

LONG-RANGE TRIAGE: ASSESSING PATIENT RISK FROM A DISTANCE

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Internal Medicine

- ▣ Broad range of diseases
- ▣ Patients often transferred to/from ICU
- ▣ Treated at UMMC by hospitalists

Inter-Hospital Transfer (IHT)

- ▣ Some patients too severe for smaller hospitals
- ▣ UMMC often accepts these patients
- ▣ IHT patients tend to be higher acuity
- ▣ These patients put a strain on hospital resources
 - ICU space
 - Nurse time
- ▣ Uncertainty in referring hospital's assessment
 - Poor documentation
 - Incomplete/inaccurate information

Objective Risk Assessment

- ▣ Better patient severity information needed
- ▣ Referring hospitals not always trusted
- ▣ Ideal tool is:
 - Objective
 - Easy to understand
 - Based on commonly used patient data
 - Quick to compute

Description of HALT

Feature	Description
<u>H</u> ypotension	Measured by mean arterial pressure. Considered low if < 65 mmHg.
<u>A</u> nemia	Measured by hemoglobin. Considered low if < 7 g/dL.
<u>L</u> eukocytosis	Measured by white blood cell count. Considered high if > 20,000 cells/mcL.
<u>T</u> achycardia	Measured by pulse. Considered high if > 100 beats per minute.

Methods

- ▣ Binary Cutoff Model
 - Simple, intuitive
- ▣ Logistic Regression
 - Easy to interpret, better power
- ▣ Naïve Bayes
 - Slightly better results, more complicated
- ▣ Combination of logistic regression and Naïve Bayes

Results

	Predicted	
	0	1
Observed		
	0	935 56
1	128 39	

HALT Binary Cutoff

	predicted	
	0	1
Observed		
	0	465 22
1	65 24	

Logistic Regression

	Predicted	
	0	1
Observed		
	0	468 22
1	62 24	

Naïve Bayes Classifier

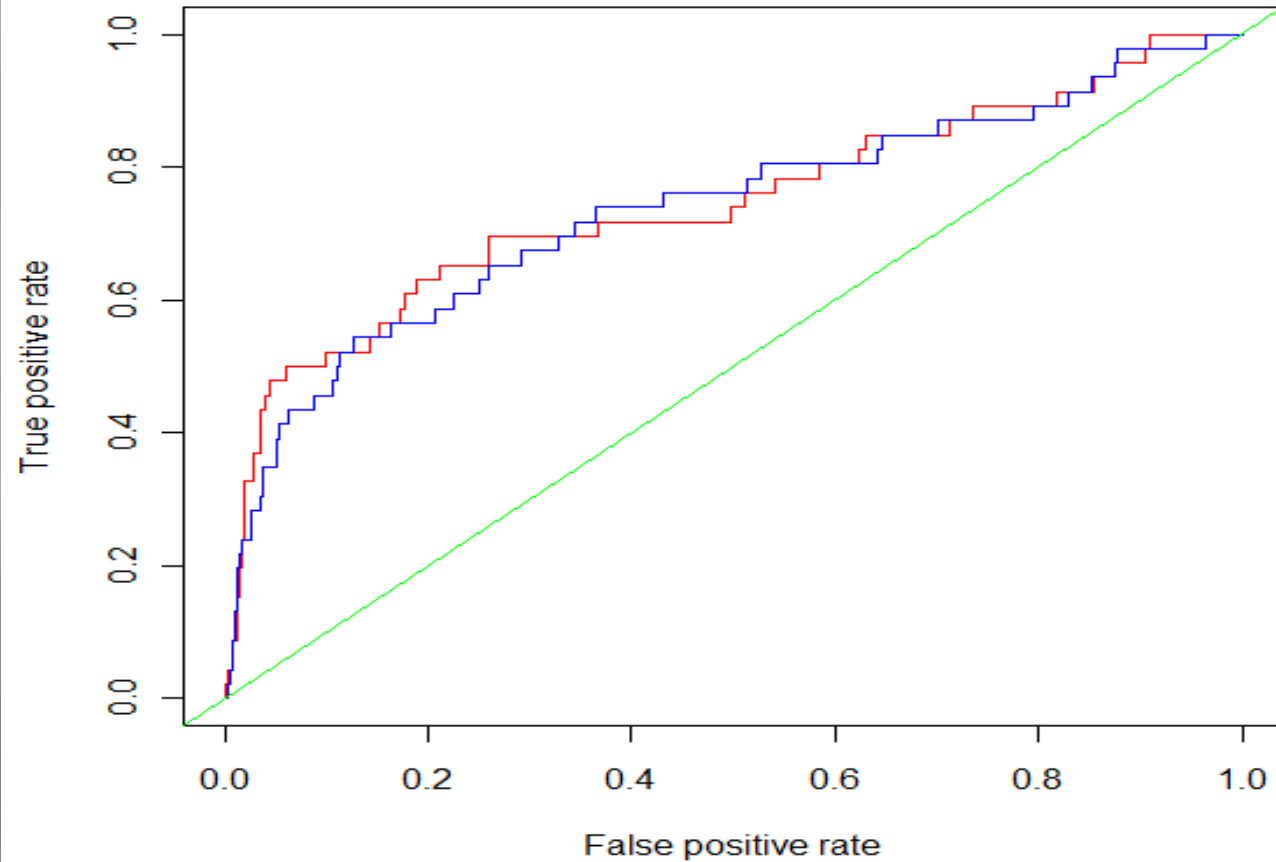
	Predicted	
	0	1
Observed		
	0	450 19
1	80 27	

