An informatics approach to monitor the coverage of antibiotic regimens using open-source software

Holten, Viggo; Schønheyder, Henrik Carl

An informatics approach to monitor the coverage of antibiotic regimens using open-source software

Viggo Holten[1] & Henrik C. Schønheyder[1,2]

AALBORG UNIVERSITY HOSPITAL

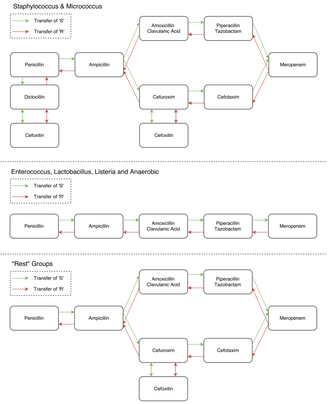
[1]Dpt. Clinical Medicine, Aalborg University; [2]Dpt. Clinical Microbiology, Aalborg University Hospital

AALBORG UNIVERSITY
DENMARK

Introduction

Antibiotic stewardship programs (ASPs) are important local countermeasures to the global problem of antibiotic resistance. An ASP can reserve broad-spectrum antibiotics for patients most in need of effective treatment or prophylaxis. Current recommendations for ASPs emphasize collaboration with departments of clinical microbiology to keep guidelines up-to-date with prevalence of antibiotic resistance. However, antibiotic susceptibility testing (AST) primarily serves the need of the individual patient, and there may be additional constrains. Therefore, AST data can be cumbersome to apply to ASP purposes. A syndromic approach have been suggested (1). We describe here an informatics approach to monitor the coverage of various empirical antibiotic regimens using open source software.

Algorithm used to apply inference within the beta-lactam antibiotic group



Methods

We obtained AST data (SIR classification according to EUCAST) for all blood culture isolates deemed clinically significant from 2011 through 2015 in North Denmark Region (population app. 650,000 inhabitants). Data was anonymized keeping information on the time sequence of isolates in individual patients.

The following tasks were implemented by use of algorithms in the following order:

- expert rules for intrinsic resistance
- inference from an antibiotic tested to other members of the class if appropriate for the species
- exclusion of repeat isolates with identical antibiogram within a given time interval. The interval was selected based on a graphical analysis (not shown).

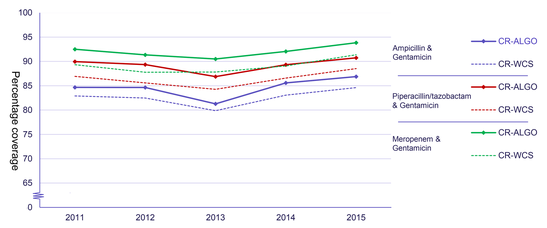
Antibiotic susceptibility was defined by SIR = S, and this rule was not relinquished for combination therapy. Coverage was calculated by the proportion of susceptible isolates among all unique isolates within the time window.

We report three estimates of coverage based on

1) AST data (CR-AST),
2) AST data emended by algorithms (CR-ALGO),
3) emended AST data, but assuming resistance for an entire class if no representative antibiotic was tested ('worst case scenario') (CR-WCS).

Algorithms were implemented in R (www.r-project.org).

Trends in coverage of antibiotic regmines in 2011 to 2015 using CR-ALGO and CR-WCS



Coverage of antibiotic regimens using CR-AST, CR-ALGO, and CR-WCS

Antibiotic Regimens	No.	CR-AST (%)	No.	CR-ALGO (%)	No.	CR-WCS (%)
Penicillin & Gentamicin	1809	81.1	1775	82.1	1892	80.4
Ampicillin & Gentamicin	1546	86.9	1767	86.9	1892	84.6
Ampicillin, Gentamicin & Metronidazol	1542	91.0	1763	90.5	1892	89.2
Piperacillin/tazobactam	1231	86.6	1809	77.4	1892	74.0
Piperacillin/tazobactam & Gentamicin	1196	91.6	1739	90.7	1892	88.5
Cefuroxim & Gentamicin	1777	82.2	1783	83.3	1892	80.5
Meropenem	244	93.9	1823	93.0	1892	89.6
Meropenem & Gentamicin	230	97.4	1753	93.8	1892	91.4

Coverage of antibiotic regimens in selected departments in North Denmark Region 2015

		Ampicilin, gentamicin & metronidazol		Piperacillin/ tazobactam & gentamicin		Meropenem	
Surgery	CR-ALGO	220	84.1	208	84.1	222	87.8
	CR-WCS	238	83.6	238	80.7	238	81.9
Abdominal Surgery	CR-ALGO	176	81.8	168	82.1	176	86.4
	CR-WCS	188	81.4	188	79.3	188	80.9
Medicine	CR-ALGO	824	89.6	816	89.5	852	91.4
	CR-WCS	876	88.1	876	88.0	876	89.0
Hematology	CR-ALGO	78	74.4	78	71.8	82	72.0
	CR-WCS	84	75.0	84	72.6	84	70.2
Intensive Care Unit	CR-ALGO	74	73.0	72	72.2	75	73.3
	CR-WCS	79	70.9	79	70.9	79	69.6

Results

First we assessed the time window for exclusion of repeat isolates. We found a distinct threshold when selecting a 5-day period, and subsequently this interval was used. During the 5-year period 10,267 blood isolates were retrieved including 1,305 repeat isolates resulting in 8,962 unique isolates. We analyzed 8 antibiotic regimens (Table). Notably, CR-ALGO included information from approximately 50% more isolates than CR-AST and showed the combination of ampicillin, gentamicin and metronidazole to be comparable with piperacillin/tazobactam in combination with gentamicin and even with meropenem monotherapy. Three antibiotic regimens were used in an analysis stratified by departments. The figure depicts the coverage of the three regimens during the years 2011-2015. A decrease in coverage in 2013 was followed by an increase during 2014-2015 as shown by all three indicators.

Conclusions

Implementation of algorithms augments

- consistency in monitoring coverage
- shows promise for antibiotic stewardship programs
- should be adaptable to other speciemen types

Bibliography

1. Hebert C, Ridgway J, Vekhter B, Brown EC, Weber SG, Robicsek A. Demonstration of the weighted-incidence syndromic combination antibiogram: an empiric prescribing decision aid. Infect Control Hosp Epidemiol. 2012 Apr;33(4):381–8.