



Patient Factors that Predict Complicated Hernia Presentation Using the National Hospital Ambulatory Medical Care Survey (NHAMCS)

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Authors' contributions

This work was carried out in collaboration between all authors. Author DG designed the study, wrote the protocol, performed analysis and interpreted data. Author EI drafted the manuscript and prepared figures and tables. Author AMM designed the study and performed critical revisions to the final manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Patient age and insurance status can lead to presentation with complicated hernias. Surgery for complicated hernias results in greater morbidity, mortality, and healthcare costs compared to elective repair of uncomplicated hernias. This study explores the association between insurance status and age with presentation of complicated inguinal hernia.

Methodology: Data from Center for Disease Control (CDC) National Hospital Ambulatory Medical Care Survey (NHAMCS) for 1992-2010 of inguinal hernia encounters from emergency department and outpatient visits were selected and combined. This cross-sectional study compared presentation of complicated inguinal hernia with explanatory variables of insurance status and age through chi-square and logistic regression analysis. Ethnicity and sex were potential confounders.

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Results: Of the 1452 inguinal hernia encounters, 4.1% were complicated. Lack of insurance did not predict presentation with a complicated hernia (OR=0.11, 95%CI [0.04-0.35]), even after adjusting for age, sex, and ethnicity. Age 65 years and older was a strong predictor of complicated hernia presentation ($P<.0001$). The reduced odds of presenting with a complicated hernia for those without insurance persisted across different age groups.

Conclusion: Our results suggest that age is a strong predictor of complicated hernia presentation; however, lack of insurance is not. Elderly patients, regardless of insurance status, should be considered for early elective hernia repair.

Keywords: Inguinal hernia; healthcare disparities; general surgery; health insurance.

1. INTRODUCTION

Abdominal wall hernia repairs were the third leading cause of ambulatory care visits in 2004 [1], and one of the most common surgical procedures in the U.S, with over one million inguinal, ventral and umbilical herniorrhaphies performed annually [2]. Approximately 75% of these are inguinal hernia repairs [3]. Elective surgery for a symptomatic inguinal hernia is the preferred method of treatment. With elective surgery there is typically a lower risk of mortality and morbidity, and a shorter length of stay in the hospital (usually ambulatory surgery in most instances) [4]. It is when the hernia is irreducible, incarcerated or strangulated, that elective surgery becomes emergent. Reducible hernias are defined as those in which hernia sac contents can be returned to the peritoneal cavity through external manipulation, whereas irreducible, or incarcerated, hernias cannot be reduced through manual pressure. Finally, strangulated hernias are those whose vascular supply has been compromised and are now ischemic. In these cases the risks of morbidity, mortality, and hospital stay increase [5]. In the case incarcerated hernias, between 10%-19% of patients require bowel resection. A presentation with an irreducible hernia not only increases the risks of morbidity and mortality, but also increases costs because of required resources, increased hospital length of stay, and morbidity. Within the United States, abdominal wall hernias cost \$2.5 billion in yearly health care expenditure [3].

There are known disparities, with respect to ethnicity and socioeconomic status (SES), in presentation of ventral hernias [6]. Moreover, delay in receiving medical care is an important cause of poor outcomes in the treatment of emergent incarcerated, obstructed, or strangulated groin hernias [7]. Cost concerns, socioeconomic issues, and lack of insurance are some of the most important reasons that make patients delay in seeking medical attention [8].

Prior studies have examined the effect of insurance status and socioeconomic parameters on the outcomes of ventral [9] and groin hernias [2,10], however, very few studies have looked at the effect of insurance status and socioeconomic factors on whether there is a delay of care leading to an initial complicated presentation.

Increased age has been shown to increase morbidity and mortality in the management of all incarcerated abdominal wall hernias (inguinal, femoral, incisional) [11]. A prior study found that, at one practice, median age for patients with incarcerated groin hernias (inguinal and femoral) was 70 years [12]. Other studies have found similar results [13,14]. This risk has led to the recommendation for early elective repair of hernias especially in elderly patients [7]. However, there is a lack of investigation regarding the complicated vs. uncomplicated status of the inguinal hernia at presentation with age of patient.

