

A BINARY LOGISTIC REGRESSION ANALYSIS OF RISK FACTORS FOR FAILURE OF LOWER EXTREMITY SALVAGE IN TRAUMA PATIENTS: AN EXAMINATION OF THE AMERICAN COLLEGE OF SURGEONS TRAUMA QUALITY IMPROVEMENT PROJECT

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INTRODUCTION

In lower extremity trauma patients with extensive soft tissue loss, a difficult decision arises in whether to attempt to reconstruct or to perform a primary amputation of the extremity.

There is no clear standard-of-care in the management of Gustilo 3B lower extremity injuries.

- The LEAP, OUTLET, and METALS studies found similar functional outcomes between patients undergoing amputation or limb salvage for trauma-associated lower extremity injuries.

Tillman et al. found only 16.3% of lower extremity trauma patients undergo early amputation, and 42.5% of those initially managed with attempted limb salvage undergo amputation prior to discharge.

- Early amputation is associated with lower odds of acute kidney injury, but no significant difference in hospital length of stay or mortality. [1]

A number of scoring systems have attempted to predict which patients are likely to have successful lower extremity salvage: MESS, MESI, PSI, LSI, NISSA, GHQISS, HFS-97.

Limitations of existing scoring systems:

- Advances in imaging and surgery have made these scoring systems outdated.
- There is little evidence that they were ever predictive of salvage failure; they are highly specific (low scores predictive of successful salvage), but have low sensitivity (high scores not adequate predictors of salvage failure and secondary amputation).
- Variables include subjective and intraoperative findings, by which time the Plastic Surgery team has committed to a reconstruction.

METHODS

PURPOSE: To develop a novel lower-extremity injury severity scoring system.

DATA: American College of Surgeons Trauma Quality Improvement Project, 2019

- 467 hospitals in data set
- Trained data abstractors at each institution, data reliability ensured through routine validation.

TYPE: Retrospective Cohort Study

INCLUSION CRITERIA:

- Adults (age ≥18)
- Blunt or penetrating injury
- Lower extremity debridement and tissue transfer during trauma admission

EXCLUSION CRITERIA:

- Traumatic amputation
- Transfer to/from another hospital
- Missing data

OUTCOME MEASURE: Amputation (ie. failure of limb salvage pathway)

STATISTICS:
Binary logistic regression analysis, Method: Enter, α = 0.05, SPSS
*p<0.0001

Table 1. Definitions of injuries and procedures.

Injury/Procedure	Definition (ICD-10-CM/ICD-10-PCS)
Traumatic Lower Extremity Amputation	S78, S88, S98
Tibia Fracture	S82.1-S82.3, S82.5
Lower Extremity Arterial Injury	S75.0, S85.0-S85.2, S95.0-S95.1
Soft Tissue Transfer	
Free Flap/Graft (Replacement)	0JRN07Z-0JRP3KZ, 0KRQ07Z-0KRW4KZ
Local Flap (Transfer, Reposition)	0JXL0ZB-0JXR3ZZ, 0KXQ0Z0-0KXW4ZZ, 0KSQ0ZZ-0KSW4ZZ
Lower Extremity Operative Amputation	0Y620ZZ - 0Y6J0Z3, 0Y6N0Z0

