Clinical and Economic Value of Anti-Xa Monitoring in Patients Receiving Unfractionated Heparin

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Instrumentation Laboratory
Affordable Care Act: Triple Aim

- Improve quality of care
- Enhance patient experience
- Reduce costs through enhanced efficiencies
Objectives

• Describe the role of heparin as an anticoagulant
• Explain why monitoring unfractionated heparin (UFH) with Anti-Xa is superior to aPTT
• Review results of a study comparing Anti-Xa monitoring with aPTT in patients on UFH therapy
• Outline a plan to ensure a smooth transition from aPTT to Anti-Xa monitoring
What is Heparin?

- Widely used anticoagulant discovered in 1916
- Used for treatment and prevention of thrombotic diseases
- Maintains blood fluidity in extracorporeal devices
- Chains of sulfated glycosaminoglycans
- Molecular weight: 5,000 – 30,000 daltons

http://circ.ahajournals.org
Clinical Use of Unfractionated Heparin

- **Antithrombotic agent** – high dose
  - Acute thrombosis
- **Prophylaxis** – low dose to prevent thrombosis
  - Pre-/post- surgery: orthopedic, general, vascular
  - Prevention of VTE and preeclampsia recurrence during pregnancy
  - Acutely ill patients: congestive heart failure, severe respiratory disease
- **Maintenance** of arterial and venous lines
  - Possible heparin contamination

Potentially high-risk

“Drug widely used…that has a high risk of patient injury when administered incorrectly.”

Clotting Enzyme Inactivation by Heparin

AT is a slow Inhibitor without heparin
Clotting Enzyme Inactivation by Heparin

AT is a slow Inhibitor without heparin

- Heparin binds to AT through a high-affinity pentasaccharide
- Conformational change to AT converts AT from slow to rapid inhibitor (2-3X)
Clotting Enzyme Inactivation by Heparin

AT is a slow Inhibitor without heparin

- Heparin binds to AT through a high affinity pentasaccharide
- Conformational change to AT converts AT from slow to very rapid inhibitor (2-3X)

AT binds covalently to clotting enzyme
- Heparin dissociates itself from the complex and can be reutilized
Coagulation Cascade: *in vitro* Model

**HEPARIN**
A non-specific inhibitor

- FXII
- FXI
- FIX
- FVIII
- FV
- FX
- FII
- Thrombin
- Fibrinogen
- Fibrin

**aPTT**

**PT**

Heparin: A non-specific inhibitor
UFH-Binding Candidates

Monitoring UF Heparin

- For venous thrombosis
  - Heparin Anti-Xa: 0.3 – 0.7 Anti-Xa units
  - aPTT
    - Correlated to 0.3 – 0.7 Anti-Xa units
    - 0.2 – 0.4 units by protamine sulfate titration

- For coronary indications
  - The therapeutic range is unknown but is likely to correspond to heparin levels approximately 10% lower than used to treat patients with VTE

- Monitoring required
  - Variable dose-response rate, due to binding to proteins
  - Varying rates of heparin clearance
  - Ensures patient is not sub-therapeutic or over anti-coagulated

Heparin Monitoring with aPTT

- aPTT - traditional method (1.5 - 2.5x “control”)
  - Based on a retrospective study (1970s)
  - Not confirmed with randomized clinical trials
- \textit{In vitro} heparin dose-response curve
  - Spiked normal plasma with UFH
  - Not recommended by CAP, over-estimates when compared with patient samples
- \textit{Ex vivo} heparin therapeutic range using aPTT and Anti-Xa assay
  - Recommended method by CAP

Drawbacks to aPTT

- Does not directly measure heparin
- Variable responsiveness of aPTT reagents
- aPTT cannot be used to monitor LMWH, fondaparinux, rivaroxaban, apixaban, edoxaban
- High base-line aPTT (Lupus Anticoagulant, Factor deficiency)
- Increased Factor VIII, Fibrinogen
Monitoring Anticoagulant Therapy
Using the aPTT

aPTT response to anticoagulant therapy is exaggerated

- Numerous factors may elevate aPTT
  - Concomitant warfarin therapy
  - Lupus anticoagulant
  - Factor deficiency
  - Liver disease
Monitoring with aPTT
Increases in Acute Phase Reactants

