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Pediatric Clinical Pearls

Disclosure

- The program chair and presenters for this continuing education activity have reported no relevant financial relationships.

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Pediatric Clinical Pearls: Statins in Pediatric Heart Transplantation

Emily Benefield, PharmD, BCPS, BCPPS
Advanced Clinical Pharmacist-Pediatric Solid Organ Transplant
Primary Children's Hospital
Salt Lake City, UT

Learning Objective

- Evaluate the potential benefits and risks of using HMG co-A reductase inhibitors (statins) following pediatric heart transplantation.

What do the guidelines say?

- "In adults, the use of statins beginning 1 to 2 weeks after heart transplant is recommended regardless of cholesterol levels."
  - Class I, Level of evidence A
- "Routine use of statins in recommended for all pediatric patients with evidence of hyperlipidemia, CAV, or after retransplantation."
  - Class IIa, Level of evidence C
- "Routine use of statins is recommended for adolescents and selected younger children with an increased risk of rejection and CAV."
  - Class IIb, Level of evidence C
- "Statin therapy has been shown to reduce CAV and improve long-term outcomes regardless of lipid levels and should be considered for all heart transplant recipients (adult and pediatric).
  - Class I, Level of evidence A

CAV = Cardiac Allograft Vasculopathy

Costanzo MR et al. J Heart Lung Transplant. 2010;29:914-56.

Initial Pediatric Evidence for Statin Use

Study	Intervention	Immuno-supression	Outcomes
Mahle WT, et al. Retrospective, single center	Pravastatin (n=90) vs no statin (n=39)	Steroid sparing	Trend toward ↓ incidence of CAV (≥50% stenosis) (p=0.07) in univariate analysis
Lukito CC, et al. Retrospective, single center	Atorvastatin initiation ≤ 9 weeks of transplant (n=33) vs. no statin/late start (n=32)	CSA predominate Induction with daclizumab and OKT3	↓ incidence of CAV (≥25% stenosis) (p<0.005) ↓ episodes of rejection treated in the first year post-transplant (p=0.0005)

CAV = Cardiac Allograft Vasculopathy, CSA = Cyclosporine, OKT3 = Muromomab

Lukito CC et al. Pediatr Transplant. 2008;12:442-6.
Mahle WT et al. J Heart Lung Transplant. 2005;24:63-6.

Retrospective Review of Pediatric Statin Use

- Registry data
- Statin in first year post-transplant (n=317) vs. no statin prior to event (n=647) in children 5-18 years of age
- Baseline characteristics:
  - Tacrolimus based immunosuppressive regimens most common
  - Statin group:
    - Induction therapy more common
    - Maintenance steroids more common
    - More patients with panel reactive antibody > 10%
- Results:
  - ↑ incidence of rejection following the first year post-transplant
  - No difference in overall survival or CAV

Greenway SC et al. J Heart Lung Transplant. 2016;35:457-65.

Key Takeaways

- Statins remain standard of care for all heart transplant patients at high risk for CAV despite new evidence that may have selected for patients at higher risk of rejection

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Dexamethasone versus Prednisolone in Pediatric Asthma: Less is More!

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Pediatric Clinical Pharmacist: Medication Therapy Management
Children's Hospitals and Clinics of Minnesota
Minneapolis, MN

Do You Utilize Dexamethasone for Management of Acute Asthma Exacerbations in Your Practice?

A YES

B NO

Quick Guideline Review: Asthma Exacerbation Management

	NAEPP 2007	GINA 2016
Home	Initiate OCS treatment under certain circumstances (AAP)	Add OCS for patients with severe exacerbation or not responding to treatment over 48 hrs (AAP)
Primary Care/ED/Hospital	SABA + OCS + oxygen +/- ipatropium +/- IV magnesium	SABA + early initiation of OCS + controlled oxygen +/- ipatropium +/- IV magnesium

OCS, oral corticosteroids; SABA, short acting beta agonist; AAP, asthma action plan

Bottom line: "systemic corticosteroids speed resolution of exacerbations and prevent relapse, and should be utilized in all but the mildest exacerbations"

What Agent What Dose: Guidelines

	NAEPP 2007	GINA 2016
Prednisolone/prednisone	Adult: 40-60 mg in a single or divided doses for 5-10 days	Adult: 1 mg/kg, max 50 mg/day x 5-7 days
	Child: 1-2 mg/kg/day, max 60 mg in 2 divided doses for 3-10 days	Child 6-11 years: 1-2 mg/kg/day , max 40 mg/day x 3-5 days
Hydrocortisone	N/A	200 mg in divided doses
Dexamethasone	N/A	Oral dexamethasone for 2 days can also be used

"Other systemic corticosteroids such as hydrocortisone and dexamethasone given in equipotent daily doses are likely to be as effective as prednisolone"

Let's Compare

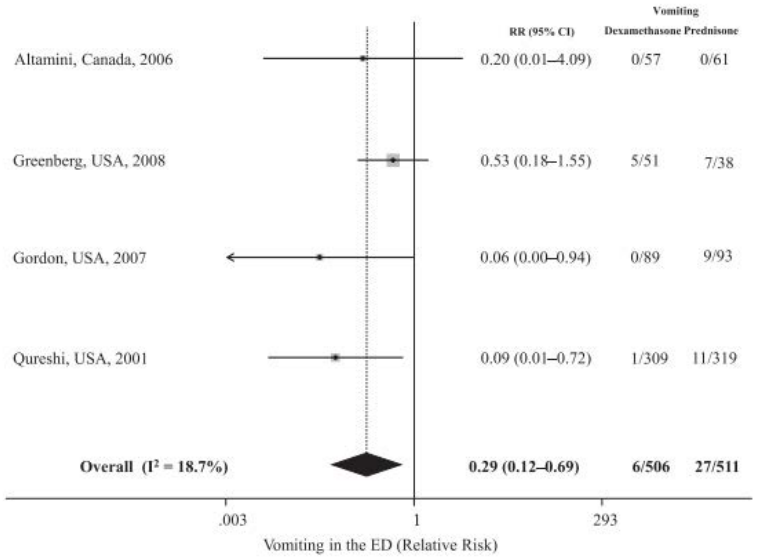
Medication	Route	Potency	Onset	Duration	Taste	Cost
Prednisolone	PO	4	1-2 hrs	1-2 days	Poor, bitter	Most
Dexamethasone	PO	25 to 30	1 hr	2.5-3 days	Excellent *compounded	Least
Dexamethasone	IM	25 to 30	<1 hr	3-6 days	N/A	Middle

