Adequacy of a single dose of vancomycin as antimicrobial prophylaxis in posterior spinal fusion surgery for adolescent idiopathic scoliosis

P Joseph [a], D Chau [b], T Vazifedan [c], J Chow [d], CP Comstock [e], M Gangadharan [f]

[a] Pediatrics Resident, Driscoll Children's Hospital; [b] Dept. of Pediatrics ,Div. of Anesthesia, Eastern Virginia Medical School ; [c] Biostatistician Children's Hospital of the King's Daughters; [d] Pharm.D, Children's Hospital of the King's Daughters; [e] Dept. of Pediatric Orthopedics, Driscoll Children's Hospital; [f] Dept. of Anesthesiology and Critical care, UTMB Galveston

BACKGROUND

- Surgical site infection (SSI) is a serious complication of spinal fusion surgery for adolescent idiopathic scoliosis (AIS).
- Vancomycin is used for prophylaxis at our hospital due to a high incidence of MRSA (62.4% of staph aureus isolates in 2003).
- No guidelines are available for re-dosing vancomycin during this procedure. Data regarding appropriate trough levels for surgical prophylaxis are also not available.
- Infectious Disease Society of America (IDSA) recommends maintaining vancomycin concentrations above 10 mcg/ml to prevent the development of antibiotic resistance.

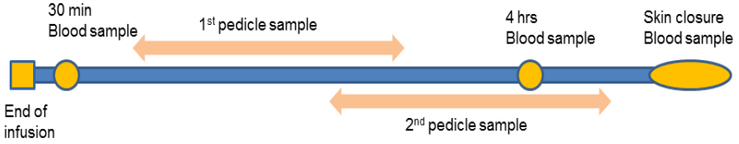
AIMS Determine if:

(a) one dose of vancomycin (15 mg/kg) administered intravenously within two hours prior to incision resulted in adequate serum levels for the duration of surgery in AIS,

(b) vancomycin reached the surgical site (vertebral pedicles) in adequate concentrations.

METHOD

- Prospective observational study at a freestanding tertiary care children's hospital with local IRB approval. Cost of testing was absorbed by the pathology dept. No other costs were incurred.
- Fifteen eligible consecutive patients were enrolled after consent, between July 2016 and February 2017.
- Vancomycin (15 mg/kg) was administered intravenously within 2 hours before surgical incision
- Collected 3 peripheral and 2 vertebral pedicle blood samples according to the timeline below.



- Data recorded: fluid/product administration, urine output, EBL at each time point, demographics, comorbidities, preop creatinine and eGFR.
- Since pedicle samples were not taken coincidentally with peripheral samples, pharmacokinetic equations were used to estimate and compare simultaneous values at these two sites.

Pharmacokinetic Equations used

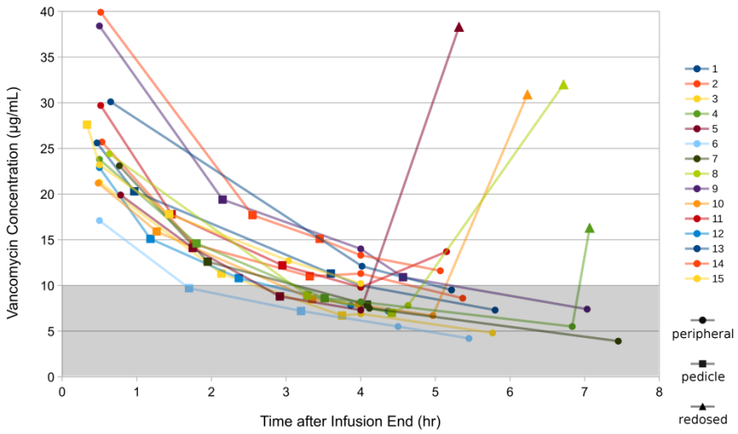
Elimination rate constant

$$k_e = \frac{CL}{V_d} = \frac{ln\left(\frac{C_1}{C_2}\right)}{t_2 - t_1} = \frac{lnC_1 - lnC_2}{t_2 - t_1}$$

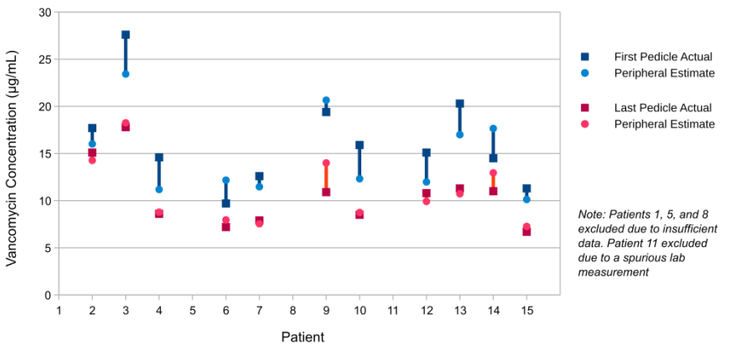
Plasma concentration

$$C = C_0 \cdot e^{-k_e t}$$

All Peripheral and Surgical Site Samples for All Patients



Surgical Site Measurement and Peripheral Estimate Comparison



Mean Error: First Pedicle: -1.34 µg/mL, Last Pedicle: 0.42 µg/mL
Error S.D.: First Pedicle: 2.57 µg/mL, Last Pedicle: 1.21 µg/mL

POWER OF THE STUDY

- A priori power analysis indicated a sample size of 10 would yield 80% power to detect a fall in vancomycin concentration from 30 µg/ml to 10 µg/ml (i.e from peak to skin closure) with $p < 0.05$ with moderate effect size.

ELIGIBILITY CRITERIA

- Inclusion: Patients undergoing posterior spinal fusion for AIS and using vancomycin for antimicrobial prophylaxis who provided written consent and assented.
- Exclusion: Patients with impaired renal function, vancomycin allergy, presurgical antibiotic use, or refusal to consent.

RESULTS

- Intraoperative Vancomycin concentration in peripheral blood:
  - 13 of 15 (87%) lowest vancomycin level fell below 10 µg/ml
  - 3 of 15 (20%) lowest vancomycin level fell below 5 µg/ml
- Vancomycin concentration at surgical site fairly similar to peripheral blood concentration calculated by pharmacokinetic modeling at that time point.

LIMITATIONS

- Limited to five samples per patient due to resources, thus limiting ability to measure peripheral blood and surgical site samples simultaneously.
- Intrinsic pharmacokinetic modeling limitations due to limited number of measured levels and dynamic intraoperative conditions.

DISCUSSION

- Most vancomycin concentrations were **not** maintained above the goal of 10 µg/ml.
- The authors recommend re-dosing vancomycin every 6 hours during surgery in patients with normal renal function, as the risks of vancomycin are very low with short courses.
- The concentration of vancomycin achieved at the surgical site (vertebral pedicle) was similar to that in the peripheral blood. This can likely be extrapolated to other drugs with similar pharmacokinetic properties.

FUTURE DIRECTIONS Study:

- Simultaneous correlation of surgical site and serum levels
- Appropriate serum trough levels for surgical prophylaxis to minimize SSI
- Intraoperative factors affecting vancomycin surgical site and serum levels (EBL, fluid management, UOP, etc). ~85 patients needed for accurate correlations.

REFERENCES

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