In this study, we assessed the possible association of age and insurance status with complicated inguinal hernia presentation at time of hospital visit. Following the results of previous studies that looked at all abdominal wall hernias, we hypothesized that those with inguinal hernia who are older and uninsured will have higher odds of presenting in the complicated state compared to those with inguinal hernias who are younger and insured.

2. METHODOLOGY

2.1 Study Design

A cross-sectional study of outpatient and emergency department patients diagnosed with inguinal hernias was performed to evaluate the association of insurance status with complicated hernia presentation. Hernias involving intestinal obstruction or gangrene were classified as complicated.

2.2 Study Population

Patients who present with an inguinal hernia were included in the study. The age restriction of patients greater than the age of five was put in place to decrease the proportion of patients who are unable to detect the presence of a hernia and hence are unable to seek medical attention before progression of the hernia to the complicated stage.

2.3 Data Source

The data for this study was obtained from the National Hospital Ambulatory Medical Care Survey (NHAMCS) for the years 1992-2010. This survey includes samples of non-institutional general and short-stay hospitals, exclusive of Federal, military, and Veterans Administration hospitals, located in the 50 States and the District of Columbia. The NHAMCS dataset is separated into outpatient department and emergency department. The outpatient department includes clinics and ambulatory surgery centers that are either hospital based or freestanding.

A four-stage probability sampling design is used for the NHAMCS. The first stage involves the sampling of geographically defined areas. There a total of 1900 geographically defined Primary Sampling Units (PSUs) within the United States of America and the District of Columbia. PSUs are comprised of counties, groups of counties, county equivalents, towns, townships, minor civil divisions and metropolitan statistical areas defined by the U.S. Office of Management and Budget. The second stage involves sampling of hospitals within the sampled PSUs. There were a total of 600 hospitals sampled for the survey, of which 550 had an emergency department and/or an outpatient department, and 50 had neither an emergency department nor an outpatient department. These hospitals were then randomly assigned to 16 subgroups, which participated for a designated four week reporting period. This method ensured that a hospital did not participate in a survey multiple times within one year or during the same time period every year.

During the third stage, clinics within the outpatient departments were selected and all emergency service areas and in-scope ambulatory surgery locations are included. To be considered in-scope, ambulatory medical care had to be supervised by a physician; and

services had to be provided within a hospital, at an established location and a set schedule. Beginning in 2009, hospital based ambulatory surgery centers were included. The fourth stage entailed the selection of the patient visits within the selected settings over a four week period. The desired number of patients for the emergency departments, outpatient departments, and ambulatory surgery centers per hospital for each 4-week reporting period were 50, 150 and 100, respectively. For hospitals with a higher volume of visits, patients were selected using a systematic procedure, which selects every n th visit after a random start to obtain the desired number of visits for each setting. For instance, to obtain 150 patient visits for the outpatient department of a hospital that had 1500 encounters during the 4-week reporting period, every 10th visit was selected for the sample after starting at a random visit between the 1st and 10th visit. This resulted in 150 visits for the sample of this hypothetical outpatient department.

NHAMC variables available varied by year and by hospital department - emergency and outpatient. Only those variables which were similar for both the emergency and outpatient datasets were used. The variables utilized for 1992-2010 included age, sex, ethnicity, expected source of payment, and diagnosis. For the variables age, sex, and ethnicity some of the values were imputed by using the information from subjects with similar characteristics. Non-response was typically low, less than or equal to 5%, but for the aforementioned variables non-response was slightly higher. For the years 2007-2008, non-response (13.1% missing values for ethnicity in the ED, 12.4% missing values for ethnicity in the OPD, 21.9% for ethnicity in the ED and 19.3% for OPD) for the demographic variables was much higher than for other years, but the percentage improved in 2009 after improvements were made to the data collection process. As a result of this improvement, missing values were not imputed for 2009-2010 contributing to the missing data for ethnicity in the compiled dataset. For 2006-2010 SES related variables % poverty in patient's zip-code, median household income in patient's zip-code, % of adult's with bachelor's degree or higher in patient's zip-code and rural-urban classification of patient's zip-code were included along with the aforementioned demographic, outcome and explanatory variables. For 2009-2010, co-morbidity variables (diabetes, cerebrovascular disease and congestive heart failure) were also included.

