The National Hospital Discharge Survey and Nationwide Inpatient Sample: The Databases Used Affect Results in THA Research

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Abstract

Background The National Hospital Discharge Survey (NHDS) and the Nationwide Inpatient Sample (NIS) collect sample data and publish annual estimates of inpatient care in the United States, and both are commonly used in orthopaedic research. However, there are important

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differences between the databases, and because of these differences, asking these two databases the same question may result in different answers. The degree to which this is true for arthroplasty-related research has, to our knowledge, not been characterized.

Question/purposes We tested the following null hypotheses: (1) there are no differences between the NHDS and NIS in patient characteristics, comorbidities, and adverse events in patients with hip osteoarthritis treated with THA, and (2) there are no differences between databases in factors associated with inpatient mortality, adverse events, and length of hospital stay after THA.

Methods The NHDS and NIS databases use different methods of data collection and weighting to provide data representative of all nonfederal hospital discharges in the United States. In 2006 the NHDS database contained 203,149 patients with hip arthritis treated with hip arthroplasty, and the NIS database included 193,879 patients. Multivariable analyses for factors associated with inpatient mortality, adverse events, and days of care were constructed for each database.

Results We found that 26 of 42 of the factors in demographics, comorbidities, and adverse events after THA in the NIS and NHDS databases differed more than 10%. Age and days of care were associated with inpatient mortality with the NHDS and the NIS although the effect rates differ more than 10%. The NIS identified seven other factors not identified by the NHDS: wound complications, congestive heart failure, new mental disorder, chronic pulmonary disease, dementia, geographic region Northeast, acute postoperative anemia, and sex, that were associated with inpatient mortality even after controlling for potentially confounding variables. For inpatient adverse events, atrial fibrillation, osteoporosis, and female sex were associated with the NHDS and the NIS although the effect rates differ

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more than 10%. There were different directions for sources of payment, dementia, congestive heart failure, and geographic region. For longer length of stay, common factors differing more than 10% in effect rate included chronic pulmonary disease, atrial fibrillation, complication not elsewhere classified, congestive heart failure, transfusion, discharge nonroutine compared with routine, acute postoperative anemia, hypertension, wound adverse events, and diabetes mellitus, whereas discrepant factors included geographic region, payment method, dementia, sex, and iatrogenic hypotension.

Conclusions Studies that use large databases intended to be representative of the entire United States population can produce different results, likely related to differences in the databases, such as the number of comorbidities and procedures that can be entered in the database. In other words, analyses of large databases can have limited reliability and should be interpreted with caution.

Level of Evidence Level II, prognostic study. See the Instructions for Authors for a complete description of levels of evidence.

Introduction

The National Hospital Discharge Survey (NHDS) and the Nationwide Inpatient Sample (NIS) [1, 2, 7, 10] are large national databases of inpatient care in the United States that frequently are used in clinical research. Both databases generate estimates of care nationwide using data from a sample of hospitals selected to represent different types of care in different regions using ICD-coding [2, 17, 22].

The NHDS, published annually since 1965 by the National Center for Health Statistics (NHCS) at the Centers for Disease Control and Prevention (CDC), consists of data collected on a systematic random sample of discharges from 438 nonfederal (hospitals not operated by the department of Defense, the Department of Health and Human Services, and the Veterans Health Administration), short-stay hospitals in all 50 states. This represents 1% of all discharges in the US, but the hospitals are selected and weighted so that this 1% sample is representative of the entire US population. The data are collected manually for approximately 55% of hospitals and via commercial abstracting services and state data systems for 45%. From 376,000 discharges in the 2006 NHDS database, the weighted sample represents an estimated 34.9 million discharges. The NHDS is limited to seven diagnosis codes and four procedure codes [7, 8, 17].

The NIS, developed by the Healthcare Cost and Utilization Project (HCUP), is created by selecting hospitals for one of 60 groups based on region, teaching, bed size, and ownership. In each of the 60 groups a systematic random sample of hospitals

is selected to represent 20% of all nonfederal discharges in US hospitals. Systematic random sampling was done to avoid over presentation in groups. Data for all discharges in the calendar year are retrieved from state databases for each hospital selected. In 2006 the NIS includes 1045 hospitals in 38 states, with approximately 8 million hospitalizations. After weighting to represent all US hospitals the database represents 40 million hospitalizations. Entries in the NIS can include up to 15 ICD-9 diagnosis and procedure codes. The information is translated into a uniform format to facilitate comparison and analysis [8, 17].

