Validating Use of Medical Record Data to Predict Risk Factors of Hospital Acquired Pressure Ulcers

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ABSTRACT

Purpose: To derive and validate a model for predicting risk of hospital acquired pressure ulcers (HAPU) in adults, by day 5 of hospitalization.

Background & Significance: HAPU are a serious patient safety issue. Current risk assessment scales for HAPU have limitations. It is unknown if factors found in the electronic medical record (EMR) are useful in predicting HAPU risk in a broad population of hospitalized adults.

Design: Retrospective, descriptive, EMR review.

Sample & Setting: Hospitalized medical-surgical adults from a quaternary-care medical center in Northeast OH during 3-months in 2009 (derivation model) and 2011 (validation model). Exclusions were age ≥90 years, BUN ≥ 60 mg/dL, creatinine ≥10 mg/dL, or hematocrit <10% or ≥50%.

Procedures/measures: Data (Braden total/components, demographics, medical diagnosis, laboratory values, surgical procedures and history of PU) were abstracted from EMRs. A full logistic regression model included all potentially important clinical factors. Data reduction was performed by choosing factors that best approximated the fit of the full model with the least loss of information. Factors with counterintuitive effects (greater mobility = greater risk) were removed and the impact of the removal was evaluated. Concordance index (CI) was used to discriminate HAPU development. Bootstrap resampling was performed to bias correct the estimate in the derivation and validation models.

Findings: The derivation and validation cohorts numbered 13,560 and 3,160 patients, respectively. By derivation, 12 factors were associated with HAPU; CI was 0.89. The validation cohort that used the same 12 factors had a CI of 0.78. Model factors performed better than chance at predicting HAPU; but calibration of low (<30%) HAPU risk was stronger than that of moderate or high HAPU risk. Models of Braden total/component scores performed worse than the 12-factor model in the derivation cohort (CI, 0.68), but similar to the 12-factor model in the validation cohort (CI, 0.81); however, calibration of predicted to actual HAPU was best when HAPU risk was below 20%.

Implications: In hospitalized medical-surgical adults with multiple diagnoses, EMR factors were unreliable for predicting moderate-high risk of HAPU. New models need to be developed and tested that do not rely on EMR data; or that focus on specific populations (vascular disease) or hospital environments (intensive care).

BACKGROUND

- A hospital acquired pressure ulcer (HAPU) is defined as any area of skin or underlying tissue that has been damaged when in the hospital by unrelieved pressure or pressure in combination with friction and shear. (NPUAP, 2014)
- HAPU are a serious patient safety issue, The Agency for Healthcare Research and Quality (AHRQ, 2008), reported a nearly 80% increase from 1992 to 2006 in hospital stays of patients with pressure ulcers, resulting in annual costs of $11 billion for treatment related to the ulcers.
- Current risk assessment scales for HAPU have limitations. Braden Scale for Pressure Sore Risk is the most commonly used tool for measuring pressure ulcer risk in the United States (Cox, 2012).

Purpose:
- To derive and validate a model for predicting risk of HAPU in adults, by day 5 of hospitalization.

METHODS

- Medical record research study
- Used administrative and electronic medical record data
- The Institutional Review Board approved this study

Setting and Sample
- A 1200+ bed quaternary care medical center in Northeast OH.
- All hospital admissions for patients ≥ 18 years of age were abstracted for two separate time periods: March 1, 2009 thru May 31, 2009 (derivation cohort) and October 1, 2011 thru December 31, 2011 (validation cohort).
- Models were reduced to results predicting a hospital acquired pressure ulcer (HAPU) at 5 days.
- Exclusions: Patients > 90 years, blood urea nitrogen ≥ 60 mg/dL, creatinine ≥10 mg/dL, or hematocrit < 10% or > 50%.

Outcomes, Measures and Data Collection
- After learning of 12 factors associated with HAPU development (derivation cohort; 65 factors studied); the same 12 factors were assessed in a validation cohort.
- Data retrieved retrospectively from 2 data repositories:
  - Administrative database: demographic information; primary and secondary diagnosis; surgical procedures; admit and discharge dates.
  - Electronic medical record: Braden score and component, Lab results, behavior/cognition; physical factors; and factors related to surgical procedures.