The diagnosis variable is comprised of three separate categories—Diagnosis 1, Diagnosis 2 and Diagnosis 3. Diagnosis 1 is the primary ICD-9 diagnosis provided by the physician, while Diagnosis 2 and Diagnosis 3 are other conditions related to choice of treatment, and choice of medication ordered or provided for the patient at time of visit. Diagnosis 2 and Diagnosis 3 can also be chronic conditions related to the visit. No unique identifiers were included; therefore anonymity is maintained for the subjects.

2.4 Hernia Classification

The guidelines used for hernia classification were directly modeled, with two diagnosis additions, based upon existing literature [2]. For both the emergency department and outpatient department datasets, all subjects which have any of the following characteristics were classified as complicated:

1. Diagnosis 1 was coded as a complicated inguinal hernia (550.00, 550.01, 550.02, 550.03, 550.1, 550.11, 550.12, 550.13).
2. Diagnosis 2 and Diagnosis 3 were coded as a complicated inguinal hernia and primary diagnosis was coded for other specified intestinal obstruction (560.89), unspecified intestinal obstruction (560.9), sepsis/septic shock (038.0-038.49, 038.9, 995.91, 995.92, or 785.52), peritonitis (567.0, 567.2, 567.21, 567.22, 567.29, 567.9, 567.3, 567.31, 567.38 or 567.39), or bowel ischemia (557.0).
3. Diagnosis 1 was coded as an uncomplicated inguinal hernia (550.9, 550.91, 550.92 or 550.93) and secondary or tertiary diagnosis was coded for other specified intestinal obstruction (560.89), unspecified intestinal obstruction (560.9) sepsis/septic shock (038.0-038.49, 038.9, 995.91, 995.92, or 785.52), peritonitis (567.0, 567.2, 567.21, 567.22, 567.29, 567.9, 567.3, 567.31, 567.38 or 567.39), or bowel ischemia (557.0).

All subjects who have Diagnosis 1 of 550.9, 550.91, 550.92 or 550.93 and do not have Diagnosis 2 or 3 for other specified intestinal obstruction (560.89), unspecified intestinal obstruction (560.9) sepsis/septic shock (038.0-038.49, 038.9, 995.91, 995.92, or 785.52), peritonitis (567.0, 567.2, 567.21, 567.22, 567.29, 567.9, 567.3, 567.31, 567.38 or 567.39), or bowel ischemia (557.0), were classified as uncomplicated.

2.5 Exposure Classification

Insurance status was divided into two categories of insured and uninsured. The insured category includes those with private insurance, Medicare and Medicaid. The uninsured category includes those who have a value of zero for all categories of payment and also those who self-pay. An additional subset analysis was performed with insurance status categorized into five categories: private, Medicare, Medicaid, uninsured and other. The uninsured category includes those without insurance, those with unknown pay, and the self-pay group. The Other category included worker's compensation, other insurance, other government insurance and other private insurance.

2.6 Statistical Analysis

Bivariate analysis of association of insurance status and demographic characteristics with inguinal hernia classification using chi square tests was performed. A multivariate logistic regression including demographic characteristics and insurance category—dichotomous and categorical—with hernia classification as the dichotomous variable was performed for the years 1992-2010. Age, sex, ethnicity were treated as potential confounders. For 2009-2010, comorbidity (diabetes) and ecologic SES (percent of patient's zip code below poverty level, percent of patient's zip code median household income, percent of patient's zip code with bachelor's degree or more and urban rural classification of patient's zip code) variables were included in the logistic regression. Age and comorbidities are considered potential confounders because: (1) patients with Medicare are older and, on average, have more chronic diseases than patients in other insurance categories; and (2) age and comorbidities may be independently associated with deferral of elective repair by patients or surgeons. For the final model only the variables that were statistically significant ($P < .05$) remained. For completeness, we ran a model which included the borderline insignificant results ($0.05 < p < 0.3$), which resulted in no change in the final model.