The HCUP compared the NHDS and NIS estimates from 2007 and described them as broadly similar [2]. The NIS is believed to be better for epidemiologic studies and less common diseases because of the larger sample [2]. The Agency for Healthcare Research and Quality compared the NHDS, NIS, and American Hospital Association Annual Survey data from 1995 and found variations in discharge status by diagnosis, comparable length, and greater in-hospital mortality with the NIS (presumably because the NIS samples more large hospitals with relatively infirm patients) [1]. A recently published study explored the interdatabase reliability between the NIS and National Surgical Quality Improvement Program (NSQIP) regarding demographics, comorbidities, and adverse events after hip fractures [4]. Bohl et al. [4] found differing results between the databases. They compared one database collecting inpatient data using ICD-9 documentation and one database collecting postoperative data until 30 days after discharge not using ICD-9 documentation. What is interesting is whether differences in outcome exist when comparing the NIS with another inpatient-only database and for elective admissions rather than fractures.

These large databases often are used for orthopaedic clinical research [18, 19, 21], however, there are differences between the databases, and because of these differences, asking these two databases the same question might result in different answers. The degree to which this is true for arthroplasty-related research has, to our knowledge, not been characterized. We tested the following null hypotheses: (1) there are no differences between the NHDS and NIS in patient characteristics, comorbidities, and adverse events in patients with hip osteoarthritis treated with THA, and (2) there are no differences between databases in factors associated with inpatient mortality, adverse events, and length of stay after THA.

Patients and Methods

An estimated total of 203,149 discharges (56% female) in the NHDS and 193,879 discharges in the NIS (57% female) in 2006 were analyzed. We used ICD-9 codes to select

Table 1. Overview of patients with hip osteoarthritis and THA

Parameter	NHDS (n = 203,149)	NIS (n = 193,879)	Δ^* (+4.8)
Sex (number of patients)			
Male	90,412 (45%)	83,937 (43%)	+2.5
Female	112,737 (56%)	109,385 (57%)	-1.9
Age (years) [‡]	65 $\pm$ 12	66 $\pm$ 12	-0.41
Geographic region (number of patients)			
Northeast	49,078 (24%)	37,469 (19%)	+25 [†]
Midwest	52,489 (26%)	52,600 (27%)	-4.8
South	57,505 (28%)	59,759 (31%)	-8.1
West	44,077 (22%)	44,050 (23%)	-4.4
Source of payment (number of patients)			
All other sources	102,122 (50%)	105,349 (46%)	+10
Medicare	101,027 (50%)	88,530 (54%)	-8.4
Comorbidities (number of patients)			
No	63,125 (31%)	53,690 (28%)	+12 [†]
Yes	140,024 (69%)	140,189 (72%)	-4.7
Length of stay $\geq$ 2 SD (number of patients)			
No	193,949 (96%)	187,635 (97%)	-1.3
Yes	9200 (5%)	6244 (3%)	+40 [†]
Adverse events (number of patients)			
No	123,346 (61%)	116,415 (60%)	0
Yes	79,803 (39%)	77,464 (40%)	-1.8
Discharge status (number of patients)			
Routine/discharged home	114,453 (56%)	93,816 (48%)	+16 [†]
Nonroutine	88,616 (44%)	99,911 (52%)	-15 [†]
Dead	80 (0.04%)	152 (0.08%)	-50 [†]
Days of care [‡]	3.7 $\pm$ 1.5	3.8 $\pm$ 2.1	-3.1

* Relative difference between NHDS and NIS, with NIS = 100%, [†]if greater than 10%; [‡]values are expressed as mean $\pm$ SD; NHDS = National Hospital Discharge Survey; NIS = Nationwide Inpatient Sample.

adult (18 years and older) patients who had a THA (procedure code 81.51) for hip osteoarthritis [3, 15] (715.15 for osteoarthritis localized primary in the pelvis and thigh; 715.25 for osteoarthritis localized secondary in the pelvic region and thigh; 715.35 for osteoarthritis localized in the pelvic region and thigh [unspecified whether primary or secondary]; and 715.95 for osteoarthritis [unspecified whether generalized or localized] in the pelvic region and thigh). Patient data available from both databases included: sex, age, geographic region, source of payment, comorbidities, length of hospital stay, adverse events, discharge status, and days of care (Table 1). Both databases provided data for comorbidities (Table 2) and adverse events (Table 3), based on ICD-9 codes.

Continuous variables were presented as mean $\pm$ SD. Categorical variables are listed with the estimated number of patients in each category and percentage of the total.

