Clinical Safety & Effectiveness
Cohort # 10

Improving Weight-Based Vancomycin Dosing and Monitoring

UT Health Science Center
San Antonio
Educating for Quality Improvement & Patient Safety
Financial Disclosure

Elizabeth A. Walter, MD, has no relevant financial relationships with commercial interests to disclose.

Heta Javeri, MD, MPH Fellow, has no relevant financial relationships with commercial interests to disclose.
The Team

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  Dr. Heta Javeri, MD, MPH
  James Lewis, Pharm D
  Bin Xiao, Pharm D
  Internal Medicine Nursing/Technicians

• Sponsor Department
  Internal Medicine
What We Are Trying to Accomplish?

OUR AIM STATEMENT

1 a. To improve the use of initial weight-based vancomycin dosing in hospitalized patients by implementing and encouraging the use of a vancomycin dosing order set in Sunrise.

- Currently, 66% of patients with weight > 100 kg are inappropriately dosed with vancomycin and we aim to decrease this to 50%.

1 b. To improve the timing of initial vancomycin trough levels to ensure rapid achievement and maintenance of therapeutic drug levels (TDM).
Project Milestones

- Team Created: January 2012
- Aim statement created: January 2012
- Weekly Team Meetings: February 2012
- Background Data, Brainstorm Sessions, Workflow and Fishbone Analyses: March 2012
- Interventions: March 2012
- Data Analysis: May 2012
- CS&E Presentation: June 2012
Background: Dosing in Obesity

• San Antonio, Texas is one of the most obese cities in the nation.
  ▪ San Antonio obesity rate of 28.2%
  ▪ United States average of 27%¹

• A multicenter evaluation of vancomycin dosing found:
  ▪ 86% of overweight patients (BMI = 25-29.9 kg/m²)
  ▪ 91% of obese patients (BMI ≥ 30 kg/m²) with gfr > 60 mL/min
  ▪ Received a fixed dose of 2 g daily divided into two doses⁴

• A pilot study (n=65) conducted at our institution revealed that only
  33% of patients > 100 kg received weight-based vancomycin dosing
  greater than 30 mg/kg/day.
• Doses of 15-20 mg/kg actual body weight every 8-12 hr are optimal for most patients with normal renal function to achieve the suggested serum concentration.

• A loading dose of 25-30 mg/kg (based on ABW) in seriously ill patients to achieve a more rapid target trough concentration.

• Trough serum vancomycin concentrations of 15–20 mg/L are recommended for complicated infections (bacteremia, endocarditis, osteomyelitis, meningitis and hospital acquired pneumonia) caused by MRSA.

• Maintain trough > 10 mg/L, based on evidence suggesting that strains with VISA like characteristics (hVISA) may develop.
Current Status of Therapeutic Drug Monitoring (TDM)

- Large number of vancomycin trough levels incorrectly ordered.
- Difficulty in interpreting results of inappropriately drawn levels.
- Increases unnecessary costs from additional ordering of levels.
- Potential increase length of stay due to inability to ensure target serum concentration prior to patient discharge.
Background: Review of Literature

Effect of the implementation of vancomycin dosing and TDM guidelines in computerized prescriber-order-entry (CPOE) system:

• Traugott, et al.
  ▪ Demonstrated a significant increase in the number of appropriately obtained serum vancomycin levels (58% to 68%, p = 0.02)$^5$

• McCluggage, et al.
  ▪ Observed a significant increase in the percentage of patients with an initial optimal vancomycin regimen that met nomogram recommendations (36% versus 24%, p = 0.0028)$^6$

• Li, et al.
  ▪ Demonstrated that patients in the post education group on vancomycin dosing protocol had significantly higher, initial median weight-based doses (12.5 mg/kg vs 20.0 mg/kg, p < 0.001), trough concentration (6.8 mg/L to 10.1 mg/L, p= 0.013) and AUC/MICs (262.5 to 365.0, p= 0.001) when compared with the pre-intervention group$^7$
Pre-intervention Process Analysis Tool

