>
<td>9.54%</td>
<td>3.49%</td>
<td>1.02</td>
</tr>
<tr>
<td>2017</td>
<td>7.56%</td>
<td>1.75%</td>
<td>.97</td>
</tr>
<tr>
<td>2018</td>
<td>6.06%</td>
<td>1.37%</td>
<td>.90</td>
</tr>
<tr>
<td>2019</td>
<td>6.35%</td>
<td>.71%</td>
<td>.85</td>
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</table>
AKI/Hypotension Quarterly Progress

SLUH: AKI and Hypotension QTR Rate

Q1 15' Q2 15' Q3 15' Q4 15' Q1 16' Q2 16' Q3 16' Q4 16' Q1 17' Q2 17' Q3 17' Q4 17' Q1 18' Q2 18' Q3 18' Q4 18' Q1 19' Q2 19'

- AKI
- Hypotension
- Peer Hypotension Rate
- Peer AKI Rate

Project Implementation
Initiated electronic Nurse Hypotension Protocol
Failures in Protocol
Network dissemination
Epic workflow change with hypotension protocol
Rule built in Prep for Procedure to Hold ACE/ARB and Nephrology consults pre-op
Return on Investment

- From FY16 - FY19, cumulative cost savings of:
  > $ 585,000!
Check/Act

- Pre-operative Clearances
  - Hard Stops:
    - Bilateral Knee Procedures
    - GFR- Nephrology Consults- Decision Support builds
    - Remove Celebrex from Pre and Post-op order sets

- Physician Documentation
- Staff engagement
- Network dissemination
  - December 2017
- Ongoing Multidisciplinary Workgroups
Discharge/Transition of Care
Phase of Care
AKI Beyond Joint Replacement...

- Addressing those with an AKI event:
  - KDIGO BPA
  - AKI Bundle Order Set
  - SNF Geriatric AKI Pathway
  - Discharge Home AKI Pathway **November roll out**
AKI Event

AKI → BPA → Order set

Patient Safety (1)

This patient has developed AKI based on KDIGO criteria. Follow the link to the AKI Order set.

Nephrology KDIGO Guidelines for AKI Focused

Dehydration
Correct volume depletion
Consider IV fluid bolus and/or maintenance IV fluids

Obstruction
Check bladder scan
Consider straight catheterization if indicated
Consider renal ultrasound

Nephrotoxins
Discontinue and avoid all potentially nephrotoxic medications:
- NSAIDs
- ACEI or ARB
- Diuretics (loop, thiazide, potassium sparing)
- Aminoglycosides
- Statins (if LFTs are elevated)
- Iodinated dye and Gadolinium
- Renal dose adjust medications

Urine
Order strict I/O's
Check urinalysis

Think Sepsis
Sepsis protocol if evidence of sepsis

Systolic BP
Avoid relative hypotension
Adjust hold parameters on BP meds to maintain SBP 130-140 as clinical condition allows.

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The linked order set provides guidance for addressing AKI.

Please determine what diet your patient requires. A renal diet is pre-populated here, but based on the assessment of your patient’s current need, please make the appropriate changes.

KDIGO Guidelines for AKI - an increase in creatinine of 0.3 mg/dL over a 48 hour period or a greater than 1.5 times baseline increase over 7 days or a urine output less than 0.5 ml/kg/h for 6 hours.
# Audit: KDIGO BPA and Order Set

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## Geriatric AKI Discharge Pathway

**For nursing home patients on the AKI Pathway**

- **Medications to avoid:** phosphate or magnesium based laxatives, NSAIDs
  
  Routine, Clinic Performed, Should notify patient’s pharmacy and flag in patient’s nursing home chart

- **Maintain SBP between 120-140 mm/Hg**
  
  Routine, Clinic Performed, Call Nursing Home physician with any abnormality

- **Call Nursing Home MD for decreased oral intake**
  
  Routine, Clinic Performed, Call NH MD if oral liquid intake < 1 L for 2 consecutive days or meal intake < 30% for 2 consecutive days

- **Daily Weights**
  
  Routine, Clinic Performed, For 30 days, call Nursing home physician if weight increases or decreases > 3 lbs from initial admission/return weight to nursing home. Any further orders will be per the discretion of nursing home physician

- **Bladder Scan**
  
  Day #2 after discharge, if bladder scan is greater than 250ml call nursing home physician

- **Strict Intake and Output**
  
  Routine, Clinic Performed, For 30 days, Strict I&O and document. Any further orders will be per the discretion of nursing home physician.

- **Follow up bloodwork**
  
  Routine, Clinic Performed, BMP to be performed day #3 and day #9 after hospital discharge Call nursing home MD if creatinine increases > 0.3 from discharge creatinine, refer to After Visit Summary for the latest serum creatinine.

- **No BPS, IV’s or Labs in nondominant arm for GFR < 45**
Key Lessons Learned

- Utilizing Electronic Medical Record (EMR) to drive adherence/compliance
  - Include reporting early on
- Simple measures done well and consistently can have a huge positive impact
  - NSAID Holds, fluid management, Nephrology Consults, Systolic Blood Pressure (SBP) parameters and intra-op monitoring
  - Defining a high risk population
- Keep your eye on the ball or results can slip
  - Sustaining behavior
  - Accountability
- Keep up with education because of resident, provider turnover
- Empowering nurses works
Recognitions

- Hospital and Healthsystem Association of Pennsylvania (HAP) Achievement Awards Program
- I am Patient Safety - Pennsylvania Safety Authority
- Journal of Arthroplasty
- National Association of Healthcare Association (NAHQ)
- Institute for Healthcare Improvement
- Premier Breakthroughs
- Network Quality Award
- EPIC AKI Module
- Community Health