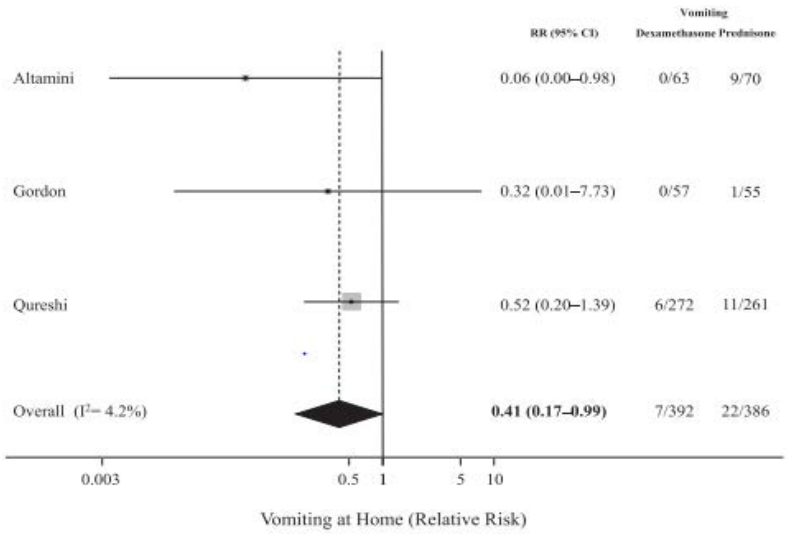
Compliance

- Caregivers report compliance to OCS regimen only 64% of time
- Impact of non-compliance
  - 14 day ED relapse rate with OCS compliance 6.3%
  - 14 day ED relapse rate with OCS non-compliance 17.4%
- As many as 70% of the parents of children receiving either oral prednisone or IM dexamethasone said they would prefer the IM injection

Adverse Effects

- Nausea/Vomiting
  - General
    - Dex <1%
    - Pred 5-10%
  - Clinical studies
    - Pred: 5.7%
    - Dex: 0%





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Meat and Potatoes: Single Oral Dose

Author	Results
Altamini et al 2006, Canada	134 children 2-16 yo ED patients PO Dex 0.6 mg/kg x 1 vs Pred 2 mg/kg/day x 5 days No statistical difference (clinical difference?) 5-day relapse rates of 6.6% with Dex versus 1.8% with Pred
Cronin et al 2016, Dublin	226 children 2-16 yo ED patients PO Dex 0.3 mg/kg x 1 vs. Pred 1 mg/kg/day x 3 days No significant difference 13.1% Dex group required further OCS within 14 days vs. 4.2% Pred

Meat and Potatoes: Multiple Oral Doses

Author	Results
Qureshi et al 2001, US	628 children 2-18 yo ED patients PO Dex 0.6 mg/kg x 2 vs. Pred 2 mg/kg/day x 5 days No significant difference 10-day relapse rates of 7.4% with Dex versus 6.9% with Pred
Greenberg et al 2008, US	89 children 2-18 yo ED patients PO Dex 0.6 mg/kg x 2 vs. Pred 2 mg/kg/day x 5 days No significant difference 10-day relapse rates of 15.7% with Dex versus 8% with Pred

Meat and Potatoes: Hospitalization

Author	Results
Parikh et al 2015, multicenter	40,257 children 4-17 yo HOSPTIALIZED patients, 2.9% received Dex No Dex dosing or route information LOS shorter in Dex group No difference in all cause re-admission Lower cost

Pediatric Study Conclusions

- No difference in rate of hospitalization during initial ED visit
- No statistical difference in relapse rate between groups at any time point up to 30 days
- Patients who received Dex were less likely to experience vomiting in either the ED or at home
- Compliance rate when measured was >96%

"Practitioners should consider single or 2-dose regimen of dexamethasone as a viable alternative to a 5 day course of prednisone/prednisolone"

Key Takeaways

- Dexamethasone and prednisolone are equally efficacious
- Dexamethasone is better tolerated than prednisolone and simplicity is preferred by families
- Suggest dexamethasone 0.6 mg/kg (max 16 mg) X1 and repeat in 48 hours for pediatric patients with acute asthma

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Cystic Fibrosis Transmembrane Conductance Regulator (CFTR) Modulators: Changing the Future of Cystic Fibrosis Treatment & Management

Claire Elson, PharmD, BCPPS
Clinical Pharmacy Specialist
Children's Mercy Hospital
Kansas City, MO

