534 USING EHR DATA TO DYNAMICALLY PREDICT INCIDENCE OF HOSPITAL-ACQUIRED PRESSURE ULCERS

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Background Hospital-acquired pressure ulcers (HAPUs) are costly to treat and can result in Medicare reimbursement penalties. Statistical models can identify patients at greatest HAPU risk and improve prevention.

Objectives To use electronic health record (EHR) data to predict HAPUs among hospitalized patients.

Methods EHR data were obtained from an academic medical center that included hospitalized patients with at least 1 skin examination between 2011–2014. These data contained encounter-level demographic variables, diagnoses, prescription drugs and provider orders. HAPUs were defined by stages III, IV or unstageable pressure ulcers not present-on-admission as a secondary diagnosis, and excluded diagnosis of paraplegia/quadriplegia. Random forests and k-means clustering were applied to reduce the dimensionality of the large dataset. A 2-level mixed-effects logistic regression of patient-encounters evaluated associations between covariates and HAPU incidence (Equation 1).

Results The approach produced a sample population of 23,054 patients with 1,549 HAPUs. The mixed-effects model predicted HAPUs with exceptional (99%) accuracy for a rare event (table 1). The greatest odds ratio (OR) of HAPU incidence was among patients diagnosed with spinal cord injury (ICD-9 907.2: OR=247.4; P<0.001). Other high ORs included osteomyelitis (ICD-9 730: OR=27.7, P<0.001), bed confinement (ICD-9 V49.84: OR=31.7, P<0.001), and prescribed topical/subcutaneous enzymes (OR=5.7, P<0.001).

Conclusions Early detection of HAPUs is feasible and the results of these statistical predictions can allow providers to better target prevention to specific patients. This model also implicates spinal cord injury as a potential risk-factor for unavoidable HAPUs. Providers may be missing opportunities to co-diagnose spinal cord injury with paraplegia/quadriplegia which could improve hospital performance measures.

Equation 1. Mixed-effects Logistic Regression Model
Level-1: Encounter-level Fixed Effects

$$\text{Logit}[E(Y_{ij})] = b_0 + \beta_1 \mathbf{Age}_{ij} + \beta_2 \mathbf{BradenScore}_{ij} + \beta_3 \mathbf{Rx}_{ij} + \beta_3 \mathbf{Dx}_{ij} + \beta_3 \mathbf{Order}_{ij} + \ldots + Z_{ij}$$

Level-2: Patient/Cluster-level Random Effect

$$b_0 = \beta_0 + u_{i0}$$

Where…
i: Patient
j: Encounter

Table 1 Results of 2-level Mixed-effects Logistic Regression and population-average estimates for HAPU incidence by patient-encounter.

	2-Level Mixed-effects Logitistic Regression				Population-average Estimates (GEE)			
Variable	**Estimate**	**Odds Ratio**	**Standard Error**	**P-value**	**Estimate**	**Odds Ratio**	**Standard Error**	**P-value**
Intercept	−9.469	0.000	0.331	<0.001	−7.016	0.001	0.175	<0.001
Age	0.049	1.050	0.003	<0.001	0.040	1.041	0.002	<0.001
Bronchoscopy	0.513	1.671	0.248	0.038	0.408	1.504	0.190	0.032
Culture, Stool	0.514	1.672	0.158	0.001	0.414	1.512	0.123	0.001
Urinalysis Chemistry Screen	0.841	2.319	0.089	<0.001	0.693	2.000	0.073	<0.001
Pre-albumin	0.983	2.674	0.091	<0.001	0.761	2.141	0.067	<0.001
Vancomycin Random Assay	0.959	2.609	0.094	<0.001	0.728	2.071	0.069	<0.001
Culture & Stain, Wound Drainage	0.790	2.203	0.135	<0.001	0.582	1.790	0.098	<0.001
Topical Sulfonamides	1.732	5.653	0.115	<0.001	1.297	3.660	0.078	<0.001
Topical/Mucous Membrane/Subcutaneous Enzymes	3.389	29.622	0.276	<0.001	2.109	8.236	0.167	<0.001
Phosphate Replacement	0.260	1.297	0.085	0.002	0.204	1.227	0.068	0.003
Antifu ngal Agent	0.472	1.603	0.094	<0.001	0.385	1.470	0.075	<0.001
Erythropoiesis-stimulating Agent	0.995	2.705	0.134	<0.001	0.768	2.156	0.098	<0.001
ICD-9 V49.84: Bed Confinement	3.457	31.730	0.539	<0.001	2.198	9.003	0.334	<0.001
ICD-9 907.2: Spinal Cord Injury	5.511	247.364	0.500	<0.001	3.814	45.311	0.318	<0.001
ICD-9 730.15: Chronic Osteomyelitis – Pelvic a nd Thigh Regions	3.323	27.746	0.697	<0.001	2.312	10.094	0.474	<0.001
ICD-9 730.18: Chronic Osteomyelitis – Other	3.001	20.099	0.806	<0.001	1.932	6.904	0.516	<0.001
Variance(Intercept)	4.355		0.486					
Log-likelihood	−4737.36							