Statistical Analysis
- Data frequencies were summarized by descriptive statistics.
- Outcome variables were compared between patients with and without HAPU by Pearson's Chi-square or Wilcoxon rank sum test with continuity correction.
- Full logistic regression model fit, with potentially important clinical variables.
- Since the number of events did not permit inclusion of all factors, data reduction was performed by choosing the factors that best approximated the fit of the full model with the least loss of information. Factors that had counterintuitive effects (i.e. greater mobility = greater risk) were removed and the impact of the removal was evaluated. This model was used as the final model.
- After this model was fit, the ability of the model to discriminate between those who develop pressure ulcers and those who do not were measured using a concordance index.
- Bootstrap re-sampling was performed to bias correct this estimate.
- Calibration of the model was based on agreement between predicted and actual risk.
- All analyses were performed using R software (version 2.12; Vienna, Austria).

RESULTS

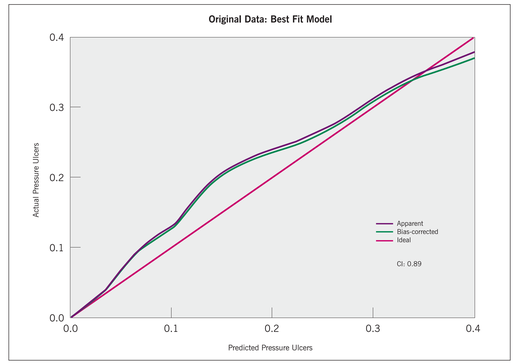
- Initial derivation cohort n=14,232; validation cohort n=3,377 subjects.
- After removal exclusion cases (889; 5%), 672 derivation cohort and 217 validation cohort subjects were removed.
- **Table 1** provides factors of patients with and without HAPU for derivation and validation cohorts.
- **Figure 1:** shows the best fitting model in the derivation cohort (concordance index [CI], 0.89) and the validation cohort (CI, 0.78).

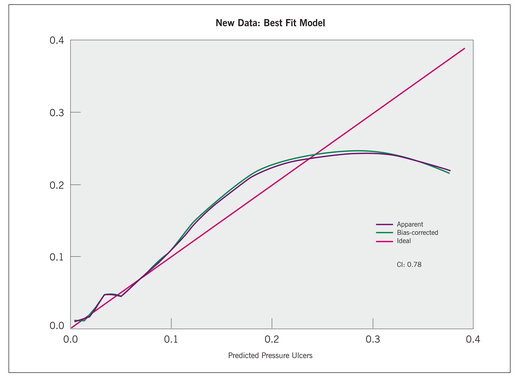
Table 1. Patient Factors (inc. Braden Scores)