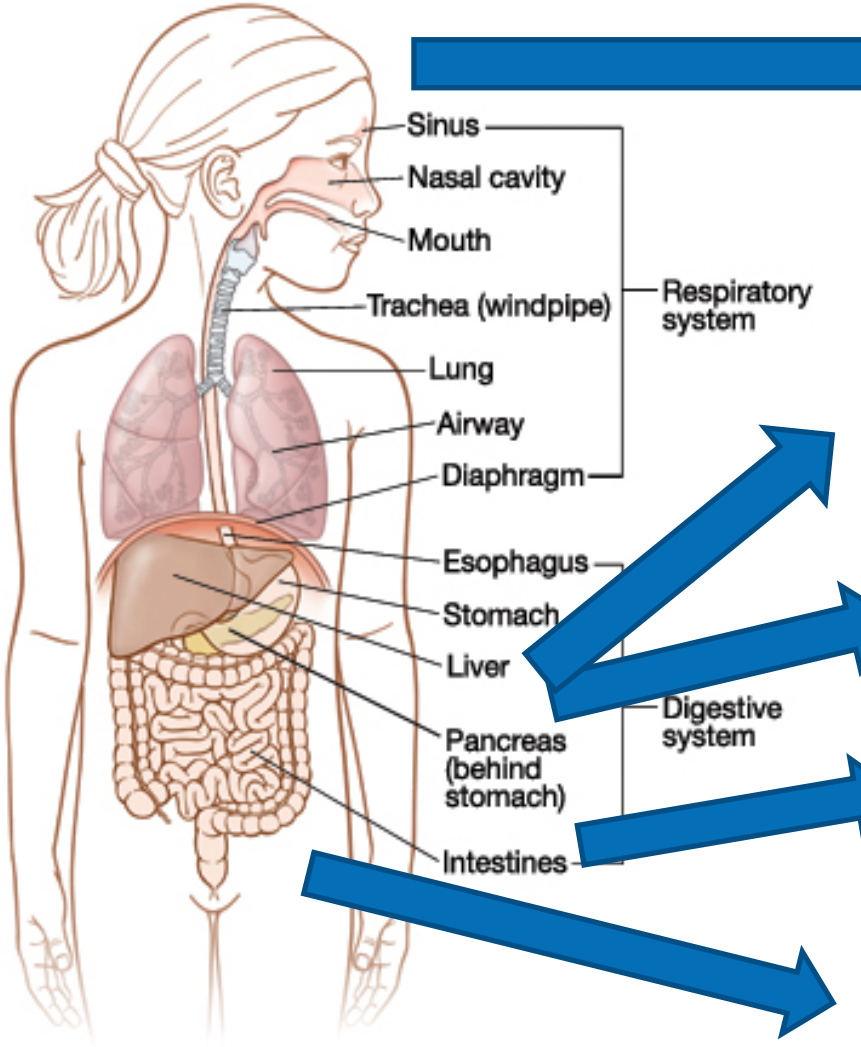
Learning Objective

- Recall relevant drug information regarding CFTR modulators and the pharmacist role with these novel therapies.

Cystic Fibrosis (CF) Basics

- Epidemiology
  - 30,000 individuals in the US
  - 1,000 new diagnosis annually
- Pathophysiology
  - Autosomal recessive mutation in gene encoding the cystic fibrosis transmembrane conductance regulator (CFTR) protein
  - Mutations classified based on functional mechanism into classes I to VI

Manifestations



SINOPULMONARY DISEASE
- Obstructive pulmonary disease
- Nasal polyps
- Infection (sinus, pneumonia, etc.)

HEPATOBILIARY DISEASE
- Biliary: obstruction
- Hepatic: cirrhosis

PANCREATIC DISEASE
- Exocrine: insufficiency
- Endocrine: growth, diabetes

GASTROINTESTINAL
- Obstruction
- Malnutrition & malabsorption

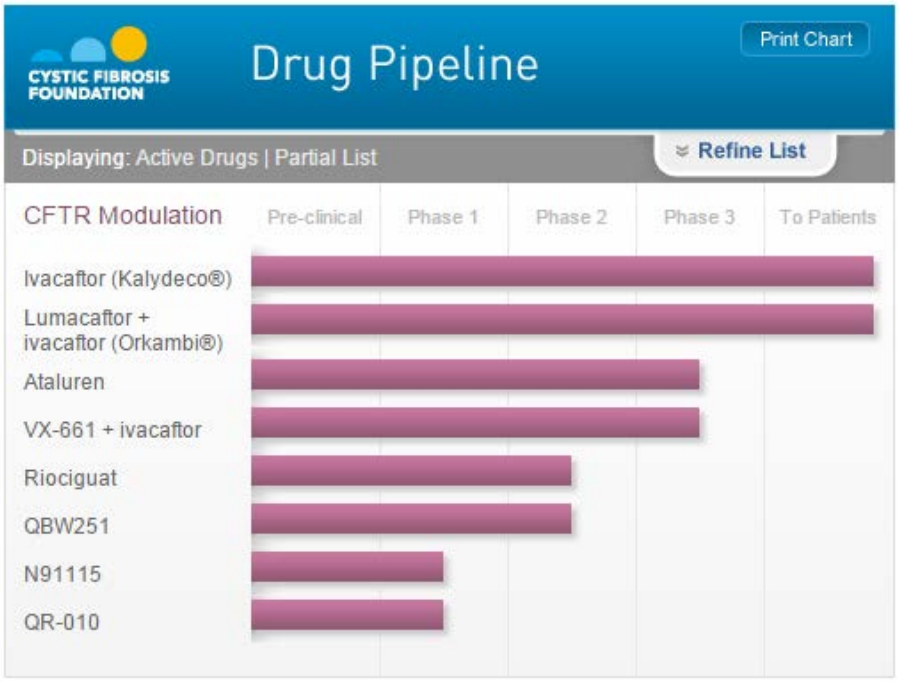
INFERTILITY
- Males: absence of vas deferens
- Females: mucoid obstruction

CF Therapeutic Areas

Historical

- Lung disease
  - Anti-obstructive
  - Anti-infective
  - Anti-inflammatory
- Pancreatic insufficiency & Gastrointestinal Disease

