VENTRAL HERNIAS ARE COMMONLY ENCOUNTERED IN GENERAL SURGERY PRACTICE. OBESITY, WHICH HAS REACHED EPIDEMIC PROPORTIONS IN THE UNITED STATES, IS A KNOWN RISK FACTOR FOR VENTRAL HERNIA. WITH THE INCREASING PREVALENCE OF OBESITY IN THE UNITED STATES, IT IS IMPORTANT TO IDENTIFY VENTRAL HERNIA REPAIR (VHR) TECHNIQUES THAT REDUCE MORBIDITY AND COST OF CARE IN OBSESE PATIENTS. THE UTILITY OF A LAPAROSCOPIC VS AN OPEN APPROACH HAS BEEN WELL ESTABLISHED FOR BARIATRIC PROCEDURES.

WHILE OPEN AND LAPAROSCOPIC APPROACHES ARE ACCEPTED SURGICAL TECHNIQUES FOR VHR, THE LITERATURE IS LIMITED IN ADDRESSING THE UTILITY AND POTENTIAL BENEFITS OF LAPAROSCOPIC VHR IN OBSESE PATIENTS. SEVERAL SMALL STUDIES HAVE DEMONSTRATED THAT LAPAROSCOPIC VHR FOR OBSESE PATIENTS IS SAFE AND MAY HAVE A LOWER COMPLICATION RATE.

HOWEVER, NO STUDIES HAVE DIRECTLY COMPARED OUTCOMES OF OPEN AND LAPAROSCOPIC VHR IN OBSESE PATIENTS USING A LARGE PATIENT SAMPLE DATABASE. THEREFORE, OUR OBJECTIVES FOR THIS STUDY WERE TO (1) COMPARE THE BASELINE DEMOGRAPHICS, (2) EVALUATE THE NATIONAL TREND IN THE USE OF LAPAROSCOPIC VHR IN OBSESE PATIENTS, (3) COMPARE OUTCOMES OF OBSESE PATIENTS UNDERGOING OPEN VS LAPAROSCOPIC VHR, AND (4) IDENTIFY PREDICTIVE VARIABLES FOR THE USE OF LAPAROSCOPIC VHR.
Methods

Data Source
This was a retrospective analysis of the National Inpatient Sample, a large national administrative database produced as part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality.8 The National Inpatient Sample is an all-payer database that annually collects information from up to 8 million inpatient discharges from approximately 1000 hospitals across the United States. A data use agreement is held by the Agency for Healthcare Research and Quality.

Patient Selection
From the National Inpatient Sample database (2008-2009), all patients with a diagnosis of ventral hernia and obesity were selected using the International Classification of Diseases, Ninth Revision (ICD-9) codes. ICD-9 procedure (eTable in Supplement) codes were used to identify open vs laparoscopic VHR. ICD-9 diagnosis codes (eTable in Supplement) were also used to identify obesity (278.0X) and body mass index (calculated as weight in kilograms divided by height in meters squared) greater than 30 (V85.30-9).

Outcomes
Various patient demographic variables were analyzed for age, sex, race, and insurance status. Outcomes of interest were compared for LOS, THC, and complications. Analysis of postoperative complications included postoperative shock, hemorrhage, hematoma, seroma, wound complications, infection, fistula, and pulmonary complications. Analysis of intraoperative complications included iatrogenic injury to surrounding structures.

Statistical Analysis
Categorical and continuous variables were analyzed using the χ² and t test, respectively. A 2-sided P value of less than .05 was considered statistically significant. Independent predictive variables for laparoscopic VHR were identified using a multivariable logistic regression analysis. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 19.0 (SPSS, Inc). Recommended discharge and hospital weights were incorporated to create national estimates for all analyses.

Results

Demographics
A national estimate of 47 661 obese patients underwent VHR during the study period. Overall mean (SD) age was 54.7 (12.5) years, with a predominantly white (76.5%), female (73.3%) patient population who had private insurance coverage (48.1%). Relative frequencies of patient demographics and their relationships with open vs laparoscopic VHR were calculated (Table 1).