Pt requiring Vancomycin (Vanc) → Weight in chart → MD orders Vanc → Is weight-based dose ordered → Weight-based vancomycin dose given → MD reviews dose given and orders level

- MD requests weight
- Non-weight based dose given

MD reorders level → Is level ordered appropriately*

- Vanc level drawn
- Incorrect level obtained

- Blood drawn by RN or tech

- RN

- Tech

- Tech hands blood draw to nurse

MD reviews level and orders new dose or continues current dose → Is the level drawn appropriately **

- Pt given next dose

* prior to next or 4th dose
** 30 mins prior to dose

Yes

No
Decision Making Tool

Nursing
- Limited techs
- Insufficient staff
- Limited nurses
- Limited knowledge regarding drug pharmacokinetics

Technicians
- Pt weight not entered in sunrise
- Incorrectly timed level
- Inappropriate timing
- Incorrectly timed dose
- Delay in drawing level
- Lack of communication with nurses

Pharmacy
- Ordering incorrectly timed vancomycin levels
- Limited knowledge regarding drug pharmacokinetics

Physician

Inappropriate dose and levels of Vancomycin
- Loading dose not ordered
- Inappropriate vancomycin dose ordered
- Weight-based dose not ordered
Plan: Intervention

We implemented the following intervention:

• A vancomycin dosing order set within the computerized prescriber-order-entry (CPOE) system.

• Education of physicians and nursing staff on vancomycin dosing, use of CPOE system and accession of appropriate vancomycin level when indicated.

• Assessment of the effect on vancomycin dosing and therapeutic drug monitoring (TDM).
Do: Implementing the Change

1. System Changes within Sunrise

• Meetings were held with pharmacy staff and sunrise informatics specialists to develop the new order set within Sunrise.

• The newly developed order set was tested on a sample patient list within Sunrise to identify flaws in functioning.

• The order set was then reviewed, accepted, implemented by the P &T committee and incorporated into Sunrise on March 1\textsuperscript{st}, 2012.
Do: Implementing the Change

• The order set provided weight-based dosing.
  ▪ Skin/soft tissue infections
  ▪ Serious infections (bacteremia, endocarditis, osteomyelitis, meningitis and hospital acquired pneumonia)
  ▪ Incorporated patient’s renal function
• Added a loading dose for serious infections.
• Linked the order for vancomycin trough level to the order set.
  ▪ Default time for vancomycin trough level eliminated
  ▪ Facilitated providers to self-select times for trough levels

Odd dosing and continuous infusion order set were retained.
### Vancomycin Adult for Serious Infections [2 orders of 3 are selected]

<table>
<thead>
<tr>
<th>Medication Details</th>
<th>Order</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>PRN</th>
<th>PRN Reason</th>
<th>Start Date</th>
<th>Administration Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Dose - 1 item(s)</td>
<td>✔️ Vancomycin 1 g IV Piggy Back</td>
<td>1</td>
<td>g</td>
<td>IV Piggy Back</td>
<td>Every 8 Hours</td>
<td>May-07-2012</td>
<td>If &quot;Red Man&quot; syndrome develops, infuse at a lower...</td>
<td></td>
</tr>
</tbody>
</table>

### Vancomycin Level (Trough) Pre-Dose [* Draw 30 minutes prior to] [Special Instructions]

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Ht (in)</th>
<th>Ht (cm)</th>
<th>Wt (lb)</th>
<th>Wt (kg)</th>
<th>BSA (m²)</th>
<th>Creatinine Clearance (Estimated Cockroft-Gault)</th>
<th>QG (ml)</th>
<th>Relevant Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>68</td>
<td>172.7</td>
<td>242</td>
<td>109.6</td>
<td>2.21</td>
<td>Actual</td>
<td>Estimated</td>
<td></td>
</tr>
</tbody>
</table>