Future

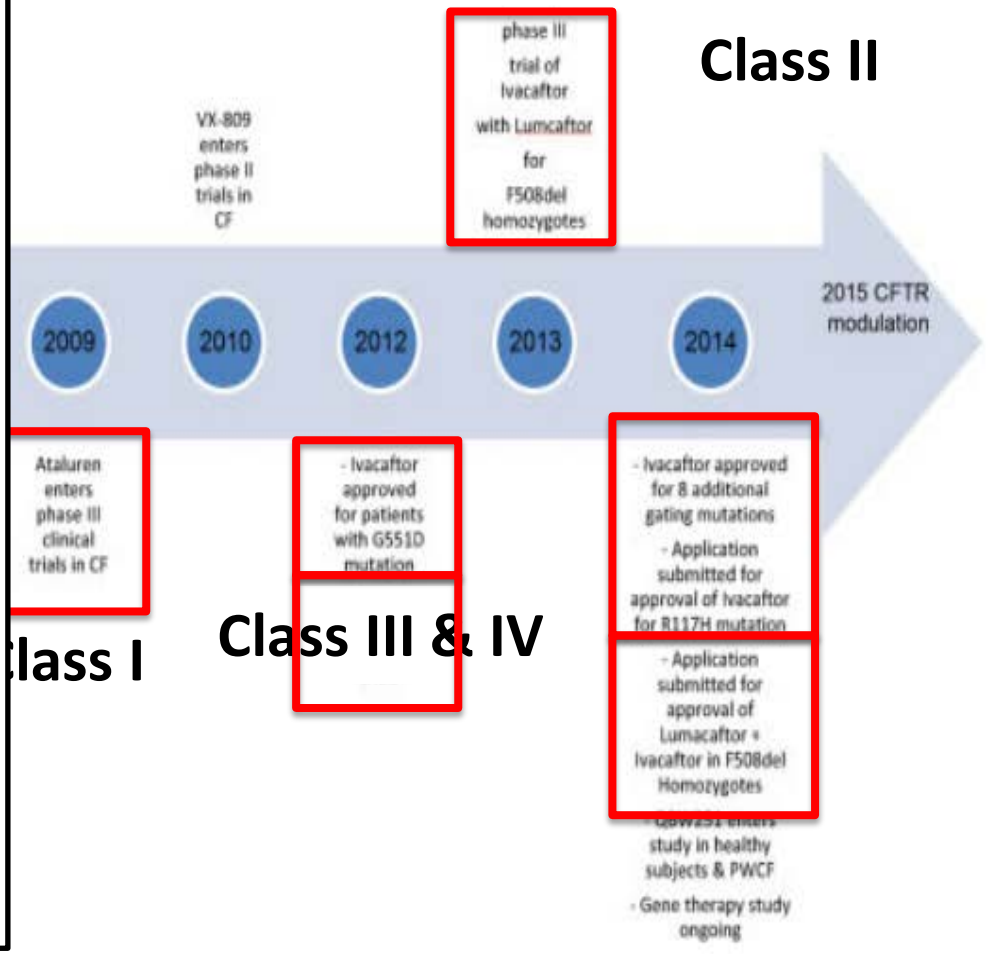


acure4lilchris.blogspot.com
www.cff.org/research/DrugDevelopmentPipeline/

CFTR Modulators Timeline

Ivacaftor/Lumacaftor (Orkambi®)

- FDA approved for CF patients ≥ 6 years old with homozygous F508del mutation
- Dosing & Formulations
  - 6-11 years old: 100 mg lumacaftor/125 mg ivacaftor
  - > 12 years old: 200 mg lumacaftor/125 mg ivacaftor
  - Directions: Two (2) tablets by mouth twice daily
- Outcomes (≥ 12 years old)
  - FEV1, BMI and Exacerbation Rate
  - Non-significant improvement CFQ-R respiratory domain
- AWP: $23907.70/28 day supply



Seminars in Respiratory and Critical Care Medicine Vol. 36 No. 2/2015

Pharmacist Role

- Medication Counseling
  - Administration
  - Drug interactions
- Medication adherence
- Medication access
  - Outpatient
  - Inpatient
- Clinical trials and research

Key Takeaways

- Key Takeaway #1
  - CF pharmacotherapy is changing to more targeted therapies with the introduction and expansion of CFTR modulators.
- Key Takeaway #2
  - As more combinations of CFTR modulators are developed, it is essential to critically evaluate overall healthcare impact in CF.
- Key Takeaway #3
  - Pharmacists play a critical role in monitoring these therapies, especially medication adherence and drug interactions.

In which of the following pediatric heart transplant patient populations is statin therapy recommended?

A. Those at increased risk of cardiac allograft vasculopathy

B. Pediatric patients > 8 years-of-age

C. Children receiving proliferation signal inhibitors

D. Patients at high risk for post-transplant lymphoproliferative disorder

Dexamethasone has been shown to be equally effective to prednisolone for children with acute asthma exacerbation

A TRUE

B FALSE

Which CFTR disease causing mutation does NOT have an FDA approved CFTR modulator?

A. G551D

B. Homozygous F508del

C. Heterozygous F508del

D. R117H

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Getting Higher and Higher: Levetiracetam Loading Doses in Status Epilepticus

Stephanie Weightman, PharmD, BCPS, BCPPS
Clinical Pharmacist – Emergency Department
Children's Health – Children's Medical Center Dallas

Learning Objective

- Examine new recommendations of larger loading doses of levetiracetam in acute management of pediatric status epilepticus

What's the actual mechanism of action?

- Binds to synaptic vesicle protein SV2A
  - Saturable and stereoselective
- Inhibition of voltage-dependent N-type calcium channels
- Facilitation of GABA-ergic inhibitory transmission
- Reduction of delayed rectifier potassium current

Shetty AK. *Front Neurol.* 2013;4:172:1-6.
Lee YJ et al. *Korean J Pediatr.* 2016;59(1):35-39.

Where is levetiracetam's place in acute management of status epilepticus (SE)?

- Levetiracetam use varies by patient age
- Prevention of SE-induced brain edema and neuronal loss
- ↑ antioxidant cysteine/glutamate exchanger
- A pharmacist's dream!

Itoh K et al. *Brain Res.* 2015;1608:225-34.
Riviello JJ Jr et al. *Neurocrit Care.* 2013;18(2):193-200.
Shetty AK. *Front Neurol.* 2013;4:172:1-6.