Under-estimates anticoagulation level

- Factor VIII and Fibrinogen increases
  - Can shorten the aPTTT in a clinically significant manner
  - Factor VIII increases from 100 - 600% can shorten aPTT by 33-50%

- One cause of *in vitro* drug “resistance”

aPTT vs Anti-Xa in Pregnant Population

Unpublished study courtesy of Dr. D Adcock
Establishing the Therapeutic Range for aPTT with Anti-Xa

- Preferred method (e.g., ISTH, CAP)
- Collect samples from patients receiving heparin only
  - Normal PT
  - Minimum 50
  - No more than 2 samples from the same patient
- Perform aPTT and Anti-Xa testing
  - Can freeze samples for Anti-Xa testing later- follow CLSI guidelines
  - If samples are frozen, repeat aPTT after thawing for quality check
- Plot heparin vs. aPTT using regression analysis
- Determine the aPTT therapeutic range that corresponding to 0.3 - 0.7 U/mL
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Your Results.

Anti-Xa Therapeutic Range

Sub-therapeutic

Supra-therapeutic

Therapeutic

Data obtained from a typical hospital laboratory
Evaluation of Outcomes in Anti-Xa Versus aPTT Monitored Patients Receiving Unfractionated Heparin
## Anti-Xa vs APTT Publications

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Stay</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faster Time to Therapeutic</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Discordant Results</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fewer Dosage Changes/Tests</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cost per test</td>
<td>X</td>
<td></td>
<td>Xa $13.30 vs PTT $13.97</td>
<td>Xa $31.46 vs PTT $27.10</td>
<td></td>
</tr>
<tr>
<td>Adverse Outcomes</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic outcomes</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Number of sites</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Key Points of the IL Study

- **Scope**
  - Compare performance of Anti-Xa vs aPTT assays for patients on UFH treatment

- **Outcomes with Anti-Xa**
  - Significant hospital cost savings in patient care
  - Significant reduction in patient complications (*e.g.* major hemorrhage, VTE, mortality)

- **Disease state**
  - Focus on VTE, Acute Coronary Syndrome, Stroke, and complications (*e.g.* hemorrhage, thrombosis)

- **Method**
  - Data Analytics Group retrospective review of key markers in large multi-hospital database

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Database Contents

- Hospital characteristics
  - region, bed size, teaching status
- Patient demographics
  - Age, gender
- Diagnosis
  - ICD-9 diagnosis codes, clinical groupings (MS-DRG)
- Procedure
  - ICD-9 procedure codes, CPT codes, procedure date
- Metrics
  - Length of stay, mortality, readmissions
Anti-Xa Study Design

• Create a patient-matching algorithm to identify “like” patients in aPTT and Anti-Xa cohorts

• Matching variables for all populations included:
  - Hospital bed size and teaching status
  - Hospital region
  - Patient age
  - Gender
  - Patient comorbidities
  - Transfers to another facility and left against medical advice
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Study Population

Patients on IV UFH discharged over 5 years (2009-2013)

- Monitored with aPTT
  - Venous Thromboembolism as primary diagnosis (VTE)
  - Stroke
  - Acute Coronary Syndrome (ACS)

- Monitored with Anti-Xa
  - Venous Thromboembolism as primary diagnosis (VTE)
  - Stroke
  - Acute Coronary Syndrome (ACS)

The 2 cohorts were defined using CPT codes and the name of the assay. Matched cohorts included:
- N= 2207 for Venous Thromboembolism (VTE)
- N= 784 for Stroke
- N= 7411 for Acute Coronary Syndrome (ACS)
Indications for Anticoagulation in Ischemic Stroke

- Conditions with potential high risk of early cardiogenic reembolization
- Symptomatic dissection of the arteries supplying the brain
- Symptomatic extracranial or intracranial arteriosclerotic stenosis with crescendo TIAs or early progressive stroke
- Basilar artery occlusion before or after intra-arterial pharmacological or mechanical thrombolysis.
- Known hypercoagulable states
- Cerebral venous sinus thrombosis

