A Novel Informatics Tool to Detect Antibiotic Allergies Occurring After Cardiovascular Implantable Electronic Device Procedures

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BACKGROUND

ANTIBIOTICS are amongst the most common drugs associated with **HYPERSENSITIVITY** reactions in hospitalized patients.

Downstream **EFFECTS** of antibiotic allergy include:
- Longer length of stay
- Increased healthcare $$$
- Use of broad-spectrum antibiotics
- Mortality

Antibiotic allergy **MISLABELING** is common and has negative downstream effects.

STANDARDIZED PROCESSES for identifying when allergic reactions occur and linking allergic reactions to drug exposures are **LIMITED**.

AIMS

Develop an **ELECTRONIC FLAGGING TOOL** using structured and unstructured data to identify antimicrobial allergic reactions at the time of their initial occurrence.

CHARACTERIZE the nature and severity of these reactions.

METHODOLOGY

Design:
Retrospective cohort study.

Inclusion:
Patients who underwent a CIED procedure and received an antibiotic within the national VA Healthcare System.

Methods:
- Cohort was split into training and testing cohorts, and cases were manually reviewed to determine presence of an allergic reaction and severity of reaction.
- Variables potentially indicative of allergic reaction selected *a priori* and were analyzed using LASSO technique, and weighting of indicators of an allergic reaction was completed using logistic regression.
- A predictive model was then applied to the testing cohort and the algorithm test characteristics were assessed.

Primary Outcome:
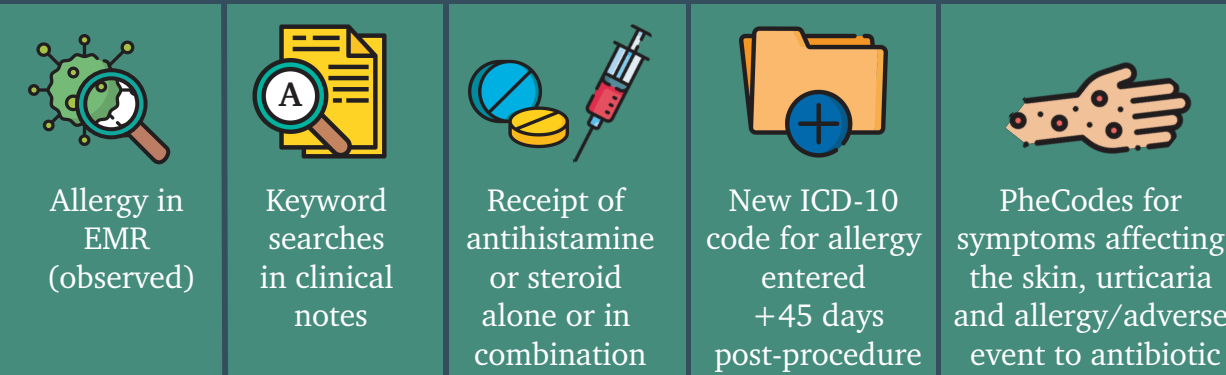Allergic reaction to antibiotic, including concordance between medical record review and the algorithm.

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RESULTS

N=36,344 PATIENTS UNDERWENT CIED PROCEDURES
34,703 (95.5%) HAD AN ANTIBIOTIC EXPOSURE

98% male   76.5% Caucasian

Model Development and Validation:

Training dataset (n=17,350); 311 underwent manual review.

Variables associated with an allergic reaction on univariate analysis included:

Allergy in EMR (observed)	Keyword searches in clinical notes	Receipt of antihistamine or steroid alone or in combination	New ICD-10 code for allergy entered +45 days post-procedure	PheCodes for symptoms affecting the skin, urticaria and allergy/adverse event to antibiotic

Testing dataset (n= 17,353); 120 underwent manual review.

- The final development model included seven variables of an allergic reaction during the 10-day period following antimicrobial exposure (Table 1).
- In the chart reviewed sample, 87% (27 cases) of allergic reactions fell into the high probability category.
- The PPV of the final model in the test dataset was 61% and sensitivity of 87%.

Table 1: Final model logistic regression

	VARIABLES	OR (95% CI)
	Allergy in EMR (historical)	42.37 (11.33 - 158.43)
	Allegry in EMR (observed)	175.10 (44.84 - 683.76)
	PheCode symptoms affecting the skin	8.49 (1.90 - 37.82)
	PheCode urticaria	7.01 (1.76 - 27.89)
	PheCode allergy/adverse event to antibiotic	11.84 (2.88 - 48.69)
	Keyword searches	3.21 (1.27 - 8.08)
	Corticosteroid Receipt	6.51 (1.90 - 22.30)

ROC Curve for Model

Area Under the Curve = 0.9517

RESULTS

Table 2: Nature & severity of antibiotic allergic reactions

ANTIBIOTIC	ALLERGIC REACTION (NO./%)	Intervention			Allergic Reaction Severity			
		ANTIHISTAMINE	CORTICOSTEROID	INTRAVENOUS EPINEPHRINE	MILD	MODERATE	SEVERE	INTUBATION/ICU
Cephalosporins	42 (40%)	21	16	1	15	25	6	
Vancomycin	24 (23%)	8	10		13	14		
Tetracycline	9 (9%)	4	3		5	1	5	
Penicilin	6 (6%)	3	2		3	1	2	
Sulfa	5 (5%)	2	3		1	2	2	
Clindamycin	8 (8%)	4	2		2	7	1	
Daptomycin	3 (3%)	1			2		1	
Fluoroquinolone	3 (3%)	3	3			2	1	
Carbapenem	2 (2%)		2	1	1		1	
Macrolide	2 (2%)			1	1		1	1
Total	**104**	**46**	**41**	**3**	**43**	**52**	**20**	**1**

Nature and Severity of Allergic Reactions
- Most allergic reactions were classified as moderate in severity.
- Most allergic reactions (72%) from pre-procedural antibiotics occurred within the first week from CIED procedure.

LIMITATIONS

- Missed reactions outside of VA electronic medical record.
- False positives due to historic ICD-10-DM codes (e.g., history of a penicillin allergy) were copied forward in EHR documentation.
- Cohort included predominantly older white males as this reflects the VA population.

CONCLUSIONS

We **DEVELOPED AND VALIDATED AN INFORMATICS MODEL** using seven key variables composed of structured and unstructured data for the **DETECTION OF ANTIBIOTIC ALLERGIC REACTIONS.**

Model had a strong positive predictive value for detecting true antibiotic allergic reactions.

Tool could be operationalized to support antimicrobial stewardship by providing clinicians with real-time feedback about when allergies occur and promoting referral to allergy services.