Increasing Levetiracetam Doses in Acute Management

- Single dose 29.4 ± 13.5 mg/kg within 30 minutes of seizure
  - 74 patients (mean age 5.59 ± 5.6 years)
  - Serial seizures (79%), single seizure (12%), SE (8%)
  - 89% seizure-free at 1 hour
    - >80% SE patients
- Loading dose 50 mg/kg (range 25 – 70 mg/kg) + maintenance 25 mg/kg BID
  - 32 patients (2 months – 18 years)
  - 16 patients with SE
    - 46.87% SE patients responded favorably; clinical and EEG improvement at 30 minutes

Reiter PD, et al. *Pediatr Neurol.* 2010;43(2):117-121.
Kirmani BF, et al. *Pediatr Neurol.* 2009;41(1):37-39.

High-dose Levetiracetam for Acute Seizure Exacerbation

- 9 patients (mean age 2.0 ± 1.2 years)
- Mean dose 228 ± 48 mg/kg/day
- Levetiracetam-naïve
  - 30 mg/kg/dose
  - Day 1: every 8 hours
  - Day 2: every 6 hours
  - Day 3: every 4 hours

- 8/9 patients resolution in acute repetitive seizures

- Tolerated without agitation, behavioral changes, or somnolence

Depositario-Cabacar DT et al. *Epilepsia.* 2010;51(7):1319-22.

Evidence Based Guidelines

Neurocritical Care Society 2012

- SE in critically ill patients
- Levetiracetam 20 – 60 mg/kg (1000 – 3000 mg)
  - Emergent, Urgent, Refractory (Class IIb, level C)

American Epilepsy Society 2016

- Convulsive SE
- Levetiracetam 60 mg/kg; max 4500mg/dose
  - Second therapy phase (Level U)

ESETT Study

Brophy GM et al. *Neurocrit Care.* 2012;17(1):3-23.
Glauser T et al. *Epilepsy Curr.* 2016;16(1):48-61.

Key Takeaways

- Key Takeaway #1
  - Newer data increasingly supports the use of high dose levetiracetam loading doses (60 mg/kg/dose) in acute status epilepticus.

- Key Takeaway #2
  - ESETT study may help elucidate levetiracetam's preferred place in acute status epilepticus management.

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Delirium in the NICU: Not Just a PICU Problem

Bob John, Pharm.D.; BCPS; BCPPS
NICU Clinical Pharmacy Specialist
The Children's Hospital at Saint Francis
December 5, 2016

Objectives

- Describe identification tools and treatment plans for delirium that have been used in neonates

My NICU Currently Evaluates Neonates for Delirium

A TRUE

B FALSE

Delirium in Pediatrics

- Delirium
  - An acute and fluctuating change in awareness and cognition
  - Occurs in the setting of serious medical condition
- Pediatric Intensive Care Unit (PICU) delirium recognized in more than 20% of patients

Silver G. Pediatr Crit Care Med. 2015;16(4):303-309.
Groves A. Pediatrics. 2016;137(3):e200153369.

Case Reports of Delirium in Neonates

Case	Symptoms	Medications	Treatment
• **Infant** boy • Congenital heart defects • ECMO	• Altered sleep wake-cycle • Increased agitation	• Fentanyl • Morphine • Lorazepam	• Olanzapine 1.25 mg orally as needed for agitation

ECMO=extracorporeal membrane oxygenation

Madden K. Pediatr Crit Care Med. 2011;12(6): 413-415.

Case	Symptoms	Medications	Treatment
Infant girl (CGA*=17 weeks) • Cardiac disease	• Increasing respiratory support • Increased agitation • Frequently inconsolable • Altered sleep wake-cycle	• Morphine 20 mcg/kg/hr • Midazolam 70 mcg/kg/hr • Dexmedetomidine 0.8 mcg/kg/hr	• Quetiapine 0.5 mg/kg every 8 hours • Increased to every 6 hours after 5 days • Tapered off over 2 weeks

CGA= Corrected Gestational Age, mcg= microgram, kg=kilogram, hr=hour

*Corrected age is calculated by subtracting the number of weeks born before 40 weeks of gestation from the chronological age

Groves A. Pediatrics. 2016;137(3):e200153369.

Case	Symptoms	Medications	Treatment
Infant girl (CGA*=11 weeks) • Cardiac disease • Infection	• Increasing respiratory support • Increased agitation • Frequently inconsolable • CAPD=16	• Fentanyl 1 mcg/kg/hr • Dexmedetomidine 0.3 mcg/kg/hr, increased to 0.6 mcg/kg/hr • No benzodiazepines in the previous 7 days	• Quetiapine 0.5 mg/kg every 8 hours for 2 months before transferred out

CGA= Corrected Gestational Age, mcg= microgram, kg=kilogram, hr=hour, CAPD=Cornell Assessment of Pediatric Delirium

*Corrected age is calculated by subtracting the number of weeks born before 40 weeks of gestation from the chronological age

Groves A. Pediatrics. 2016;137(3):e200153369.

Case	Symptoms	Medications	Treatment
Infant boy (CGA*= 4 weeks) • Complex congenital disorder	• Increased agitation • Frequently inconsolable • CAPD scores 12-14	• Morphine 100 mcg/kg as needed • Midazolam 50 mcg/kg/hr	• Quetiapine 0.5 mg/kg every 8 hours for 5 weeks then transferred to rehabilitation center

CGA= Corrected Gestational Age, mcg= microgram, kg=kilogram, hr=hour, CAPD=Cornell Assessment of Pediatric Delirium

*Corrected age is calculated by subtracting the number of weeks born before 40 weeks of gestation from the chronological age

Groves A. Pediatrics. 2016;137(3):e200153369.

Case	Symptoms	Medications	Treatment
Infant girl (CGA* unknown) • Congenital heart defects • Trisomy 21 • Weight 7.8kg	• Altered sleep wake-cycle • Increased agitation • Unstable vital signs	• Morphine 40 mg (5 mg/kg)every 6 hours • Lorazepam 4 mg (0.5mg/kg) every 6 hours • Methadone 5 mg (0.6mg/kg) every 6 hours • Furosemide 400 mcg/kg/hr	• Risperidone 0.125 mg at bedtime via NG • Dose increased to 0.3 mg • Dose tapered off over 6 weeks

CGA= Corrected Gestational Age, mcg= microgram, kg=kilogram, hr=hour, CAPD=Cornell Assessment of Pediatric Delirium, NG = nasogastric tube

*Corrected age is calculated by subtracting the number of weeks born before 40 weeks of gestation from the chronological age

Brahmbhatt K. Pediatrics 2016;137(3):e20151940.