Table 2. Comorbidities in patients with hip osteoarthritis and THA

Comorbidity	Number of patients		Δ^*
	NHDS (n = 203,149)	NIS (n = 193,879)	
Hypertension			-6.1
No	92,901 (46%)	81,826 (42%)	
Yes	110,248 (54%)	112,053 (58%)	
Diabetes mellitus			-24 [†]
No	182,190 (90%)	168,362 (87%)	
Yes	20,959 (10%)	25,517 (13%)	
Obesity			-43 [†]
No	190,407 (94%)	172,419 (89%)	
Yes	12,742 (6.3%)	21,460 (11%)	
Chronic pulmonary disease			-2.4
No	177,265 (87%)	169,175 (87%)	
Yes	25,884 (13%)	24,704 (13%)	
Chronic renal disease			-54 [†]
No	201,984 (99%)	191,428 (99%)	
Yes	1165 (0.6%)	2452 (1.3%)	
Chronic liver disease			-50 [†]
No	202,729 (100%)	193,178 (100%)	
Yes	420 (0.2%)	701 (0.4%)	
Congestive heart failure			-8
No	198,405 (98%)	189,107 (98%)	
Yes	4744 (2%)	4772 (3%)	
Atrial fibrillation			+13 [†]
No	190,798 (94%)	183,443 (95%)	
Yes	12,351 (6%)	10,436 (5%)	
Chronic alcoholism			-25 [†]
No	202,636 (100%)	193,195 (100%)	
Yes	513 (0.3%)	685 (0.4%)	
Dementia			-97 [†]
No	202,802 (100%)	179,730 (93%)	
Yes	347 (0.2%)	14,149 (7.3%)	
Osteoporosis			-7.3
No	192,758 (95%)	183,148 (95%)	
Yes	10,391 (5%)	10,731 (5.5%)	
Nutritional deficiency			-75 [†]
No	202,947 (100%)	193,037 (100%)	
Yes	202 (0.1%)	843 (0.4%)	
Malignancy			+75 [†]
No	198,913 (98%)	191,617 (99%)	
Yes	4236 (2.1%)	2262 (1.2%)	

* Relative difference between NHDS and NIS, with NIS = 100%, [†]if greater than 10%; NHDS = National Hospital Discharge Survey; NIS = Nationwide Inpatient Sample.

Based on the large sample size, we assumed normality [14] and used parametric statistical tests. We decided, a priori, that a difference of 10% between the NHDS and NIS was meaningful. The 10% cutoff was chosen based on prior use in similar studies [9, 24, 25].

Table 3. Adverse events in patients with hip osteoarthritis and THA

Adverse event	Number of patients		Δ^*	R-squared NHDS	R-squared NIS	Overall % NHDS	Overall % NIS
	NHDS (n = 203,149)	NIS (n = 193,879)					
Wound complications			+43 [†]	0.31	0.062	98%	99%
No	199,176 (98%)	191,173 (99%)					
Yes	3973 (2.0%)	2707 (1.4%)					
Hematoma and seroma			+58 [†]	0.32	0.054	98%	99%
No	199,218 (98%)	191,459 (99%)					
Yes	3931 (1.9%)	2420 (1.2%)					
Disruption wound			−100 [†]	x	0.38	x	100%
No	203,149 (100%)	193,860 (100%)					
Yes	0 (0.0%)	20 (0.0%)					
Postoperative infection			−84 [†]	1.00	0.10	100%	100%
No	203,107 (100%)	193,612 (100%)					
Yes	42 (0.0%)	267 (0.1%)					
Acute postoperative anemia			8.6	0.14	0.046	82%	82%
No	164,532 (81%)	159,911 (83%)					
Yes	38,617 (19%)	33,968 (18%)					
Complications			−1.8	0.14	0.094	66%	64%
No	123,346 (61%)	116,415 (60%)					
Yes	79,803 (39%)	77,464 (40%)					
Complications not elsewhere classified			−9.4	0.23	0.11	98%	97%
No	197,326 (97%)	187,625 (97%)					
Yes	5823 (2.9%)	6254 (3.2%)					
Acute renal failure			−44 [†]	0.32	0.18	100%	99%
No	202,220 (100%)	192,150 (99%)					
Yes	929 (0.5%)	1729 (0.9%)					
Ventricular arrhythmias and arrest			−100 [†]	x	0.26	x	100%
No	203,149 (100%)	193,849 (100%)					
Yes	0 (0.0%)	30 (0.0%)					
Iatrogenic hypotension			−45 [†]	0.20	0.036	99%	98%
No	200,621 (99%)	189,605 (98%)					
Yes	2528 (1.2%)	4274 (2.2%)					
Pulmonary embolism			0	0.17	0.092	100%	100%
No	202,773 (100%)	193,493 (100%)					
Yes	376 (0.2%)	387 (0.2%)					
Acute myocardial infarction			−67 [†]	0.30	0.19	100%	100%
No	202,881 (100%)	193,311 (100%)					
Yes	268 (0.1%)	568 (0.3%)					
Fat embolism			0	x	x	x	x
No	203,149 (100%)	193,879 (100%)					
Yes	0 (0.0%)	0 (0.0%)					
Induced mental disorder			−81 [†]	0.43	0.12	99%	96%
No	201,520 (99%)	185,785 (96%)					
Yes	1629 (0.8%)	8094 (4.2%)					
Pneumonia and pulmonary congestion			−50 [†]	0.18	0.20	100%	100%
No	202,809 (100%)	193,186 (100%)					
Yes	340 (0.2%)	693 (0.4%)					

