Abstract # 1823

Signal or Noise? A Comparison of Methods to Identify Outliers in Antimicrobial Use

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Abstract

Background: Antimicrobial Stewardship Programs (ASPs) use AU benchmarking data to help identify areas in need of investigation. The high frequency and wide variation in AU make statistical tests frequently significant.

Methods: We compared four statistical methods of analyzing AU data to quantify how often statistically significant outliers occur. We analyzed days of therapy (DOT) per 1000 days present (dp) from 2017 in medical and surgical adult wards and three NHSN AU antibiotic groups: anti-MRSA agents (anti-MRSA), broad agents for community-onset infections (CO), and broad agents for hospital-onset multidrug resistant organisms (HO/MDRO). Outliers were defined as follows: 1. Units ≥90th or ≤10th percentiles, 2. Units with Standardized Antimicrobial Administration Ratios (SAARs) outside 95% confidence intervals (CI), 3. Units with observed rates outside 95% CI predicted by a generalized estimating equation (GEE) negative binomial regression model 4. Units with observed rate outside 95% CI predicted by mixed effects negative binomial regression model with hospital as a random effect. Adjustment in method 2 included hospital teaching status and location type. Methods 3 and 4 included adjustment for teaching status, location type, average age, average hospital length of stay, surgical volume, percent sepsis admissions, and average DRG weight.

Results: Fifty-five units and 628,358 dp were included in the 1-year sample. Each method identified both positive and negative outliers. SAAR and GEE methods identified the largest number of outliers; percentiles identified the least (Table). The four methods identified different individual units as outliers (Figure).

Conclusion: Overly sensitive statistical methods may produce more signals than are clinically meaningful. Investments of ASP resources to investigate such signals may vary widely depending on statistical method used. Additional research is required to develop AU analysis methods with high positive predictive value.

Background

- ASPs use benchmarking of AU to help identify areas in need of investigation and optimization. Ideal rates of AU are unknown.
- The high frequency and wide variation in AU make statistical tests frequently significant, obscuring which observed differences are important to further investigate.
- For example, >80% of included units were significantly above or below 1 using NHSN methods and groups.[1]

Methods

- **Aim:** Compare four statistical methods to quantify occurrence of statistically significant outliers.
- AU data in days of therapy (DOT) per 1,000 days present from 2017 in adult medical and surgical wards for three NHSN antibiotic groups: Anti-MRSA, broad Community-Onset agents (CO), and broad Hospital-Onset agents (HO/MDRO).
- Compared number (%) of outliers and unit patterns for each method and agent group.

Method	Outlier definition	Adjustment Variables
1. Percentile	High ≥90%; Low ≤10%	none
2. Standardized Antimicrobial Administration Ratio (SAAR)[1]	Outside 95% confidence intervals	Teaching Status Location type
3. Generalized Estimating Equation (GEE) Model	Outside 95% confidence intervals	Teaching status Location type Average Age Average LOS Surgical Volume % sepsis admissions Average DRG weight
4. Mixed Effects Model using hospital as random effect	Outside 95% confidence intervals	Teaching status Location type Average Age Average LOS Surgical Volume % sepsis admissions Average DRG weight

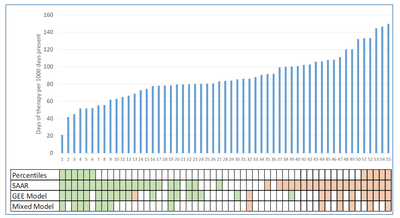
Results

- Fifty-five adult medical and surgical units and 628,358 days present were included in the 1-year sample.
- Each method identified both positive and negative outliers. SAAR and GEE methods identified the largest number of outliers; percentiles identified the least (Table).
- The four methods identified different individual units as outliers (Figures).

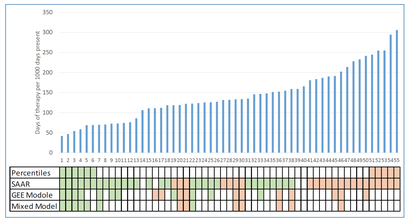
Table: Number (%) of Outliers Per Method

Group	AU in DOT/1000 dp median (IQR)	1. Percentile	2. SAAR	3. GEE model	4. Mixed model
Anti-MRSA	84 (73-103)	10 (18%)	42 (76%)	30 (55%)	14 (26%)
CO	132 (106-184)	10 (18%)	50 (91%)	22 (40%)	14 (26%)
HO/MDRO	132 (118-151)	12 (22%)	38 (69%)	31 (56%)	14 (26%)

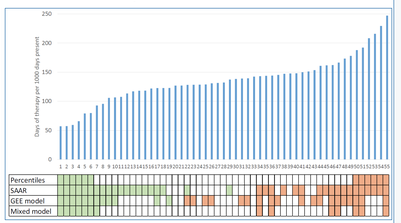
Anti-MRSA



Community Onset



Hospital-Onset/MDRO



Orange=high outlier; Green=low outlier; White=within bounds

Conclusions

- Overly sensitive statistical methods may produce more signals than are clinically meaningful. Investments of ASP resources to investigate such signals may vary widely depending on statistical method used.
- Additional research is required to develop AU analysis methods with high positive predictive value.

1. Van Santen et al. Clin Infect Dis. 2018 Jul 2;67(2):179-185.

RWM was supported by K08 HS023866.