National Trends
During the study period, the use of laparoscopic VHR increased more than 4-fold, from 1547 of 23 917 (6.5%) in 2008 to 6629 of 23 704 in 2009 (28.0%) (P < .001) (Figure). Open VHR

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### Table 1. Baseline Demographic Comparison of Open vs Laparoscopic Ventral Hernia Repair*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total (N = 47 661)</th>
<th>Open (n = 39 485)</th>
<th>Laparoscopic (n = 8176)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>54.7 (12.5)</td>
<td>54.9 (12.5)</td>
<td>53.6 (12.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>12 715 (26.7)</td>
<td>10 552 (26.7)</td>
<td>2163 (26.5)</td>
<td>.35</td>
</tr>
<tr>
<td>Female</td>
<td>34 928 (73.3)</td>
<td>28 915 (73.2)</td>
<td>6013 (73.5)</td>
<td></td>
</tr>
<tr>
<td>Race*</td>
<td></td>
<td></td>
<td></td>
<td>.61</td>
</tr>
<tr>
<td>White</td>
<td>29 687 (76.5)</td>
<td>24 583 (76.6)</td>
<td>5104 (75.9)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>4444 (11.5)</td>
<td>3631 (11.3)</td>
<td>813 (12.1)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>3536 (9.1)</td>
<td>2952 (9.2)</td>
<td>584 (8.7)</td>
<td></td>
</tr>
<tr>
<td>Payer</td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Medicare</td>
<td>15 501 (32.5)</td>
<td>13 072 (33.1)</td>
<td>2429 (29.7)</td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>5414 (11.4)</td>
<td>4538 (11.5)</td>
<td>876 (10.7)</td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>22 916 (48.1)</td>
<td>18 664 (47.3)</td>
<td>4252 (52.0)</td>
<td></td>
</tr>
</tbody>
</table>

* Values are presented as number (percentage) unless otherwise indicated. Analyses were restricted to patients without missing values.

* The total number of patients for total, open, and laparoscopic are 38 803, 32 079, and 6724, respectively. Excluded other categories, including others/Native Americans, Pacific Islanders, etc.

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Figure. National Trend of Laparoscopic vs Open Ventral Hernia Repair

Percent use of laparoscopic vs open ventral hernia repair depicted in the Nationwide Inpatient Sample trend from 2008 through 2009.

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Laparoscopic vs Open VHR in Obesity

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use decreased during the same period, from 22,424 (93.5%) to 17,075 (72.0%) (P < .001). Ventral hernia without gangrenous bowel or obstruction constituted 51.4% of all VHRs, followed by ventral hernia with obstruction (46.4%) and with gangrenous bowel (0.4%). Correlating with the ICD-9 diagnosis codes, relative frequencies and percentages were calculated for open vs laparoscopic VHR. Ventral hernias with obstruction (47.0% vs 43.9%; P < .001) were more likely to undergo open repair.

Outcomes
Table 2 shows outcomes of open vs laparoscopic VHR. For the total study population, median (SEM) LOS was 4 (0.04) days, with a mean (SEM) THC of $47,106 ($252). The median LOS for the laparoscopic VHR group was significantly shorter (3 vs 4 days; P < .001). Similarly, the mean THC was also significantly lower ($40,387 vs $48,513; P < .001) for the laparoscopic VHR group. Laparoscopic VHR was also associated with decreased disposition to rehabilitation facilities at 257 (3.1%) vs 2682 (6.8%) (P < .001).

Laparoscopic VHR was associated with a lower overall complication rate at 514 (6.3%) vs 5408 (13.7%) (P < .001). Postoperative wound complications were lower for the laparoscopic vs open VHR at 10 (0.1%) vs 604 (1.5%) (P < .001), as well as postoperative pulmonary complications at 197 (2.4%) vs 1891 (4.8%) (P < .001). The intraoperative complication rate of iatrogenic injury was also lower for laparoscopic vs open VHR at 131 (1.6%) vs 1071 (2.7%) (P < .001).