	Derivation Cohort (N=13560)					Validation Cohort (N=3160)				
Factors	**n**	**NO PU n=13230**	**n**	**Yes PU n=330**	***p*-value**	**n**	**NO PU n=3071**	**n**	**Yes PU n=89**	***p*-value**
Age years [a]	13230	57.1	330	65.6	**<0.001**[W]	3071	60.9	89	65.3	0.006[W]
Primary Diagnosis[b]					0.50[c]					0.002[c]
Circulatory Disorders	3346	25.3	93	28.2		1248	40.6	19	21.4	
Endocrine Disorders	515	3.9	9	2.7		80	2.61	2	2.3	
Skin Disorders	185	1.4	5	1.5		49	1.6	1	1.12	
Other	9184	69.4	223	67.6		1694	55.16	67	75.3	
Circulatory Disorders[b]					**<0.001**[c]					0.34[c]
0-1	7449	56.3	70	21.21		795	25.88	20	22.5	
> 2	5781	43.7	260	78.78		2276	74.12	69	77.5	
Endocrine Disorders[b]					**<0.001**[c]					0.059[c]
0-1	8067	60.9	109	33.03		1409	45.88	33	37.1	
> 2	5163	39.0	221	66.96		1662	54.12	56	62.9	
Skin Disorders[b]					**<0.001**[c]					**<0.001**[c]
0-1	12825	45.9	160	48.48		2855	45.88	57	64.1	
> 2	405	37.6	170	51.51		216	37.55	32	35.9	
Surgery[b]					**<0.001**[c]					**<0.001**[c]
None	7370	55.7	193	58.5		1439	46.9	59	66.3	
Cardiac Neuro Plastics	2055	15.5	64	19.4		834	27.2	20	22.5	
Other	3869	38.5	73	22.1		798	25.9	10	11.2	
BUN[a]	13230	17.89	330	17.8	**<0.001**[W]	3071	19.45	89	24.8	0.002[W]
Creatinine[a]	13230	1.06	330	1.06	**<0.001**[W]	3071	1.17	89	1.25	0.50[W]
Glucose[a]	13230	124	330	124	0.30[W]	3071	129.91	89	122	0.069[W]
Hematocrit[a]	13230	35.9	330	35.91	**<0.001**[W]	3071	33.71	89	32	0.006[W]
Hemoglobin[a]	13230	11.8	330	11.76	**<0.001**[W]	3071	11.2	89	10.4	**<0.001**[W]
Sex[b]					0.92[c]					>0.99[c]
Female	6471	48.9	160	48.48		1380	44.9	40	44.9	
Male	6759	51.1	170	51.52		1691	55.06	49	55.1	
Marital Status[b]					**<0.001**[c]					0.047[c]
Divorced/Sep	1313	9.92	25	7.58		25	7.58	7	7.87	
Married	7577	57.3	163	49.4		163	49.39	41	46.1	
Single	3059	23.1	79	23.9		79	23.94	29	32.6	
Widowed	1281	9.7	63	19.1		63	19.09	12	13.5	
History of PU[b]	661	5	114	34.6	**<0.001**[c]	267	8.69	33	37.1	**<0.001**[c]
PU[b] Present on Admission	585	4.42	150	45.5	**<0.001**[c]	324	10.55	44	49.4	**<0.001**[c]
Braden Total Scores[a]	13230	19.95	330	18.1	**<0.001**[W]	3071	19.32	89	15.6	**<0.001**[W]
Activity[b] Bed/Chairfast	2540	19.2	131	39.7	**<0.001**[c]	897	17.6	69	77.5	**<0.001**[c]
Walks Occ/Freq	10690	80.6	199	60.3		2174	60.3	20	22.5	
Friction[b] Problem	240	1.81	42	12.7	**<0.001**[c]	91	2.96	18	20.2	**<0.001**[c]
Potential Problem	1107	8.37	77	23.3		694	22.6	38	42.7	
No Problem	11883	89.8	211	63.9		2286	74.4	33	37.1	
Mobility[b], Immobile	196	1.48	13	3.94	**<0.001**[c]	48	1.56	3	3.37	**<0.001**[c]
Limitations Very/Slight	7771	58.7	230	69.7		1763	58.7	74	83.1	
No Limitations	5263	39.8	87	26.4		1260	41.0	12	13.5	
Moisture[b], Complete/Very	141	1.07	19	5.76	**<0.001**[c]	61	1.99	8	8.99	**<0.001**[c]
Occasionally/Rare	13089	98.9	311	94.2		3010	98.0	81	91.0	
Nutrition[b], Poor/Inadeq	1488	11.3	87	26.4	**<0.001**[c]	617	20.1	44	49.4	**<0.001**[c]
Adequate/Excellent	11742	88.75	243	73.6		2454	79.9	45	50.1	
Sensory[b], Complete/Very	285	2.15	34	10.3	**<0.001**[c]	168	5.47	14	15.7	**<0.001**[c]
Slight/No Limitations	12945	97.84	296	89.7		2903	94.53	75	84.1	

[a]Mean (95% Bootstrap CI); [b]Percentage; [c]Pearson's Chi-squared test with Yates' continuity correction; [W]Wilcoxon rank sum test with continuity correction

Figure 1. Calibration plot for the reduced model for the Derivation (**A**) and Validation (**B**) Cohorts





Limitations
- Single-center study of high acuity patients; patients admitted during limited time periods; results may not be generalizable beyond these patient cohorts.
- Data were retrospectively collected and could have included erroneous data

CONCLUSIONS

- In validation analyses of our model, concordance indexes were fairly strong but were only closely aligned at low levels of HAPU risk (≤ 25%).
- Since EMR factors were unreliable for predicting moderate-high risk of HAPU, new models should be developed and tested.