Table 3. continued

Adverse event	Number of patients		Δ^*	R-squared NHDS	R-squared NIS	Overall % NHDS	Overall % NIS
	NHDS (n = 203,149)	NIS (n = 193,879)					
Pulmonary insufficiency			0	0.26	0.25	100%	100%
No	202,843 (100%)	193,526 (100%)					
Yes	306 (0.2%)	353 (0.2%)					
Deep venous thrombosis			+30 [†]	0.40	0.077	100%	100%
No	202,619 (100%)	193,400 (100%)					
Yes	530 (0.3%)	480 (0.2%)					
Intubation and mechanical ventilation			−50 [†]	0.26	0.28	100%	100%
No	202,893 (100%)	193,495 (100%)					
Yes	355 (0.1%)	384 (0.2%)					
Transfusion			−17 [†]	0.13	0.069	79%	73%
No	157,391 (78%)	141,214 (73%)					
Yes	45,758 (23%)	52,665 (27%)					
Conversion			0	x	0.18	x	100%
No	203,044 (100%)	193,718 (100%)					
Yes	105 (0.1%)	161 (0.1%)					

Predictors entered: sex, age, geographic region, source of payment, days of care, hypertension, diabetes mellitus, obesity, chronic pulmonary disease, chronic renal disease, chronic liver disease, congestive heart failure, atrial fibrillation, chronic alcoholism, dementia, osteoporosis, nutritional deficiency, malignancy; x = zero or too small number for calculation; *Relative difference between NHDS and NIS, with NIS = 100% [†]if > 10%; NHDS = National Hospital Discharge Survey; NIS = Nationwide Inpatient Sample.

In bivariate analysis, in each dataset, mortality, adverse events, and days of care were the response variables and patient characteristics and comorbidities were the explanatory variables. To test whether variables fit in the regression models for mortality, adverse events, and days of care, we used an independent T-test to compare continuous variables and a chi-square test for categorical variables. The association between days of care and continuous outcomes was tested with a Pearson correlation test, between days of care and dichotomous variables an independent T-test, and between days of care and categorical variables a one-way ANOVA.

We entered variables with a minimum 2% prevalence (with the exception of clinically relevant adverse events [Table 3] with variables with a 1% minimum prevalence) and p values of 0.001 or less [15] for statistical significance based on the large dataset and to correct for multiple comparisons [13] in stepwise backward logistic regressions for mortality and adverse events and a backward linear regression for days of care. We excluded discharge status in the model of mortality since discharge status contains death as a category. In the regression models for adverse events, we excluded death and each of the distinct adverse events. The first model for the length of stay of the NIS showed multicollinearity, and we decided to remove mental disorder from the regression. The subsequent model did not violate the assumptions for linear regression.

Results

We found that 26 of 42 of the patient factors we analyzed were more than 10% different between databases. Factors sequenced from largest to smallest meaningful difference between the NHDS and NIS included: ventricular arrhythmias and arrest, disruption wound, dementia, postoperative infection, induced mental disorder, nutritional deficiency, malignancy, acute myocardial infarction, hematoma and seroma, chronic renal disease, discharge status, chronic liver disease, pneumonia and pulmonary congestion, intubation and mechanical ventilation, iatrogenic hypotension, acute renal failure, wound complications, obesity, length of stay of 2 SD or greater, deep venous thrombosis, geographic region Northeast, chronic alcoholism, diabetes mellitus, transfusion, atrial fibrillation, and total amount of comorbidities.