Monitoring for Delirium

- Vital signs
  - Heart rate, blood pressure, respiratory rate
- Behavior
  - Altered wake-sleep cycle, inconsolable
- Medications
  - Opioids –morphine, methadone, fentanyl
  - Benzodiazepines – lorazepam, midazolam
- Assess and document every 8-12 hours
  - At least once per shift

Groves A. Pediatrics. 2016;137(3):e200153369.
Harris J. Intensive Care Med. 2016;42:972-986.

Monitoring for Delirium

- **Cornell Assessment Pediatric Delirium tool (CAP-D)**
  - **0 to 18 years of age**
- Pediatric Confusion Assessment Method for ICU (pCAM-ICU)
  - 5 years of age and older

Harris J. Intensive Care Med. 2016;42:972-986.
Traube C. Crit Care Med. 2014; 42:656-663.

Treatment Options

Pharmacologic

- Atypical Antipsychotics
  - **Quetiapine** 0.5 mg/kg orally every 8 hours
    - One case report increased to every 6 hours
  - **Risperidone** 0.125 mg orally daily at bedtime
    - One case report increased to 0.3 mg once daily
  - **Olanzapine** 1.25 mg orally at bedtime as needed for agitation
- Baseline and repeat EKG
- Taper dose up only if needed and down

Groves A. Pediatrics. 2016;137(3):e200153369.
Brahmbhatt K. Pediatrics 2016;137(3):e20151940.
Madden K. Pediatr Crit Care Med. 2011;12(6): 413-415.

Key Takeaways

- **Key Takeaway #1**
  - Delirium is a concern in neonates in both the NICU and PICU
- **Key Takeaway #2**
  - CAP-D is the only scoring system that has been validated in neonates
- **Key Takeaway #3**
  - Atypical antipsychotics have been used to treat delirium in neonates

Appendix 1

Summary of Case Reports	
Case	**Treatment**
Infant girl (CGA=17 weeks)	• Quetiapine 0.5 mg/kg every 8 hours • Increased to every 6 hours after 5 days • Tapered off over 2 weeks
Infant girl (CGA=11 weeks)	• Quetiapine 0.5 mg/kg every 8 hours for 2 months
Infant boy (CGA= 4 weeks)	• Quetiapine 0.5 mg/kg every 8 hours for 5 weeks
Infant girl (CGA unknown)	• Risperidone 0.125 mg at bedtime via NG • Dose increased to 0.3 mg • Dose tapered off over 6 weeks
Infant boy	• Olanzapine 1.25 mg orally as needed for agitation
*Corrected age is calculated by subtracting the number of weeks born before 40 weeks of gestation from the chronological age	

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Not This Again: Vancomycin PK Primer

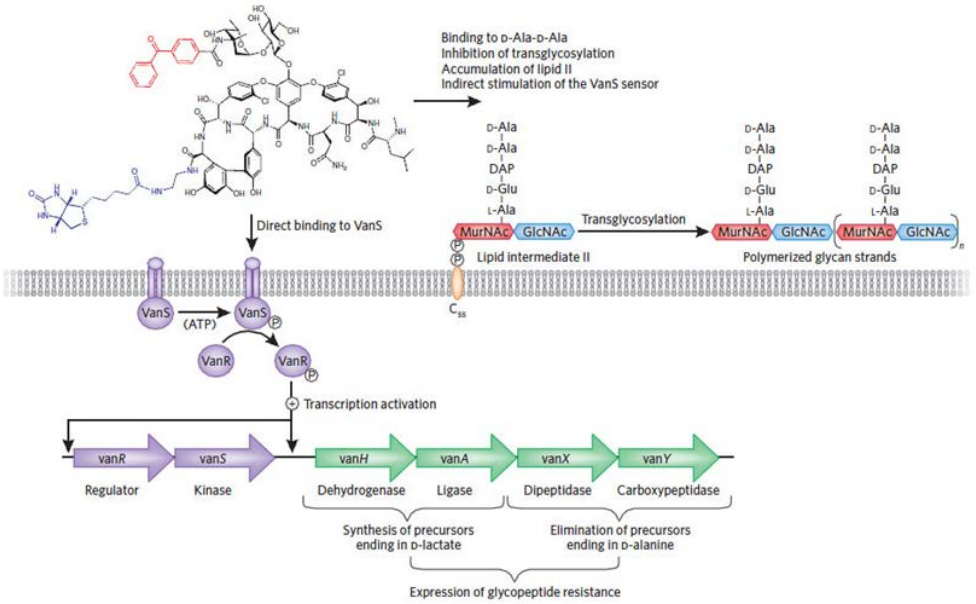
Kyana D. Stewart, MS, PharmD, BCPS
Clinical Specialist Pharmacist, Pediatric Infectious Diseases
Antimicrobial Stewardship Program Co – chair
Children's Health System, Children's Medical Center
Dallas, Texas