**Note:** The stroke group numbered 784, significantly smaller than ACS and VTE

# Study Design - Outcomes Included

<table>
<thead>
<tr>
<th>Overall cost of care</th>
<th>Length of stay</th>
<th>Number of monitoring tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of heparin dose changes</td>
<td>Readmissions</td>
<td>In-hospital mortality</td>
</tr>
</tbody>
</table>

**Complications:**
- RBC transfusions
- Protamine Sulfate
- Thromboses
Statistical Methods Used

**Univariate analysis:** Observing only one variable at a time
  - Numeric data
    - Variance (how widely point varies from the mean)
  - Qualitative data
    - Chi-square (compares the significant difference of 2 variables)

**Multi-variate analysis:** Observing multiple variables to isolate the impact of Anti-Xa on outcomes
  - Regression (compares points to show cause and effect)

\( p \text{ value} < 0.05 \) is considered significant
Venous Thromboembolism (VTE) Results
VTE: Cost of Care

Median cost of care for patients monitored with Anti-Xa was $808 less than those monitored with aPTT.

(N = 2207, p = 0.0022)
VTE: Number of Heparin Dose Changes

Average number of heparin dose changes was lower in patients monitored with Anti-Xa.

![Bar chart showing mean number of heparin dose changes.](chart)

**Mean Number of Heparin Dose Changes**

- **Anti-Xa**: 1.48
- **aPTT**: 1.61

(N = 2207, p = 0.0365)
On average, patients monitored with Anti-Xa had 2 fewer tests than patients those monitored with aPTT.

- For a larger hospital with 75-150 VTE patients on unfractionated heparin annually, this results in a difference of 150-300 tests.

(N = 2207, p < 0.0001)
Patients monitored with Anti-Xa had nearly 5% fewer RBC blood transfusions.

- **Average cost of care for patients with a transfusion is twice as much** as those without transfusions ($29,943 vs. 11,248).
There were no significant differences for in-hospital mortality for patients monitored with Anti-Xa compared to those monitored with aPTT.

(N = 2207, p = 0.9213)
VTE: Multivariate Results

• Evaluation of the cost, length of stay, readmission and mortality measures using multi-variate regression showed estimated savings of $402 for patients with Anti-Xa

For a large hospital with 75-150 VTE patients on UFH, this saves $30,000-$60,000 annually
VTE: Multi-variate Blood Complication Results

- Patients tested with aPTT were 2.8 times more likely to get a RBC transfusion than those patients tested with Anti-Xa.

- Controlled for:
  - Patient age and gender
  - Diagnostic risks
  - Invasive procedures

The average cost of treating patients with a transfusion was 2x as those without transfusions ($29,943 vs. $11,248)
Stroke Results
Stroke: Cost of Care

The median cost of care for patients tested with Anti-Xa was $3,454 less than those who were using the aPTT; however this result is not statistically significant.

(N = 784, p = 0.1526)
The average number of heparin dose changes was lower in patients tested with Anti-Xa.

**Mean Number of Heparin Dose Changes**

- Anti-Xa: 1.67
- aPTT: 1.96

(N = 784, p = 0.0276)
On average, patients monitored with Anti-Xa had approximately 1 more test than those monitored with aPTT.

(N = 784, p = 0.0104)
Patients monitored with Anti-Xa had approximately an 8% reduction in RBC transfusions

- Average cost of care for patients with transfusion is >3X those without ($88,630 vs. 25,575)

N = 784, p < 0.0001
No significant difference in-hospital mortality for patients with monitored with Anti-Xa vs. aPTT.