### Vancomycin Adult for Skin and Soft Tissue Infections [0 orders of 2 are selected]

<table>
<thead>
<tr>
<th>Medication Details</th>
<th>Order</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>PRN</th>
<th>PRN Reason</th>
<th>Start Date</th>
<th>Administration Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 55 kg - 1 item(s)</td>
<td>✔️ Vancomycin 1 g IV Piggy Back</td>
<td>1</td>
<td>g</td>
<td>IV Piggy Back</td>
<td>Every 12 Hours</td>
<td>T</td>
<td>If &quot;Red Man&quot; syndrome develops, infuse at a lower...</td>
<td></td>
</tr>
</tbody>
</table>

### Relevant Results

- Creatinine Serum: 0.66
- White Blood Cell Count: 10.7
- Hb Count: 3.39
- Hemoglobin: 10.5

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**Order Set**
### Order Set

**Order:** Vancomycin Level (Trough)

**Requested By:**

**Template Name:**

**Messages:**
- Collection Information: * Draw troughs 30 minutes before 4th dose.
- Subsequent levels weekly.
- Daily levels for renal dysfunction, concurrent nephrotoxins, or HD unstable.
- Vancomycin monitoring not recommended if: * Expected therapy < 1 week, * ORAL Vancomycin

**Request Date:** May-07-2012

**Request Time:** Pre-Dose

**Amount / Time of Last Dose:**

**Specimen Type:** Blood

**Specimen Source:**

**Attending Physician:**

**Indication for Test:**

**Conditional Order:**

- [ ] Max # of activations:

**Draw 30 minutes prior to:**

**Special Instructions:**
Do: Implementing the Change

2. Staff education

Nursing

- Nursing educators for floor 8, 9 and MICU were contacted and education method and materials were discussed with them.

- On an average 3 in-service (training sessions) each lasting 10 minutes were scheduled for each of the floors prior to either the morning or evening shift change.

- The training sessions were conducted by members of the team for the initial 3 sessions and then were followed by nurse educators who were present during the initial training.
Do: Implementing the Change

- Participation of all staff was ensured by an attendance sign in sheet placed prior to all sessions.
  - Entering patient height and weight
  - Appropriate charting of the time of medication administration and level drawn
  - Check out time of vancomycin level lab draw to oncoming nurses at the time of hand off.
  - Schedule lab draw prior to Xth dose as ordered by physician (e.g next, 4th, etc).
  - All levels to be drawn by RN only
Do: Implementing the Change

- Physicians

  - Practitioners were educated on the need for weight-based dosing, especially for patients weighing ≥ 95 kg and the need for loading dose in serious infections.

  - A 15 minute presentation was made to the Internal medicine housestaff prior to their daily noon conference.

  - A similar presentation was also made to the family medicine housestaff prior to their weekly didactic session.
Study: Determining Change

Types of Measures

• Percent of patients who have weight entered into Sunrise
• Percent of physicians/HCWs using the order set
• Comparing pre and post-intervention values of:
  ➢ Patients not receiving weight-based (<30 MG/KG/D) vancomycin dosing
    • Patients weighing less than 95 kg and greater than 95 kg
  ➢ Patients appropriately receiving loading dose
    • Serious infections
  ➢ Patients with appropriate timing of initial vancomycin level
  ➢ Time till first appropriate trough level
  ➢ Time till first appropriately timed level
Performance Improvement Design

• Retrospective chart review
• Collection of baseline, pre-intervention data
  ▪ Patients initiated on vancomycin from Dec 1, 2011 to Feb 29, 2012
• Collection of post-intervention data
  ▪ Patients initiated on vancomycin from April 1, 2012 to April 30, 2012
Subjects