Ten factors associated with inpatient mortality had a greater than 10% difference between the NHDS and NIS (death rates of 0.04% and 0.08%, respectively) (Table 4). Twelve factors associated with more inpatient adverse events had a greater than 10% difference between the NHDS and NIS (Table 5). Seventeen factors associated with longer length of stay had a greater than 10% difference between the NHDS (mean, 3.7 ± 1.5 days) and the NIS (mean, 3.8 ± 2.1 days) (Table 6).

Table 4. Predictors of mortality in patients with hip osteoarthritis and THA

Factor	NHDS (n = 203,149; mortality n = 80)				NIS (n = 193,879; mortality n = 152)			
	p value	Odds ratio	95% CI		p value	Odds ratio	95% CI	
			Lower	Upper			Lower	Upper
Wound complication					< 0.001	7.0	4.3	11
Congestive heart failure					< 0.001	6.1	4.4	8.5
New mental disorder					< 0.001	4.4	2.3	8.7
Chronic pulmonary disease					< 0.001	3.5	2.6	4.7
Complication not elsewhere classified					0.002	2.9	1.5	5.8
Dementia					< 0.001	1.9	1.4	2.7
Age	< 0.001	1.4	1.3	1.5	< 0.001	1.06	1.05	1.08
Days of care	< 0.001	1.8	1.7	2.0	< 0.001	1.04	1.03	1.06
Geographic region (reference: South)								
West					0.002	0.51	.34	.78
Northeast					< 0.001	0.43	.28	.67
Acute postoperative anemia					< 0.001	0.24	0.15	0.39
Sex (male)	< 0.001	4.8	2.6	8.9				

Variables entered on Step 1 = NHDS: source of payment, age, days of care, chronic pulmonary disease, congestive heart failure, atrial fibrillation, dementia, acute postoperative anemia, complications not elsewhere classified, new mental disorder, transfusion, wound complications, geographic region Northeast, geographic region Midwest, geographic region West; NIS = sex, age, days of care, atrial fibrillation, acute posthemorrhagic anemia, transfusion, source of payment; NHDS = National Hospital Discharge Survey; NIS = Nationwide Inpatient Sample.

Table 5. Predictors of adverse events in patients with hip osteoarthritis and THA

Factor	NHDS (n = 203,149; complications n = 79,803)				NIS (n = 193,879; complications n = 77,464)			
	p value	Odds ratio	95% CI		p value	Odds ratio	95% CI	
			Lower	Upper			Lower	Upper
Dementia					< 0.001	2.28	2.20	2.37
Sex (female)	< 0.001	1.20	1.18	1.23	< 0.001	1.54	1.51	1.57
Osteoporosis	< 0.001	1.59	1.53	1.66	< 0.001	1.22	1.17	1.27
Days of care	< 0.001	1.21	1.21	1.22	< 0.001	1.195	1.188	1.203
Geographic region (reference: South)								
West	< 0.001	1.72	1.68	1.76	< 0.001	1.14	1.12	1.17
Northeast	< 0.001	0.51	0.50	0.53	0.008	1.04	1.01	1.07
Midwest					< 0.001	0.92	0.90	0.94
Congestive heart failure	< 0.001	0.83	0.77	0.88	< 0.001	1.14	1.07	1.21
Atrial fibrillation	< 0.001	1.85	1.78	1.93	< 0.001	1.13	1.08	1.18
Age	< 0.001	1.029	1.028	1.030	< 0.001	1.013	1.012	1.014
Diabetes mellitus	< 0.001	0.67	0.64	0.69	0.005	0.96	0.93	0.99
Source of payment (reference: Medicare)								
All other sources	< 0.001	1.13	1.10	1.16				
Obesity	0.015	0.95	0.92	0.99				
Hypertension	< 0.001	0.90	0.88	0.92				
Chronic pulmonary disease	< 0.001	0.67	0.66	0.70				

Variables entered on Step 1 = NHDS: sex, age, days of care, atrial fibrillation, source of payment, nonroutine discharge, geographic region Northeast, geographic region Midwest, geographic region West, hypertension, diabetes mellitus, obesity, chronic pulmonary disease, congestive heart failure, osteoporosis; NIS = sex, age, days of care, atrial fibrillation, source of payment, nonroutine discharge, geographic region Northeast, geographic region Midwest, geographic region west, hypertension, diabetes mellitus, obesity, chronic pulmonary disease, congestive heart failure, osteoporosis; NHDS = National Hospital Discharge Survey; NIS = Nationwide Inpatient Sample.