In-Hospital Mortality

<table>
<thead>
<tr>
<th></th>
<th>0%</th>
<th>2%</th>
<th>4%</th>
<th>6%</th>
<th>8%</th>
<th>10%</th>
<th>12%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-Xa</td>
<td>9.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aPTT</td>
<td>10.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 784, p = 0.6705
Stroke Multivariate Results

- Evaluation of the cost, length of stay, readmission and mortality measures using multi-variate regression demonstrated:
  - Estimated savings of $1,932 for patients with Anti-Xa

For a large hospital with 200-350 stroke patients treated with UFH, this would result in estimated $350,000 - $700,000 savings annually*


No significant differences in length of stay, readmissions or mortality
Stroke: Multivariate Blood Complication Results

Patients monitored with aPTT were 2.5 times more likely to receive an RBC transfusion than those on Anti-Xa

Study was controlled for:
- Patient age and gender
- Diagnostic risks
  - (e.g., anemia, renal insufficiency, trauma)
- Invasive procedures
  - (e.g., cardiac catheterization, hemodialysis, coronary artery bypass graft)
Acute Coronary Syndrome (ACS) Results
Median cost of care for patients monitored with Anti-Xa was $3,982 less than those monitored with aPTT.

(N = 7411, p < 0.0001)
Average length of stay for patients monitored with Anti-Xa was more than half a day less than those monitored with aPTT.
ACS: Number of Heparin Dose Changes

Average number of heparin dose changes was higher in patients monitored with Anti-Xa

Mean Number of Heparin Dose Changes

<table>
<thead>
<tr>
<th></th>
<th>Mean Number of Dose Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-Xa</td>
<td>1.80</td>
</tr>
<tr>
<td>aPTT</td>
<td>1.44</td>
</tr>
</tbody>
</table>

(N = 7411, p < 0.0001)
On average, patients monitored with Anti-Xa had **0.44 fewer tests** than those monitored with aPTT.

- For a larger hospital with 500-900 ACS patients on unfractionated heparin annually, this would translate to a difference of 200-400 tests annually.

\[
\begin{array}{c|c|c}
\text{Tests} & \text{Ant-Xa} & \text{aPTT} \\
\hline
\text{Mean Number of Tests Administered} & 3.80 & 4.24 \\
\text{N} = 7411, \ p < 0.0001
\end{array}
\]
Patients monitored with Anti-Xa had nearly **18% fewer** RBC blood transfusions

- **Average cost of patients with a transfusion** was 2x that of those without transfusions ($51,650 vs. 22,373)

\[ \text{RBC Blood Transfusions} \]

\[
\begin{array}{c|c|c}
\text{Anti-Xa} & \text{aPTT} \\
\hline
7.02 & 24.56 \\
\hline
\end{array}
\]

\(N = 7411, p < 0.0001\)
Mortality rate in patients monitored with Anti-Xa was nearly 1% less than that in patients monitored with aPTT.

### In-Hospital Mortality

<table>
<thead>
<tr>
<th></th>
<th>Anti-Xa</th>
<th>aPTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N = 7411, $p = 0.0275$)</td>
<td>9.44%</td>
<td>10.08%</td>
</tr>
</tbody>
</table>
ACS Multi-variate Results

Evaluation of the cost, length of stay, readmission and mortality measures using multi-variate regression demonstrated:

- **Estimated savings of $741 for patients monitored with Anti-Xa**

For a large hospital with 500-900 ACS patients on unfractionated heparin, annual mean **savings estimated to be $350,000 - 700,000**
ACS Multi-variate Results

Evaluation of the cost, length of stay, readmission and mortality measures using multi-variate regression demonstrated:

- Estimated savings of 9.9 hospital hours for patients monitored with Anti-Xa

For a large hospital with 500-900 ACS patients treated with UFH, estimated 200-375 fewer days annually
ACS: Multivariate Blood Complication Results

• Patients monitored with aPTT were **6.3 times** more likely to receive a RBC transfusion and 1.7 times more likely to receive protamine sulfate than patients monitored with Anti-Xa.