- Adult inpatients at University Hospital (UHS).
  - 18 years or older
  - Admitted to UHS Medicine, Family Medicine or ICU teams
  - Receiving at least 1 dose of vancomycin
- Potential subjects were identified through pharmacy records.
- Information collected:
  - Age, gender, race, height, weight, sCr
  - Diagnosis with culture results
  - Initial dosing regimen, loading dose
  - Data on trough level (timing, level, number)
  - Length of vancomycin therapy
  - Length of stay
Subjects

- Exclusion criteria:
  - Age <18 years
  - Hemodialysis and chronic kidney disease with creatinine clearance (Crcl) <40 mL/min
Results

No. of patients prescribed vancomycin using the order set

89% Used
11% Not Used

Therapeutic Drug Monitoring

Time to therapeutic trough level (hrs)
- Pre-intervention: 47
- Post-Intervention: 37

Time to appropriately timed trough level (hrs)
- Pre-intervention: 53
- Post-Intervention: 34
Results

Lower dose vancomycin (1 gm Q12H)

Higher dose vancomycin (1 gm Q8H)
Results

Inappropriate Weight-based (30 mg/kg/d) Vancomycin dosing

% of patients receiving inappropriately dosed vancomycin/Week

Pre-Week 1

Post-Week 1

Pre-intervention

Post-intervention
G Chart: Time Between Events

Pre-Intervention
Days between Weight Based Dosing (> 30mg/kg/d)
Results

Post-Intervention
Days between Weight Based Dosing (> 30mg/kg/d)

Days between Weight-Based Dosing

<table>
<thead>
<tr>
<th>Date</th>
<th>Days Between Weight-Based Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/9/12</td>
<td>1.0</td>
</tr>
<tr>
<td>4/12/12</td>
<td>2.0</td>
</tr>
<tr>
<td>4/16/12</td>
<td>3.0</td>
</tr>
<tr>
<td>4/19/12</td>
<td>4.0</td>
</tr>
<tr>
<td>4/20/12</td>
<td>0.8163</td>
</tr>
<tr>
<td>4/25/12</td>
<td>4.47</td>
</tr>
<tr>
<td>4/26/12</td>
<td>0.8163</td>
</tr>
<tr>
<td>4/28/12</td>
<td>0.8163</td>
</tr>
<tr>
<td>5/5/12</td>
<td>5.0</td>
</tr>
<tr>
<td>5/11/12</td>
<td>6.0</td>
</tr>
</tbody>
</table>
Results

- Length of stay was 2 days shorter in the post-intervention group.
## Return on Investment

<table>
<thead>
<tr>
<th>Estimated Project Costs</th>
<th>Estimated Project Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project labor (IT personnel)</td>
<td>Increased revenue from decreased length of stay</td>
</tr>
<tr>
<td>$514</td>
<td>$31,200</td>
</tr>
<tr>
<td>Implementation costs (RN time)</td>
<td>Saved costs from decreased levels ordered</td>
</tr>
<tr>
<td>$7,000</td>
<td>$2,543</td>
</tr>
<tr>
<td></td>
<td>Soft savings from reduced LVN time</td>
</tr>
<tr>
<td></td>
<td>$5,120</td>
</tr>
</tbody>
</table>

### ROI Calculation:

- Internal Rate of Return: 109%
- Modified Internal Rate of Return: 56%
Act: The Next Step...

• Continuing education.

• Plan to expand staff and physician education to other floors and services of the hospital.

• Post intervention survey.
Limitations

• Retrospective nature of the study may have led to inaccuracies in data collection.
• Small sample size.
• Educational intervention may not have captured all physicians and nursing staff.
• Ensuring continuing education of all staff.
• Caution should be exercised in the population with renal impairment as this were not evaluated in this study.
Conclusion

• The incorporation of a vancomycin dosing order set within the CPOE system in concurrence with provider and nursing staff education led to:

  ➢ Increased the rate of appropriate weight-based dosing.
  ➢ Shortened mean time to achieving appropriate, target serum trough concentrations.
  ➢ Decreased overall length of stay.
References


Thank you!