Patients with a body mass index greater than 40 were more likely to undergo laparoscopic VHR (20.7% vs 16.1%; P < .001) compared with those with a body mass index less than 40.

Multivariable Logistic Regression Analysis
A multivariable logistic regression analysis was performed incorporating statistically significant demographic and diagnostic variables (Table 3). The predictive variables for use of laparoscopic VHR were private insurance (odds ratio, 1.20; 95% CI, 1.15-1.27; P < .001) and highest median income quartile (odds ratio, 1.26; 95% CI, 1.18-1.34). Ventral hernias with a gangrenous bowel were less likely to undergo laparoscopic VHR (odds ratio, 0.14; 95% CI, 0.06-0.34; P < .001).

Discussion
The evolution of laparoscopy and its feasibility and benefits continue to change surgical practice. Single-center studies in the literature have shown short-term benefits of laparoscopic vs open VHR.4-7 Our study uses a large national administrative database available and demonstrates an increasing national trend in the use of laparoscopic VHR for obese patients. This increase may be a function of improved laparoscopic training and high-quality, minimally invasive equipment, enabling surgeons to repair ventral hernias laparoscopically. As public awareness of minimally invasive procedures increases, the use of laparoscopy will become an even more integral part of the surgical armamentarium.

While the benefits of the laparoscopic approach have been demonstrated in the surgical treatment of multiple diseases, the same has not been true of VHR. Our study demonstrates significant reductions in LOS and THC associated with laparoscopic VHR. This suggests a significant economic benefit of laparoscopic VHR in obese patients. The current economic and political environment necessitates the optimal use of health care resources. As such, the decreased LOS and THC are potential benefits offered by laparoscopic VHR to hospital administrations and patients.

The clinical advantages of laparoscopic VHR in this patient population are evident by shorter LOS compared with open VHR, without an increase in postoperative or intraoperative complications. Surgical site infections are one of the most common morbidities associated with surgery for obese patients.9 We found that laparoscopic VHR was associated with lower rates of wound infection and iatrogenic injuries. Several studies have shown that laparoscopic procedures result in less blood loss, shorter time to first bowel movement, fewer postoperative complications, shorter LOS, and improved quality of life.10,11 The results of our study demonstrate a growing surgical trend toward minimally invasive procedures and confirm its safety and feasibility.

According to our multivariable logistic regression analysis, patients with private insurance are more likely to undergo laparoscopic VHR, which may reflect an existing health care disparity. Further studies are needed to analyze the disparity in access to laparoscopic surgery. Patients with ventral hernias with a gangrenous bowel were less likely to undergo laparoscopic VHR and more likely to undergo open VHR. Ventral hernia with bowel obstruction, however, was not a statistically significant predictor for open VHR. These variations may...
reflect unfavorable anatomy or a lower comfort level among surgeons for laparoscopy in the setting of gangrenous bowel.

Our study limitations are similar to other studies using a large administrative database. Proper identification of ICD-9 diagnostic and procedural codes is dependent on nonclinical coding staff; hence, the validity of using such codes must be considered. Given the nature of this inpatient database, we could not evaluate repeated hospital visits or follow long-term outcomes. For example, surgical site infections that occurred after discharge would not be captured in this database, thus potentially underestimating the true incidence of surgical site infections. Duration of presenting symptoms and intraoperative findings, such as the extent of adhesions, are also lacking in the database. Differences in these variables may affect the surgical approach and contribute to outcomes.

Despite these limitations, our study offers useful insight into national trends and outcomes of laparoscopic VHR in obese patients. Laparoscopy continues to be a safe and cost-effective surgical approach. Socioeconomic variations in the use of laparoscopic VHR highlight a potential disparity in access to minimally invasive surgery in the United States. Further studies are needed to define clinical criteria that may identify which obese patients with ventral hernias will benefit the most from a laparoscopic approach.

REFERENCES