• Controlled for:
  - Patient age and gender
  - Diagnostic risks
    • (e.g., anemia, renal insufficiency, trauma)
  - Invasive procedures
    • (e.g., cardiac catheterization, hemodialysis, coronary artery bypass graft)
VTE: Summary of the Advantages of Anti-Xa

Note: Length of stay, mortality, readmission, thrombotic complication rate, and protamine titration incidence were not significantly different.
Stroke: Summary of the Advantages of Anti-Xa

Note: Length of stay, mortality, thrombotic complications, readmission rate, and protamine titration incidence were not significantly different.
ACS: Summary of the Advantages of Anti-Xa

- Mortality decreased 1%
- Fewer tests ACS patients
- $3,982 lower cost of care
- 9.9 hour reduction in hospital stay
- 18% fewer RBC transfusions
- Fewer dose changes

Note: Re-admission, and thrombotic complication rate were not significantly different
Multi-variate Results

- Examination of the cost, length of stay, readmission and mortality measures using multi-variate regression demonstrated:
  - **Estimated savings of**
    - **$402 for VTE patients with Anti-Xa**
      - For a large hospital with 75-150 VTE patients treated with UFH this saves $30,000 - 60,000 annually.
    - **$1,932 for Stroke patients with Anti-Xa**
      - For a large hospital with 200-350 Stroke patients on UFH this saves $350,000 - 700,000 annually.
    - **$741 for ACS patients with Anti-Xa**
      - For a large hospital with 500-900 ACS patients on UFH this saves $350,000 - 700,000 annually.
    - **9.9 hours ACS for patients with Anti-Xa**
      - For a large hospital with 500-900 ACS patients on UFH this saves estimated 200-375 hospital days annually.
## Estimate of Financial Benefit – Large U.S. Hospital

<table>
<thead>
<tr>
<th></th>
<th>VTE</th>
<th>Stroke</th>
<th>ACS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patients/Year</strong></td>
<td>75 – 250</td>
<td>200 – 350</td>
<td>500 – 900</td>
</tr>
<tr>
<td><strong>Cost savings/Patient ($)</strong></td>
<td>402</td>
<td>1932</td>
<td>741</td>
</tr>
<tr>
<td><strong>Savings/year ($)</strong></td>
<td>30,150 – 60,300</td>
<td>386,400 – 676,200</td>
<td>370,500 – 666,900</td>
</tr>
</tbody>
</table>

**TOTAL Annual Savings = $790,000 – 1,400,000**
Hypothesis to explain Link Between Decline in RBC Transfusions and Anti-Xa Monitoring

• Anti-Xa assay use focuses more attention on the use of blood products, which causes a reduction in use
• Monitoring Heparin therapy with Anti-Xa assay involves more specialists in coagulation and transfusion medicine, resulting in more careful, evidenced-based transfusion decisions
• The use of the Anti-Xa assay provides a more accurate assessment of anticoagulant-associated bleeding risk and thus, reduces the need for RBC transfusions

Dr. Michael Laposata, AACC
Hemostasis workshop July 2015
Successful Implementation of the Anti-Xa Assay
Educate and Convince

• Present to pharmacy department to demonstrate value
  - Lab leadership: meet with pharmacy leadership and present data/references demonstrating the benefit of the Anti-Xa assay

• Present the change to caregivers
  - Lab and Pharmacy jointly present to Nursing and Physician leadership
  - Present the benefits of the change
    • Improved patient care
    • Cost benefit
    • More precise measurement of heparin concentration
Add to Electronic Medical Record

• Set up new orderable Anti-Xa assay(s)
  - Include therapeutic ranges for both UFH and LMWH
    • UFH = 0.3 – 0.7 IU/mL
    • LMWH = varies by type
    • List the range for the most commonly used drugs

• Set up new heparin protocol(s) based on Anti-Xa monitoring
  - For VTE (DVT and PE)
  - For ACS/Stroke – patients with an increased risk of bleeding
## Heparin Dosing for VTE