Table 6. Predictors of length of stay in patients with hip osteoarthritis and THA

Factor	NHDS (n = 203,149)		NIS (n = 193,879)	
	Days of care = 3.7 ± 1.5		Days of care = 3.8 ± 2.1	
	Adjusted $R^2 = 0.101$		Adjusted $R^2 = 0.076$	
	p value	Partial R^2	p value	Partial R^2
Chronic pulmonary disease	< 0.001	0.0102	< 0.001	0.000256
Atrial fibrillation	< 0.001	0.01	< 0.001	0.003249
Complication not elsewhere classified	< 0.001	0.00689	< 0.001	0.023716
Congestive heart failure	< 0.001	0.00689	< 0.001	0.003025
Geographic region (reference: South)				
Northeast	< 0.001	0.00608		
West	< 0.001	0.00533	< 0.001	0.001024
Midwest	< 0.001	0.0049		
Transfusion	< 0.001	0.00436	< 0.001	0.003025
Discharge (reference: routine)	< 0.001	0.0036	< 0.001	0.001444
Nonroutine				
Acute postoperative anemia	< 0.001	0.00203	< 0.001	0.0001
Source of payment				
Medicare	< 0.001	0.00194		
All other sources			0.025	0.000025
Hypertension	< 0.001	0.00152	< 0.001	0.0001
Age	< 0.001	0.0009	< 0.001	0.000841
Wound complication	< 0.001	0.00063	< 0.001	0.011025
Diabetes mellitus	< 0.001	0.00058	< 0.001	0.000324
Iatrogenic hypotension	< 0.001	0.00014	0.002	0.000049
Dementia			< 0.001	0.002916
Sex (female)			< 0.001	0.000196
Osteoporosis			0.009	0.000036

Predictors of NHDS = transfusion, hypertension, iatrogenic hypotension, geographic region West, complication not elsewhere classified, chronic pulmonary disease, congestive heart failure, wound complication, nonroutine discharge, diabetes mellitus, acute postoperative anemia, geographic region Northeast, source of payment, atrial fibrillation, geographic region Northeast, age; NIS = transfusion, diabetes mellitus, complications not elsewhere classified, chronic pulmonary disease, geographic region West, osteoporosis, wound complications, iatrogenic hypotension, atrial fibrillation, hypertension, congestive heart failure, sex, dementia, nonroutine discharge, acute postoperative anemia, geographic region Northeast, source of payment, geographic region Midwest, age, new mental disorder; NHDS = National Hospital Discharge Survey; NIS = Nationwide Inpatient Sample.

Discussion

The NHDS and NIS are large databases. They collect patient data containing information regarding 8.5 million hospitalizations per year. Using these tools, investigators can answer questions that are not easily answered in single- or even multicenter prospective trials. As such, both databases are widely used for clinical research. However, there is some evidence that the answer to a given study question may vary according to the database used [2, 4], that is, asking these databases the same question might result in different answers. The degree to which this is true for arthroplasty-related research has, to our knowledge, not been characterized. Thus, we determined whether there were differences between databases in terms of patient

characteristics, comorbidities, and adverse events in patients with hip osteoarthritis treated with THA and factors associated with inpatient mortality, adverse events, and length of stay after THA.

These data should be interpreted in light of several factors. First, they might apply only to 2006, and the questions we asked pertained only to patients undergoing THA, and so should be generalized with caution. Second, we have no information regarding severity of the comorbidities, which generally were coded as being either present or absent; obviously, there are relevant clinical differences between, for example, well-controlled and poorly controlled diabetes, and such distinctions cannot be drawn from these databases. Moreover, other important factors such as smoking status and use of medication were not

available. Third, based on the design of the databases, it was not always possible to distinguish whether adverse events or comorbidities were diagnosed before admission or during the hospital stay. This would be possible only in a prospective study, which would be difficult to do with this number of patients. This drawback is the same for the NHDS and NIS and in other similar databases and should not influence the hypothesis addressed in our study. Fourth, the 10% cutoff point was selected because this was the minimum difference that we thought would be clinically meaningful. It also was used in similar prior studies [9, 24, 25]. Other cutoffs might have led to different conclusions. Finally, both databases use a probability design to calculate estimates of the number of patients and their outcomes [6, 11]. The NHDS and the NIS include 1% and 20% of all hospitalizations in the US respectively and use a selection procedure to weight the cases and present the database as an estimate of all hospitalizations in the US. These shortcomings are common to both databases.