The weights provided in both the outpatient and emergency datasets were applied to account for the sampling design. Furthermore, two design variables, CPSUM and CSTRATA, were included in the datasets beginning in 2003. CPSUM represents the selection of the hospitals included in the survey, while CSTRATA represents the

selection of the PSUs. For the years prior to 2003, the design variables were created according to a formula provided in the documentation for the datasets:

```
IF CPSUM IN (1 2 3 4) THEN DO;
CSTRATM=(STRATM*100000)+(1000*(MO
D(YEAR,100)))+
(SUBFILE*100)+PROSTRAT;
CPSUM=PROVIDER+100000; END;
ELSE CSTRATM=(STRATM*100000).
```

Stratm, Year, Subfile, Prostrat, and Provider are variables included in the dataset that represents the selection process of the hospital surveyed and the geographical area in which the hospital is located. All statistical analysis was performed using SAS survey procedures.

3. RESULTS

Table 1 shows the general demographic information and insurance status of the study subjects. Of the 1452 inguinal hernia related visits from 1992-2010, 60 (4.1%) were complicated and 1392 (95.9%) were uncomplicated. The uninsured had an 89% (OR=0.11, 95%CI [0.04-0.35]) reduced odds of presenting with a complicated inguinal compared to the insured. The odds (OR=0.21, 95% CI [0.07-0.63]) of presenting with a complicated hernia for the uninsured remained unchanged after adjusting for age, sex, and ethnicity.

The median age of those with complicated hernia presentations was 67.5 years old (95%CI 59.1-76.0), while the median age for the uncomplicated group was 45.8 years old (95% CI 43.2-48.4). Age had a statistically significant association with a complicated inguinal hernia presentation ($P<.0001$). More specifically, those in the 45-64 years age group had a 75% reduced odds (OR=0.25 95% CI [0.087-0.697]) of presenting with a complicated hernia compared to the 75 years and older age group. The association remained after controlling for insurance status, the only other statistically significant variable. In a model including an interaction term for age and insurance status, along with age and insurance status alone, the interaction between age and insurance was statistically significant ($P<.0001$). More specifically, the interactions between insurance status and being in the 25-44 years and 45-64 years age group were statistically significant ($P<.0001$), as highlighted in Table 2. Furthermore, the reduced odds of presenting with a complicated hernia for those without

insurance compared to those with insurance persisted within each age group.

When insurance was categorized into five categories, those with private (OR=3.29, 95% CI [1.09-9.87], Medicare (OR=2.77, 95% CI [0.73-10.51]) and Medicaid (OR=2.94 95% CI [0.81-10.63]) had higher odds of presenting with a complicated hernia compared to the uninsured (Table 3). However, the only statistically significant association was between private and uninsured. Furthermore, insurance status is no longer significant when categorized into the five separate categories ($P=0.31$). Age, on the other hand, remained statistically significant when insurance status is categorical and it is adjusted for the demographic variables, which are not statistically significant.

For the subset analysis, including the years 2009-2010, none of the comorbidity or SES variables were statistically significant. Diabetes was only found in 13 of the uncomplicated cases. Furthermore, insurance status is not statistically significant, but age retains its statistical significance ($P=.03$).

4. DISCUSSION

Our results suggest that lacking insurance is not a risk factor for presenting with a complicated inguinal hernia (OR=0.20, 95% CI [0.07-0.63]) at time of hospital visit. These results are inconsistent with previous studies, which found that those without insurance, or with government funded plans, have a higher odds of presenting with a complicated hernia compared to those with private insurance. Even after adjusting for a number of variables and performing interaction studies, we observed no relationship between lack of insurance and presentation with a complicated hernia. London et al. [2] found that the odds of presenting with a complicated inguinal hernia were 12.4 times higher in the uninsured compared to those with private insurance. In their study, after adjusting for age and comorbidities, the uninsured had a 7.02 times higher odds of presenting with a complicated hernia compared to the privately insured. Their study differed from ours in the study population (California-based database vs. national database), sample size (147,665 vs. 1,452) and types of hernias (inguinal, umbilical, and ventral vs. inguinal only) assessed. In addition, our study did not focus on morbidity, mortality, and overall outcomes after hernia repair, only on the effect of insurance and age on the type of presentation.