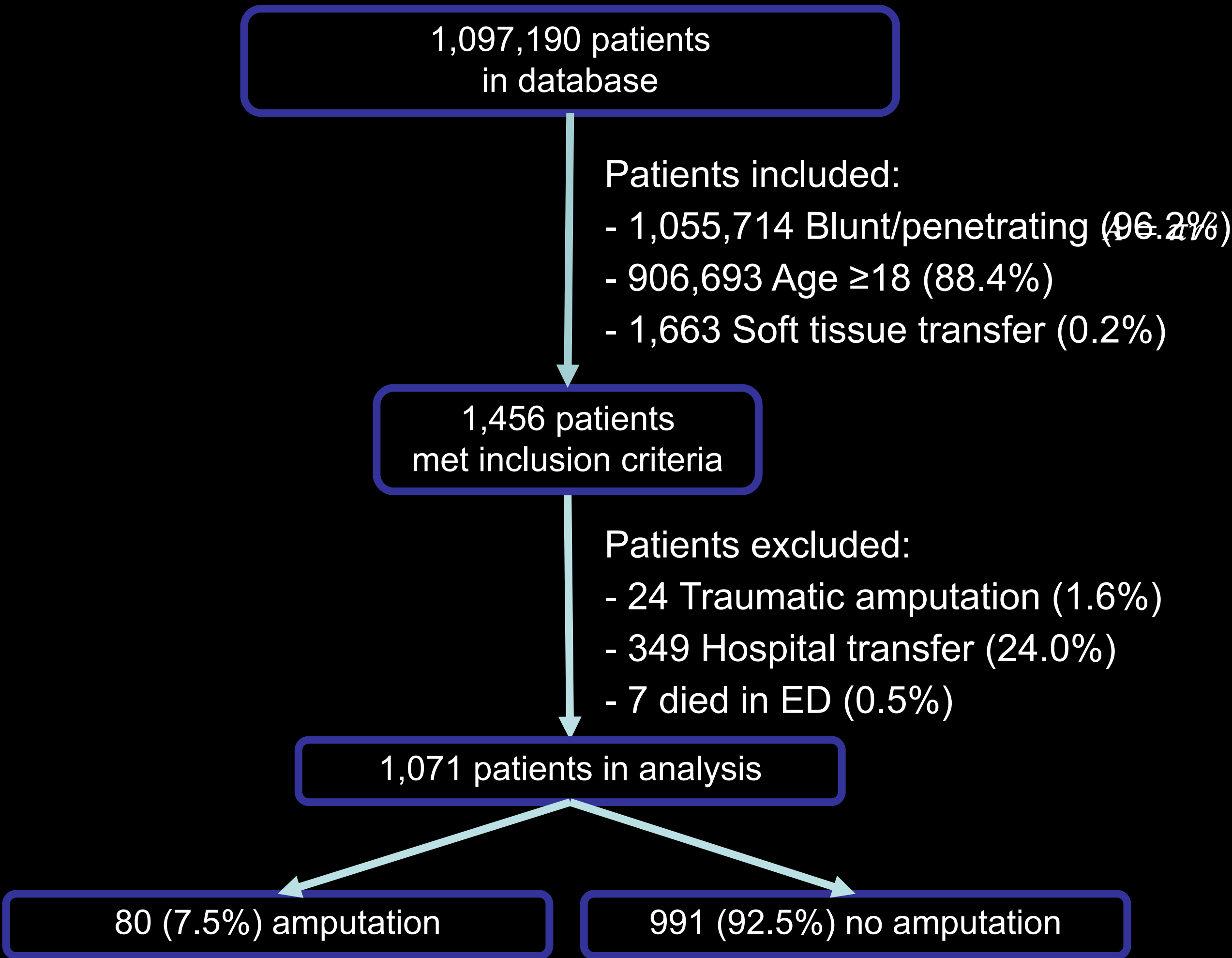


Figure 1. Research process flow diagram. Of the patients who met inclusion criteria, 73.6% were included in analysis. Limb salvage was successful in 92.5%.

REFERENCES

1. Tillmann BW, Guttman MP, Nathens AB, de Mestral C, Kayssi A, Haas B. The timing of amputation of mangled lower extremities does not predict post-injury outcomes and mortality: A retrospective analysis from the ACS TQIP database. J Trauma Acute Care Surg. 2021 Sep 1;91(3):447-456.

RESULTS

Table 2. Patient, injury, and treatment characteristics.

Variable	Salvage Group	Amputation Group	Odds Ratio (CI 95%)	P-value
	991	80		
Age	43.6+/-17.6	43.6+/-17.2		0.71
Male	715	65		0.43
Comorbidity: Smoking	263	25		0.42
Comorbidity: Diabetes	81	13		0.07
Comorbidity: Peripheral Artery Disease	3	1		0.22
Comorbidity: Hypertension	203	17		0.93
Obesity (BMI>30)	336	33		0.16
Blunt Mechanism	828	73		0.39
Crush Injury	48	16	4.4 (2.2-8.9)	<0.0001*
Hypotension on Arrival (SBP<90)	94	14		0.20
AIS Severity Score of Lower Extremity	2.8+/-1.1	3.2+/-0.8		0.06
Injury Severity Score	15.4+/-11.1	17.0+/-9.0		0.14
Lower Extremity Arterial Injury	95	25	3.9 (2.1-7.1)	<0.0001*
Tibia Fracture	638	63		0.17
Free Flap/Graft	120	5		0.12

Crush Injury	Artery Injury	Salvage Rate (%)										
		0	10	20	30	40	50	60	70	80	90	100
NO	NO	98.8%										
NO	YES	95.5%										
YES	NO	95.0%										
YES	YES	82.9%										

Figure 3. Salvage rate expected from model for patients with significant risk factors.

PROBABILITY(SALVAGE) = $\frac{1}{1 + e^{-x}}$, where $x=4.42-1.48[CRUSH]-1.36[ARTERIAL INJURY]$.

Equation 1. Equation for model estimating probability of successful limb salvage, where for each variable: 0, Absent; 1, Present.