We found similar basic epidemiologic data (age, sex, and overall rate of adverse events) between databases, but there were important differences in the incidence of certain comorbidities and adverse events. For instance, congestive heart failure and geographic region Northeast were associated with lower risk for adverse events in the NHDS and higher risk for adverse events in the NIS. This difference and the higher rate of inpatient death in the NIS have been ascribed to the sampling of more large hospitals with relatively infirm patients by the NIS [1]. Both databases attempt to represent the average patient in the average hospital in the US and it is not clear which is more successful. The larger number of factors associated with in-hospital mortality and adverse events in the NIS likely reflects the greater number of ICD-9 codes that can be entered in the database.

Other studies have documented differences in results when comparing the NHDS or NIS with other databases for specific research questions [12, 16, 20, 23]. For instance, prior research on fundoplication found more adverse events and fewer comorbidities among patients in the NIS compared with a national database established by the Society of American Gastrointestinal Endoscopic Surgeons (SAGES) [16]. Patients with nonelective admissions after injury had more comorbidities and lower mortality in the NIS than in the National Trauma Data Bank [20]. Mortality rates after pediatric cardiac surgery were lower in national databases such as the NIS and Kids' Inpatient Database than the rates derived from hospital administrative data [23].

Finally, a study found different rates of measles hospitalization when comparing the National Notifiable Disease Surveillance System, the Health Care Investment Analysts hospital discharge database, and the NHDS [12].

The numbers from the NIS database were similar to those of a prior study of 53,252 patients treated with a THA using Medicare data [5]. Although Bohl et al. [4] looked at different diagnoses and one different database (NSQIP instead of NHDS), they had similar findings regarding the prevalence of adverse events. These similar studies show that caution is warranted especially when studying acute renal failure and postoperative infections in patients having undergone orthopaedic hip surgery [4]. The prevalence of these complications could be overestimated in the NIS based on the findings of our study and that of Bohl et al. [4]. We believe our study is important because we used two similar inpatient databases and found different results in terms of predicting death and adverse events.

We identified important differences in the statistical analysis of research questions depending on the database used. We found that 26 of 42 of the patient factors we analyzed were more than 10% different, when comparing the NHDS and the NIS. We suspect our findings for hip arthroplasty would be similar for other specific diagnoses and procedures. Differences in the results of the databases can be explained in part based on the differences in collection methods, case weighting, sample size, and differences in the collected ICD-9 codes. The characteristics of a database affect the results and should be taken into account when interpreting studies based on large databases. Future research should address the accuracy of these databases, the type of studies that are best addressed by each database, and the ability to identify changes in the data with specific quality improvement initiatives.

References

1. Agency for Healthcare Research and Quality. 1996 HCUP Nationwide Inpatient Sample (NIS) Design Report. HCUP. Available at: http://www.hcup-us.ahrq.gov/db/nation/nis/reports/NIS_1996_Design_Report.jsp. Accessed May 7, 2014.
2. Agency for Healthcare Research and Quality. HCUP Facts and Figures: Statistics on Hospital-Based Care in the United States. 2009. Available at: http://www.hcup-us.ahrq.gov/reports/factsandfigures/2009/pdfs/FF_report_2009.pdf. Accessed May 7, 2014.
3. Bhattacharyya T, Iorio R, Healy WL. Rate of and risk factors for acute inpatient mortality after orthopaedic surgery. *J Bone Joint Surg Am*. 2002;84:562–572.
4. Bohl DD, Basques BA, Golinvaux NS, Baumgaertner MR, Grauer JN. Nationwide Inpatient sample and National Surgical Quality Improvement Program give different results in hip fracture studies. *Clin Orthop Relat Res*. 2014;472:1672–1680.
5. Bozic KJ, Ong K, Lau E, Berry DJ, Vail TP, Kurtz SM, Rubash HE. Estimating risk in Medicare patients with THA: an electronic risk calculator for periprosthetic joint infection and mortality. *Clin Orthop Relat Res*. 2013;471:574–583.
6. DeFrances CJ, Lucas CA, Buie VC, Golosinskiy A. Division of Health Care Statistics. 2006 National Hospital Discharge Survey. National health statistics reports; no 5. Available at: <http://www.cdc.gov/nchs/data/nhsr/nhsr005.pdf>. Accessed June 1, 2013.