Learning Objective

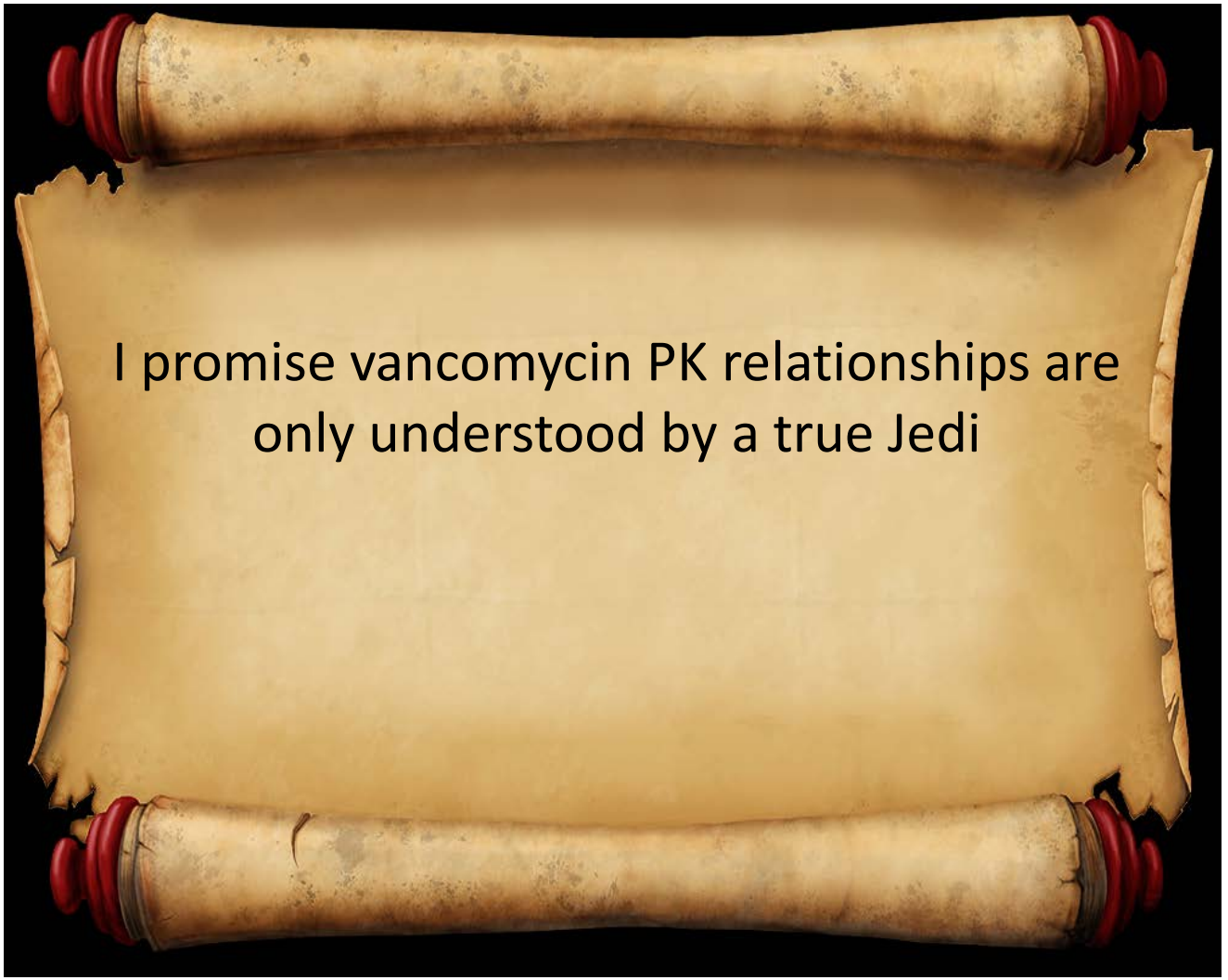
- Describe key pharmacokinetic parameters that may impact vancomycin efficacy in complex pediatric patients

Vancomycin Quick Review

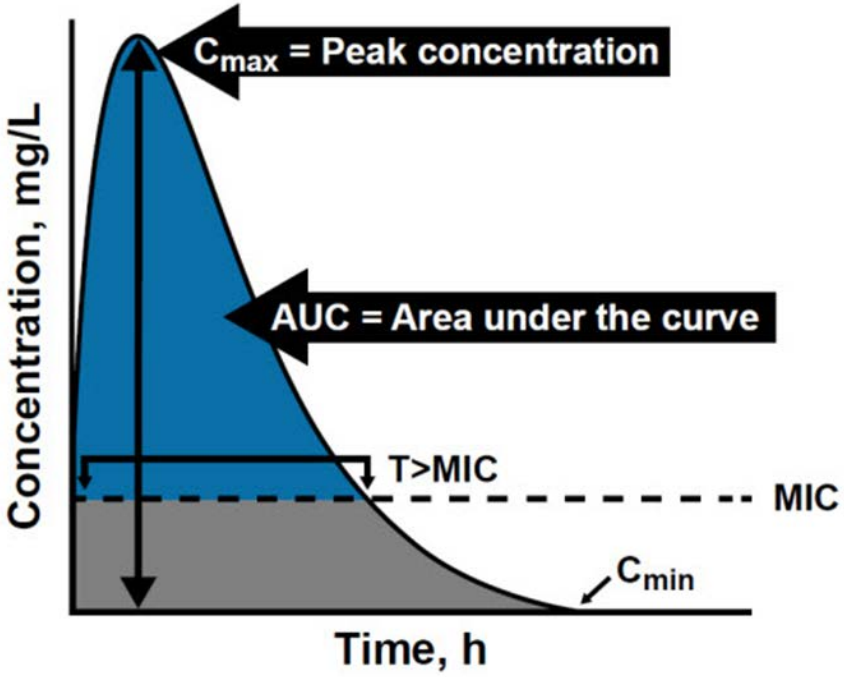
- Mechanism of action
  - Binds to peptidoglycan in gram + bacterial cell wall inhibiting synthesis
- Killing profile
  - Slowly cidal against MRSA
  - Static against enterococci
- Site penetration
  - CNS < 10%
  - Lung 15 – 20%
  - Sternal bone 50 – 60%
  - Heart valve ~ 12%
  - Adipose tissue ~ 15%
  - Muscle 10%
  - Bone 10 – 15%
- **PK/PD Parameter for efficacy**
  - **AUC:MIC > 400**