Table 1. Demographic and insurance status characteristics of emergency and outpatient department inguinal hernia related visits in the U.S. , 1992-2010, by Hernia classification**

	Complicated n=60 (4.1%)	Uncomplicated n=1320 (95.9)%	Total (n=1452)	p-value	Odds ratio
	#, [column %]	#, [column %]	#, (%)		(95% CI)
Sex					
Female	14 [16.6%]	138 [10.4%]	152(10.7%)	<i>P</i> =.16	1.72(0.81-3.71) Referent
Male	46 [83.4%]	1254 [89.6%]	1300 (89.3%)		
Age					
5-14 years old	1 [1.9%]	66 [8.6%]	67 (8.3%)	<i>P</i> =.046†	0.107 (0.102-0.962)†
15-24 years old	3 [2.3%]	127 [10.4%]	130 (10.0%)	<i>P</i> =.005†	0.109 (0.023-0.522)†
25-44 years old	13 [16.6%]	413 [26.8%]	426 (26.3%)	<i>P</i> =.023†	0.301(0.107-0.849)†
45-64 years old	14 [17.9%]	474 [35.2%]	488 (34.3%)	<i>P</i> =.008†	0.247 (0.087-0.697)†
65-74 years old	16 [38.1%]	160 [7.7%]	176 (9.3%)	<i>P</i> =.068	2.402(0.939-6.148)
75 years and older	13 [23.2%]	152 [11.2%]	165 (11.9%)	Referent	
Ethnicity					
White	48 [85.5%]	1047 [75.1%]	1095 (75.6%)	<i>P</i> =.14	Referent
Black	10 [13.4%]	303 [23.0%]	313 (22.5%)		0.51 (0.22-1.22)
Other	2 [1.1%]	42 [1.9%]	44 (1.9%)		0.52 (0.11-2.42)
Hispanic Origin	9 [9.7%]	211 [15.7%]	220 (15.4%)	<i>P</i> =.25	0.57(0.22-1.49)
Not Hispanic	46 [90.3%]	1123 [84.3%]	1169 (84.5%)		Referent
Insurance status *					
Insured	54 [90.3%]	941 [68.4%]	995 (69.5%)	<i>P</i> =.0058†	Referent
Not Insured	6 [9.7%]	433 [31.6%]	439 (30.5%)		0.23 (0.08-0.71)

**Percentages derived from weighted frequencies, †Statistically significant at the .05 level of significance ($p \leq .05$), * Missing values (18 for Insurance Status, 63 for Ethnicity)

Table 2. Insurance status by age group

	Insured n=955 (69.5%) [column%]	Uninsured n=420 (30.5%) [column%]	Total n=1375 *	P-value	OR (95% CI)
5-14 years old	57 [7.8%]	8 [0.7%]	65 [4.7%]	.45	0.50 (0.08-2.99)
15-24 years old	65 [5.1%]	57 [5.0%]	122 [8.9%]	<.0001 †	0.04 (0.01-0.19)
25-44 years old	218 [15.5%]	184 [10.8%]	402 [29.2%]	<.0001 †	0.06 (0.02-0.24)
45-64 years old	310 [21.4%]	149 [12.9%]	459 [33.4%]	.0002 †	0.07 (0.02-0.29)
65-74 years old	152 [8.0%]	16 [0.5%]	168 [12.2%]	.66	0.68 (0.12-3.83)
75 years and older	153 [11.6%]	6 [0.5%]	159 [11.5%]	Reference	

* 77 patients removed due to missing values for variables age and ethnicity, † Statistically significant at the .05 level of significance

Table 3. Association of insurance status and age with complicated inguinal hernia presentation*