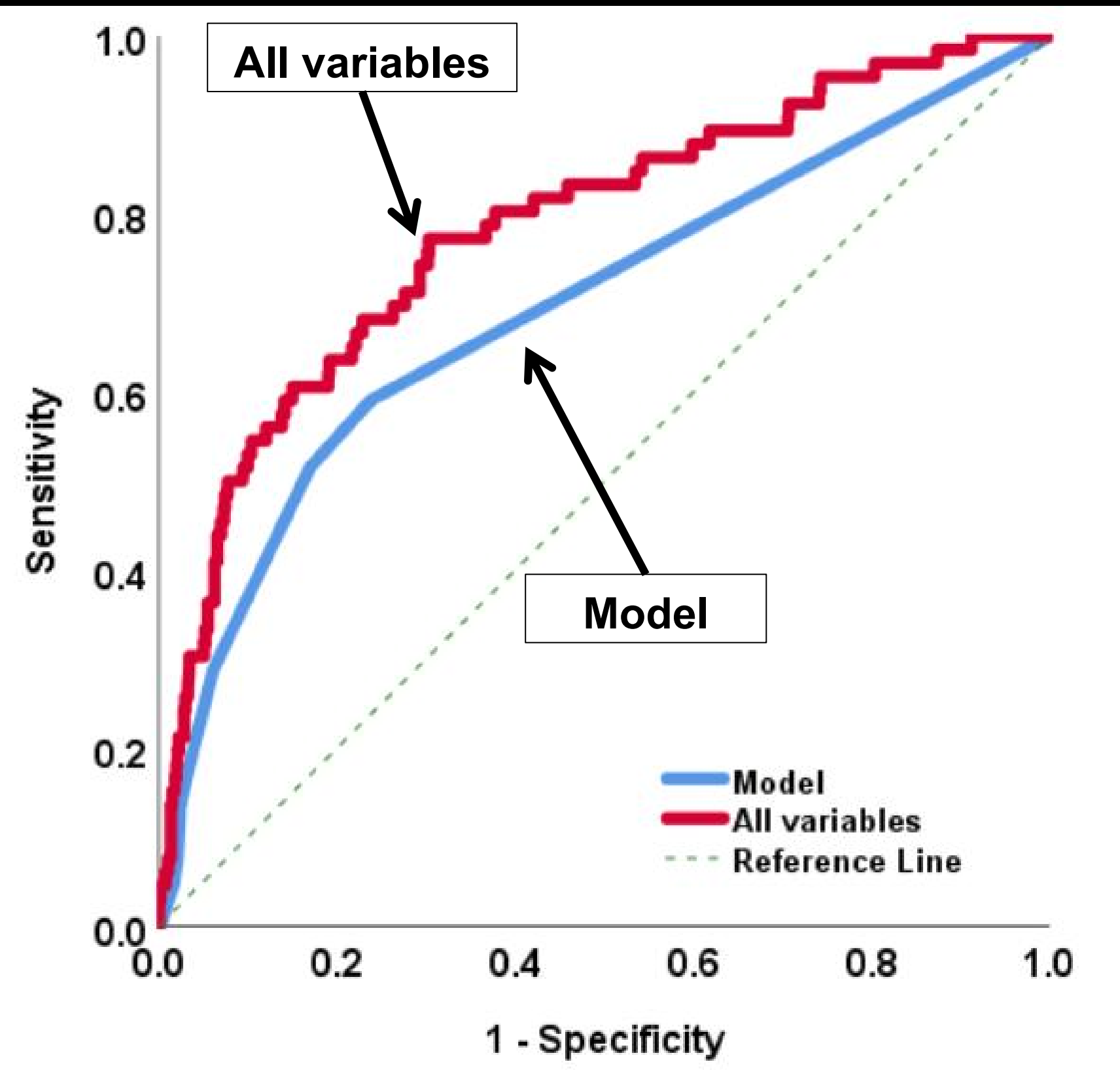


Figure 2. Reciever Operating Characteristic curve comparing predictive model and all input variables from Table 1. The model accounts for 69% of the overall predictive power, and is non-inferior to the use of all input variables.

Area Under Curve overall: 0.79 (95% CI 0.72-0.85)
Area Under Curve model: 0.70 (95% CI 0.62-0.77)

CONCLUSIONS

- Failure of lower extremity reconstruction is associated with crush injury and lower extremity arterial injury.
- A novel predictive index may help predict which patients are at increased risk for failure of limb salvage.

LIMITATIONS AND FUTURE DIRECTIONS

- The ICD-10-PCS codes do not differentiate free flaps from skin grafts, nor do they describe type of flap transferred.
- Further work is necessary to confirm laterality and timing of flap placement relative to amputation, to confirm the amputation group experienced failure of limb salvage (ie secondary amputation) rather than primary amputation.
- We have requested the ACS TQIP 2017-2018 data to use as a testing set to confirm the validity of the model.