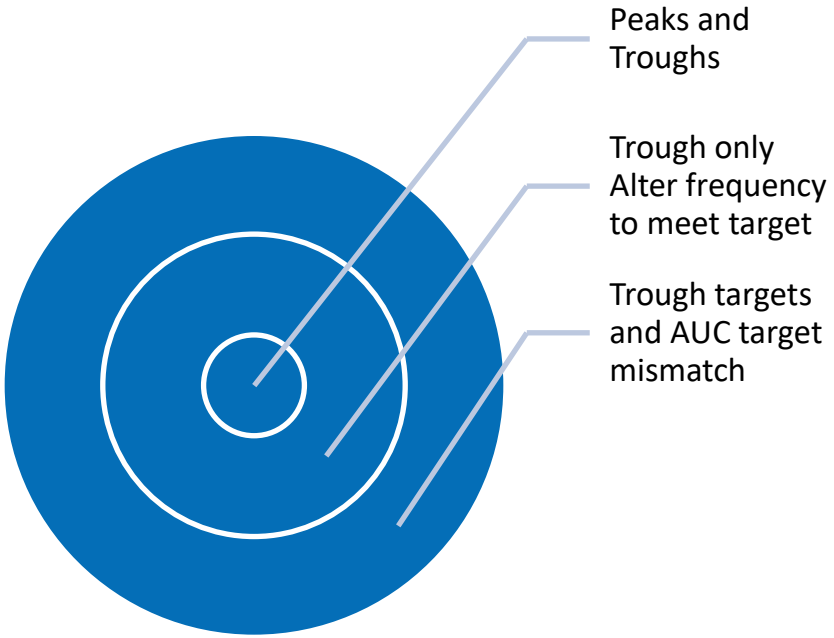


Vancomycin PK Pledge



Pharmacodynamic Parameter for Efficacy





Lodise T, Drusano G, Zasowski E, et al. CID 2014
Walraven C, North M, Marr-Lyon L, et al. J Antimicrob Chemother 2011
Brown D, Lalla C, Masselink A. Ther Drug Monit 2013;35(4):443-49.

Dosing Strategies to Optimize PK/PD Endpoint

Increased frequency of administration

- Every 8 – 12 hour frequency not fit for pediatric patients to reach target attainment C_{min} = 15 – 20 mg/L

Increased total daily dosing

- 20 mg/kg/dosing minimum needed to achieve adult serum targets in pediatric patients
- Oops…vanc induced nephrotoxicity ☹

Surrogate or Actual Target?

- Trough target & AUC:MIC mismatch
- Vancomycin as a narrow therapeutic index drug?

Brown D, Lalla C, Masselink A. Ther Drug Monit 2013.
Jin A, Yoon H, Ahn, et al. Infect Chemother. 2014.
Kullar R, Davis S, Levine D, Rybak M. CID 2011.
Frymoyer A, Hersh A, Benet L, et al. *Pediatr Infect Dis J*. 2009.
Benner K, Worthington M, Kimberlin D, et al. *J Pediatr Pharmacol Ther*. 2009.

Dosing Strategies to Optimize PK/PD Endpoint

Increased frequency & continuous infusions

- Optimize frequency based on age and developmental PK/PD changes
  - Infants and children
  - Rapid metabolic changes
  - Rapid fluid shifts

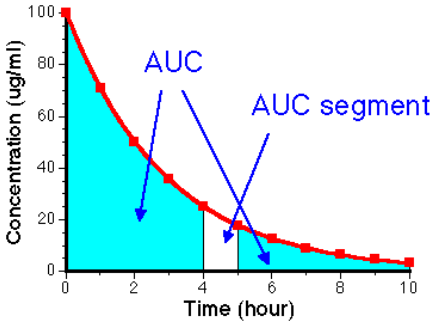
Utilization of loading doses for earlier target attainment

- 30 mg/kg/dose suggested in 2009 guidelines
- Mixed data in pediatrics
  - Weight and age stratified loading dose regimen proposed (16 – 30 mg/kg/dose)
- Renal impairment must be considered

Frymoyer A, Hersh A, Benet L, et al. *Pediatr Infect Dis J*. 2009.
Benner K, Worthington M, Kimberlin D, et al. *J Pediatr Pharmacol Ther*. 2009.
Bhagat and Bartlett. *Open Forum Infect Dis* 2014.
Janssen et al. Antimicrob Agents Chemother 2016.

Methods of AUC Extrapolation

- Linear Trapezoidal Rule
  - Break into pieces and add them up!
  - Will require multiple serum concentrations
  - AUC = $\sum \frac{C_1 + C_2}{2} X(t_2 - t_1) + \ldots$
- Vancomycin AUC Bedside Method
  - Obtain MIC from clinical laboratory
  - Estimate CrCl using the modified Schwartz
  - Calculate vancomycin clearance
    - CL (L/h) = $0.248 \times Wt^{0.75} \times (0.48/SCr)^{0.361} \times [Ln(age)/7.8]^{0.995}$
  - AUC (mg hr/L) = $\frac{\text{Daily vancomycin dose (mg/day)}}{\text{Calculated CL}}$



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Key Takeaways

- Key Takeaway #1
  - Vancomycin frequency of administration should be empirically increased as age decreases outside of the neonatal period to attain acceptable serum targets.
- Key Takeaway #2
  - A tiered approach that utilized AUC based extrapolations may be a better reflection of adequate serum exposure as compared to serum trough measurements.
- Key Takeaway #3
  - Consideration of loading doses for earlier target attainment may be advantageous in pediatric patients

In patients ≥1 year of age, levetiracetam loading doses should never exceed 30 mg/kg/dose (maximum 1000 mg/dose).

A TRUE

B FALSE

Symptoms of delirium in a neonate can be identified by utilizing which of the following scales?

A. Delirium Rating Scale–Revised -98 (DRS-R98)

B. Pediatric Confusion Assessment Method for ICU (pCAM-ICU)

C. Sophia Observation Withdrawal Symptoms-Pediatric Delirium Scale (SOS-PD)

D. Cornell Assessment Pediatric –Delirium (CAP-D)

The pharmacodynamic parameter for efficacy of vancomycin is reflected by which of the following?

A. Serum trough level

B. AUC > 400 mg/L*hr

C. AUC/serum trough level

D. AUC/MIC > 400 mg/L*hr