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)‡
Insurance status		
Uninsured**	0.11 (0.04-0.35)†	0.21(0.07-0.63)†
Age		
5-14 years	0.11 (0.01-0.96)†	0.12 (0.01-1.61)
15-24 years	0.11 (0.02-0.53)†	0.21 (0.04-1.09)
25-44 years	0.21 (0.07-0.60)†	0.34 (0.12-1.00)
45-64 years	0.25 (0.09-0.72)†	0.41 (0.13-1.29)
65-74 years	2.49 (0.95-6.51)	3.00 (1.04-8.68)†
75 years and over	Referent	

† Statistically significant ($P \leq .05$), ‡ Adjusted for ethnicity, age and sex, *Subjects missing ethnicity and insurance values excluded ($n=1375$) **Compared to insured patients

A retrospective study performed by Fan et al. [10] of patients from a single teaching hospital in China found that the risk factors predicting the need for bowel resection as a result of a complicated groin hernia were femoral hernia type, uninsured status, and presence of obvious peritonitis on admission. In their study, uninsured patients had a 4.65 ($P=.005$) times higher odds of bowel resection than the insured. Contrary to prior belief, uninsured patients had significantly decreased patient-time ($P=.001$) and total time to treatment ($P=.001$). Having health insurance was also associated with prolonged hospital stay ($P=.030$). Their study showed that lack of health insurance, along with obvious peritonitis and femoral hernia type, were independent risk factors for bowel resection in patients with incarcerated groin hernias. The investigators noted their limitations of small sample size from one hospital and the difference in China's insurance composition compared to the United States.

In our study, association between age and a complicated inguinal hernia presentation was statistically significant. Patients in the 45-64 years age group had a 75% reduced odds

presenting with a complicated hernia compared to those over the age of 75 years. The association remained after controlling for insurance status, the only other statistically significant variable. This is consistent with much of the literature, and externally validates our analysis. Alvarez et al. [12] assessed risk factors (not including insurance status) associated with morbidity, mortality and length of hospital stay for adults with incarcerated groin hernias. The study included 147 patients, who were admitted into a general hospital in Spain between 1992 and 2000. They showed that longer duration of symptoms, late hospitalization, concomitant diseases, and high ASA class were associated with unfavorable outcomes in the presentation of incarcerated hernias. Hernia type and patient sex were significantly related to need for bowel resection. Our study, in contrast, only focused on inguinal hernias, which have a lower incidence of complication when compared to femoral hernias [15], potentially explaining the relatively small complicated hernia sample in our study. Other differences include the fact that our national dataset did not have available ASA class, type of anesthesia, and duration of hospitalization, as well as a number of other comorbidities.

Moreover, Gul et al. [16] assessed factors which affect morbidity and mortality of patients who had surgery to repair incarcerated abdominal wall hernias. An analysis of 131 patients who underwent emergency surgery for incarcerated abdominal wall hernias between 2006 and 2011 revealed that bowel resection, concomitant comorbidities, age over 65, and general anesthesia predicted morbidity. However, a multivariate analysis showed that there were no risk factors that independently affected mortality.

Similar to the above studies, Oishi et al. [17] found that age was a significant risk factor for complicated hernia presentation in a cohort of over 1800 patients over 15 years of age. Advanced age predisposed to presenting with a bowel obstruction, requiring resection, and higher mortality. Unfavorable outcomes also occurred in women and in femoral hernias. In their study, the mean age for those with bowel obstruction was 65, which was statistically significantly older than those without (51.7), and this was consistent with our results: complicated (mean age 67.5) and uncomplicated (45.8). Furthermore, Rai et al. [15] also found age to be a risk factor in hernia complication in a study of the risk of strangulation and bowel obstruction in groin hernias. In a combination prospective and retrospective ten-year study, Rai et al. [15] showed that age, hernia type, gender, and duration of symptoms were significantly associated with complicated hernia presentation. In their analysis, complicated hernias were more common in adults in the 45-54 age group, while uncomplicated hernias were more common in the 15-24 age group, again a pattern consistent with our findings. Moreover, complicated inguinal hernias were more common in males, femoral hernias were more common in females and femoral hernias, overall, were more likely to be complicated. In our study, sex was not statistically significantly associated with complicated presentation of inguinal hernias. Duration of symptoms is an important variable not included in the dataset of our study and may be a more significant risk factor for the older complicated patients than insurance status. The results of these several studies, as well as our findings, highlight that advanced age is clearly associated with unfavorable outcomes and complicated presentation of a groin hernia.