Combination Tool

Results

Tool	True +	True -	False +	False -	Sensitivity	Specificity
Max	27	450	80	19	0.587	0.849
Logistic Regression	24	465	65	22	0.522	0.877
Naïve Bayes	24	468	62	22	0.522	0.883
HALT	39	935	128	56	0.411	0.88
HLT	37	946	117	58	0.39	0.89
ALT	35	947	116	60	0.368	0.891
LT	33	958	105	62	0.347	0.901
HAL	29	1010	53	66	0.305	0.95
HAT	25	962	101	70	0.263	0.905

ROC



ROC plots for Naïve Bayes (Red) and Logistic Regression (Blue)

False Positives vs. False Negatives

Model	Cost 1:1	Cost 3:1	Cost 5:1	Cost 10:1	Cost 20:1	Cost 50:1	Cost 100:1
Max	0.172	0.238	0.304	0.469	0.799	1.788	3.438
Naïve Bayes	0.146	0.222	0.299	0.49	0.872	2.017	3.927
Logistic Regression	0.151	0.227	0.304	0.495	0.877	2.023	3.932
HALT	0.159	0.256	0.352	0.594	1.078	2.529	4.947
HLT	0.151	0.251	0.352	0.602	1.103	2.605	5.11
HAL	0.103	0.217	0.331	0.616	1.186	2.896	5.745
ALT	0.152	0.256	0.359	0.618	1.136	2.691	5.282
LT	0.144	0.251	0.358	0.626	1.162	2.768	5.445
HAT	0.148	0.269	0.39	0.692	1.296	3.11	6.132

Including Age

	Actual 0	Actual 1
Extended Logit 0	434	19
Extended Logit 1	59	22

The sensitivity of the model increases from 52.2% to 53.7%, while the specificity increases from 87.7% to 88.0%. This translates to a decrease in “cost” of between 3.3% (1:1 ratio) and 6.7% (100:1 ratio).

Prospective Study

- ▣ Currently collecting data for a prospective study
- ▣ 34 patients treated so far
- ▣ 6 classified as High Risk
 - 4 Discharged Home
 - 1 Died
 - 1 Transferred to a Skilled Nursing Facility
- ▣ 28 classified as Low Risk
 - 26 discharged home
 - 1 ICU stay – colonoscopy perforated bowel
 - 1 transfer back to referring hospital

Conclusions

- ▣ Simple, objective measures can be used to accurately predict risk
- ▣ This research will lead to a useful tool in helping to make admission decisions and predict resource usage

Future Work

- ▣ We hope to implement the HALT tool as a standard part of the IHT process
- ▣ Better information about incoming patients
- ▣ Better resource management and utilization

Questions?

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