Predicting Non-Home Discharge following Primary Total Hip Arthroplasty Using an Artificial Neural Network to Identify the Most Important Variables

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INTRODUCTION: Total hip arthroplasty (THA) has continued to increase in incidence. With expanding focus on value-based care and adoption of bundled payments at some facilities, cost containment measures including discharging patients to home as soon as possible postoperatively have gained attention. Furthermore, discharge to home is often desired by patients and may improve their overall satisfaction and experience with recovery. Therefore, it is important to determine patient characteristics associated with discharge disposition. Artificial neural networks (ANNs) are computational models that change based on the input and output of data. The purpose of this study was to develop and utilize an ANN model to determine the most important non-modifiable and modifiable factors which can predispose patients to be discharged to a non-home destination following primary THA.

METHODS: From 2016-2019, the National Surgical Quality Improvement Program database was used to identify patients who underwent primary THA. Overall, 22 demographic, comorbidity, preoperative, and intraoperative variables were analyzed in this study. Chi-squared tests and analysis of variance were performed to compare the various variables between the cohort of patients who were discharged to a home destination and those who were not discharged to a home location. Variables that were statistically significant, with a p-value < 0.05, were inputted into the ANN model. The ANN module of Statistical Package for Social Sciences was used for analysis.

RESULTS: In total, 124,691 patients were analyzed in the study, of which 19,275 (15.5%) were discharged to a non-home destination (Table 1). The ANN reached a Receiver Operating Characteristic (ROC) Area-Under-the-Curve (AUC) of 0.793, which is considered to be acceptable/excellent accuracy (Figure 1). It was found that 21 out of the 22 variables analyzed were important to predict non-home discharge. The five most important variables which helped to predict non-home discharge following primary THA were age (older; importance = 0.204), operative time (increased; importance = 0.159), preoperative hematocrit (decreased; importance = 0.095), functional status (dependent; importance = 0.080), and preoperative international normalized ratio (INR) (increased; importance = 0.078) (Figure 2).

DISCUSSION AND CONCLUSION: The present study used an ANN model and identified several significant factors which can help predict patients being discharged to a non-home location following primary THA, including age, operative time, preoperative hematocrit, functional status, and preoperative INR. Clinicians should be aware of these important variables and explore reductions to non-home discharges through preoperative patient optimization, where possible. Particularly, several of these factors, such as hematocrit and INR, can be evaluated preoperatively through laboratory tests and medically managed prior to the surgery. This model also provides a simple representation of the importance of each factor in predicting discharge to home, which could be easier for surgeons to better counsel their patients preoperatively. Ultimately, evaluating factors that impact patient discharge can help optimize costs and direct social work resources more effectively to patients more likely to need support. Our study demonstrated that ANN modeling represents a novel and unique approach to determine which modifiable and non-modifiable factors can assist in predicting discharge status following primary THA.

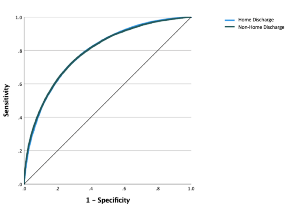

Figure 1. Receiver Operating Characteristic curve of the Artificial Neural Network model in predicting Non-Home Discharge

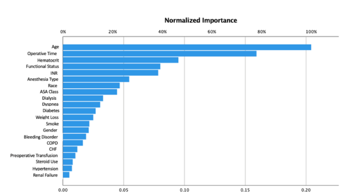

Figure 2. Importance of Variables used by the Neural Network model to predict Non-Home Discharge

Table 1. Demographics and Comorbidities of Total Hip Arthroplasty Patients

Patient characteristics	Total		Home Discharge		Non-Home Discharge		
	124,691		105,416		19,275		P-value
	N	%	N	%	N	%	
Sex							**<0.001**
Female	68,501	54.9%	55,563	52.7%	12,938	67.1%	
Male	56,190	45.1%	49,853	47.3%	6,337	32.9%	
Race							**<0.001**
White	105,005	84.2%	89,258	84.7%	15,747	81.7%	
Black or African American	11,815	9.5%	9,504	9.0%	2,311	12.0%	
Hispanic	4,799	3.8%	3,973	3.8%	826	4.3%	
Asian	2,151	1.7%	1,828	1.7%	323	1.7%	
Native American or Alaskan	569	0.5%	532	0.5%	37	0.2%	
Age (years)		65.2±11.2		63.9±10.8		72.2±11.0	**<0.001**
BMI (kg/m^2)		30.3±6.3		30.3±6.1		30.3±7.1	0.054
Anesthesia							**<0.001**
General	62,967	53.1%	51,007	51.0%	11,960	64.2%	
Neuraxial	41,049	34.6%	36,348	36.4%	4,701	25.2%	
Regional	1,810	1.5%	1,548	1.5%	262	1.4%	
MAC	12,598	10.6%	10,908	10.9%	1,690	9.1%	
Diabetes							**<0.001**
Non-insulin dependent Diabetes Mellitus	12,072	9.7%	9,566	9.1%	2,506	13.0%	
Insulin-dependent Diabetes Mellitus	3,904	3.1%	2,753	2.6%	1,151	6.0%	
Smoke	15,516	12.4%	13,274	12.6%	2,242	11.6%	**<0.001**
Dyspnea							**<0.001**
Dyspnea on exertion	5,283	4.2%	3,829	3.6%	1,454	7.5%	
Dyspnea at rest	228	0.2%	123	0.1%	105	0.5%	
Functional status							**<0.001**
Partially dependent	1,995	1.6%	935	0.9%	1,060	5.5%	
Dependent	126	0.1%	29	0.0%	97	0.5%	
Chronic Obstructive Pulmonary Disease	5,051	4.1%	3,494	3.3%	1,557	8.1%	**<0.001**
Congestive Heart Failure	525	0.4%	281	0.3%	244	1.3%	**<0.001**
Hypertension	70,666	56.7%	57,263	54.3%	13,403	69.5%	**<0.001**
Renal Failure	74	0.1%	35	0.0%	39	0.2%	**<0.001**
Dialysis	328	0.3%	163	0.2%	165	0.9%	**<0.001**
Chronic steroid use	4,751	3.8%	3,705	3.5%	1,046	5.4%	**<0.001**
Recent weight loss	275	0.2%	169	0.2%	106	0.5%	**<0.001**
Bleeding disorder	2,747	2.2%	1,866	1.8%	881	4.6%	**<0.001**
Preoperative transfusion	173	0.1%	76	0.1%	97	0.5%	**<0.001**
ASA classification							**<0.001**
III or IV	56,294	45.1%	43,088	40.9%	13,206	68.5%	
Preoperative Hematocrit (%)		41.14±4.29		41.49±4.12		39.25±4.69	**<0.001**
Preoperative INR		1.03±0.28		1.03±0.28		1.07±0.27	**<0.001**
Operative Time (min)		92.2±36.3		91.3±34.9		97.5±42.4	**<0.001**

BMI, body mass index; MAC, Monitored Anesthetic Care; ASA, American Society of Anesthesiologists; INR, International Normalized Ratio.