<table>
<thead>
<tr>
<th>Anti-Xa (IU/mL)</th>
<th>Bolus Dose (units/kg)</th>
<th>Stop Infusion (min)</th>
<th>Rate Change (Units/kg/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial dose</td>
<td>80</td>
<td></td>
<td>18 (initial rate)</td>
</tr>
<tr>
<td>&lt;0.2</td>
<td>80</td>
<td></td>
<td>Increase by 4</td>
</tr>
<tr>
<td>0.2-0.29</td>
<td>40</td>
<td></td>
<td>Increase by 2</td>
</tr>
<tr>
<td>0.3-.07</td>
<td>No</td>
<td></td>
<td>No change</td>
</tr>
<tr>
<td>0.71-0.8</td>
<td>No</td>
<td></td>
<td>Decrease by 1</td>
</tr>
<tr>
<td>0.81-0.9</td>
<td>No</td>
<td>30</td>
<td>Decrease by 2</td>
</tr>
<tr>
<td>&gt;0.9</td>
<td>No</td>
<td>60</td>
<td>Decrease by 3</td>
</tr>
</tbody>
</table>

*Ann Pharmacother 2011;45;861-8*
# Low Intensity Heparin Dosing for ACS and Stroke

<table>
<thead>
<tr>
<th>Xa Level</th>
<th>LOW INTENSITY HEPARIN PROTOCOL</th>
</tr>
</thead>
</table>
| 0.00 – 0.09 | Response: Bolus 25 units/kg; increase infusion by 3 units/kg/hr  
Next heparin level: 6 hours |
| 0.10 – 0.19 | Response: Increase infusion by 2 units/kg/hr  
Next heparin level: 6 hours |
| 0.20 – 0.29 | Response: Increase infusion by 1 unit/kg/hr  
Next heparin level: 6 hours |
| 0.30 – 0.60 | Response: NO CHANGE  
Next heparin level: 6 hours  
Once therapeutic x 2, may change to QAM |
| 0.61 – 0.69 | Response: Decrease infusion by 1 unit/kg/hr  
Next heparin level: 6 hours |
| 0.70 – 0.79 | Response: STOP INFUSION for 1 hr, then decrease by 2 units/kg/hr  
Next heparin level: 6 hours after restart |
| 0.80 – 0.89 | Response: STOP INFUSION for 1 hr, then decrease by 3 units/kg/hr  
Next heparin level: 6 hours after restart |
| 0.90 – 0.99 | Response: STOP INFUSION for 2 hr, then decrease by 4 units/kg/hr  
Next heparin level: 6 hours after restart |
| > 1.00    | Response: STOP INFUSION for 2 hr, then decrease by 5 units/kg/hr and notify MD  
Next heparin level: 6 hours after restart |

Used with permission from Univ of NM MC Pharmacy
Caregiver Training on New Heparin Protocols

Educate on why the change to Anti-Xa and the benefits

- Nursing continuing education/competency program
  - Available as online presentation or live
- Physician training
  - Grand Rounds
  - Department meetings

- The bolus and infusion dose for the UNMH high-intensity heparin protocol are:
  - A. 80 units/kg and 18 units/kg/hr
  - B. 60 units/kg and 12 units/kg/hr
  - C. 5000 unit bolus and 1000 units/hr
  - D. 75 units/kg and 20 units/kg/hr
  - E. None of the above
Who to Target: Pharmacy & Therapeutics Committees

- Pharmacy Newsletter Article
  - Briefly describe reason behind the change

Pharmacy Newsletter

A new method for heparin monitoring: Antifactor Xa Assay
Notification of the Change

• Laboratory bulletins
  - Include other hospitals using Anti-Xa (local if possible)
  - Describe assay and its benefits vs. the APTT
  - Include new therapeutic range
  - State what is changing (i.e. dosing nomogram) and what is not
  - Mention that pharmacy is in agreement/involved

Letter courtesy of Dr. Higgins, UHS San Antonio, TX
Challenges to Acceptance

- Need to move beyond a departmental budget and to focus on **improving patient care**
  - Reagent costs will increase for the lab
  - **Overall cost to the medical center will be reduced**
  - Nursing department must have adequate time for complete training before “going live” with Anti-Xa
Conclusions

• Monitoring UFH therapy with the Anti-Xa assay can help achieve the “Triple Aim” for healthcare improvement
  - **Patient care will improve** by maintaining levels of anticoagulation and reduce RBC transfusions
  - **Patient experience** will improve with fewer tests and fewer dose changes
  - **Cost of hospital care** is reduced
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