Askew et al. [18] assessed the risk factors associated with delay in presentation and misdiagnosis of strangulated hernia. In this prospective cohort study of 54 patients with strangulated external hernias, the only

statistically significant association was delay in presentation and lack of awareness of the risk of strangulation. According to the authors, part of the delay was a misdiagnosis by the general practitioner. As expected, patients who were educated on the risk of strangulation had a mean presentation time of 15h post onset of symptoms, while those who were not informed of the risk had a mean presentation time of 56h post symptom onset.

The risk factors for hernia development have been previously described as the following: increased age, male gender, Caucasian ethnicity, increased intraabdominal pressure, and smoking. Both increased age and smoking (Theorized to be due to imbalance of blood protease and antiprotease levels [19]) lead to weakening of the connective tissue [20]. Processes that increase abdominal pressure, such as chronic cough or constipation can overcome this weakened connective tissue causing herniation of abdominal contents. Our results compliment these findings, where elderly patients are at greater risk of presenting with incarcerated hernias. Likewise, McEntee et al. [21] have previously reported that majority of patients who present with strangulated hernias often are aware of the hernia's presence for at least 1 month and that the incidence of new hernias becoming strangulated is low. This idea of "accumulated risk" is supported by Hair et al. [22] who found that a hernia present for 12 months had a 6.5% chance of irreducibility, whereas this chance increased to 30% in patients with hernia age of 10 years.

The aforementioned studies show the association of lack of insurance status with various adverse outcomes related to complicated hernias and appendectomies. Our study however shows the opposite effect, with lack of insurance not acting as a predictor of complicated hernia presentation in patients. Also, for our study, age appears to be the primary risk factor of interest and should be explored further. The previous studies do not include a national sample as our study does and could be a leading contributor to the difference in results.

Moreover, there are several important limitations to our study that should be noted. The sampling design of the survey, along with the masking of patient identities, did not allow for the identification of a possible repeat patient. Furthermore, the emergency department and outpatient department datasets only included the

demographic, diagnosis, and insurance status variables from 1992 to 2004. In 2005, comorbidity variables were included in the outpatient dataset, but not the emergency department dataset. Comorbidity variables were not included in the emergency department dataset until 2009, with the only common variables being congestive heart failure, cerebrovascular disease and diabetes. Socioeconomic status related variables were not included into the outpatient and emergency department datasets until 2006. The SES variables are only ecological in nature; it is not known what the patient's SES is but rather only the average SES of the ZIP code where the patient resides. Our sample size was also smaller than many of the other studies. In addition, public administrative datasets do not allow for granular analysis and evaluation of many clinical variables that may confound results. Finally, the data is categorized into hernia subtypes by CPT coding, and therefore is subject to coding error when the original case is entered. It is therefore impossible to know if an incarcerated inguinal hernia is truly acutely incarcerated or chronically incarcerated, as they would be likely coded in the same fashion.

5. CONCLUSION

Despite the previously mentioned limitations, our study was able to support that age is an important predictor of presentation of complicated hernia to the hospital, regardless of insurance status. Moreover, insurance status, especially lack of insurance, did not predict whether a patient is more likely to present with a complicated hernia. Elderly patients with inguinal hernias in an elective setting should be considered for timely repair as they may be at risk for incarceration or strangulation, likely more often than younger patients.

CONSENT

This project was conducted with the use of a publicly available, de-identified database, and therefore, individual patient consent is not applicable.

ETHICAL APPROVAL

Institutional Review Board (IRB) approval was obtained through the Newark Health Sciences IRB at Rutgers University (IRB number Pro2013003739).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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