7. Dennison C, Pokras R. Design and operation of the National Hospital Discharge Survey: 1988 redesign. Available at: http://www.cdc.gov/nchs/data/series/sr_01/sr01_039.pdf. Accessed May 7, 2014.
8. Dubberke ER, Butler AM, Nyazee HA, Reske KA, Yokoe DS, Mayer J, Mangino JE, Khan YM, Fraser VJ. Centers for Disease Control and Prevention Epicenters Program. The impact of ICD-9-CM code rank order on the estimated prevalence of *Clostridium difficile* infections. *Clin Infect Dis*. 2011;53:20–25.
9. Edwards GA, Metcalfe AJ, Johansen A, O'Doherty D. Performance monitoring in hip fracture surgery: how big a database do we really need? *Injury*. 2010;41:374–376.
10. Gorina Y, Owings M, Elgaddal N, Weeks J. Comparability between the rates for all-listed inpatient procedures using National Hospital Discharge Survey and Medicare claims, 1999 and 2007. National health statistics reports; no 57. Available at: <http://www.cdc.gov/nchs/data/nhsr/nhsr057.pdf>. Accessed on May 7, 2014.
11. Hall MJ, DeFrances CJ, Williams SN, Golosinskiy A, Schwartzman A. National Hospital Discharge Survey: 2007 summary. National Health Statistics Reports; no 29. Available at: <http://www.cdc.gov/nchs/data/nhsr/nhsr029.pdf>. Accessed May 29, 2013.
12. Lee B, Ying M, Papania MJ, Stevenson J, Seward JF, Hutchins SS. Measles hospitalizations, United States, 1985–2002. *J Infect Dis*. 2004;189(suppl 1):S210–215.
13. Lemeshow S, Teres D, Klar J, Avrunin JS, Gehlbach SH, Rapoport J. Mortality Probability Models (MPM II) based on an international cohort of intensive care unit patients. *JAMA*. 1993;270:2478–2486.
14. Lumley T, Diehr P, Emerson S, Chen L. The importance of the normality assumption in large public health data sets. *Annu Rev Public Health*. 2002;23:151–169.
15. Memtsoudis SG, Gonzalez Della Valle A, Besculides MC, Gaber L, Sculco TP. In-hospital complications and mortality of unilateral, bilateral, and revision TKA: based on an estimate of 4,159,661 discharges. *Clin Orthop Relat Res*. 2008;466:2617–2627.
16. Morton JM, Galanko JA, Soper NJ, Low DE, Hunter J, Traverso LW. NIS vs SAGES: a comparison of national and voluntary databases. *Surg Endosc*. 2006;20:1124–1128.
17. National Center for Health Statistics. Health, United States, 2011: With Special Feature on Socioeconomic Status and Health. Available at: <http://www.cdc.gov/nchs/data/abus/abus11.pdf>. Accessed June 3, 2013.
18. Neuhaus V, King J, Hageman MG, Ring DC. Charlson comorbidity indices and in-hospital deaths in patients with hip fractures. *Clin Orthop Relat Res*. 2013;471:1712–1719.
19. Odum SM, Troyer JL, Kelly MP, Dedini RD, Bozic KJ. A cost-utility analysis comparing the cost-effectiveness of simultaneous and staged bilateral total knee arthroplasty. *J Bone Joint Surg Am*. 2013;95:1441–1449.
20. Phillips B, Clark DE, Nathens AB, Shiloach M, Freil AC. Comparison of injury patient information from hospitals with records in both the National Trauma Data Bank and the Nationwide Inpatient Sample. *J Trauma*. 2008;64:768–779; discussion 779–780.
21. Sassoon A, D'Apuzzo M, Sems S, Cass J, Mabry T. Total hip arthroplasty for femoral neck fracture: comparing in-hospital mortality, complications, and disposition to an elective patient population. *J Arthroplasty*. 2013;28:1659–1662.
22. Steiner C, Elixhauser A, Schnaier J. The healthcare cost and utilization project: an overview. *Eff Clin Pract*. 2002;5:143–151.
23. Welke KF, Diggs BS, Karamlou T, Ungerleider RM. Comparison of pediatric cardiac surgical mortality rates from national administrative data to contemporary clinical standards. *Ann Thorac Surg*. 2009;87:216–222; discussion 222–223.
24. Wieringa NF, de Graeff PA, van der Werf GT, Vos R. Cardiovascular drugs: discrepancies in demographics between pre- and post-registration use. *European Journal of Clinical Pharmacology*. 1999;55:537–544.
25. Wieringa NF, Vos R, van der Werf GT, van der Veen WJ, de Graeff PA. Co-morbidity of 'clinical trial' versus 'real-world' patients using cardiovascular drugs. *Pharmacoepidemiol Drug Saf*. 2000;9:569–579.