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Preoperative hyponatremia in women with ovarian cancer: an additional cause for concern?

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Abstract

Objective—To determine if preoperative hyponatremia in women with ovarian, fallopian tube (FT), and primary peritoneal cancers (PPC) is associated with postoperative complications.

Methods—We performed a retrospective population-based cohort study of women with a postoperative diagnosis of ovarian, FT, or PPC who had a cytoreductive procedure in the National Surgical Quality Improvement Program (NSQIP) database from 2005-2013. The primary exposure, preoperative sodium, was classified as normal (135mEq/L - 142mEq/L) or hyponatremic (< 134mEq/L). Where appropriate, preoperative characteristics were compared with Chi-squared or Fisher's exact tests. Multivariate logistic regression was used to determine adjusted odds ratios (aOR) with 95% confidence intervals (CI).

Results—4009 subjects met inclusion criteria. Thirty day mortality was higher in the hyponatremic group compared to the normal serum sodium group (3.56% vs 1.18%). When patients of any age were noted to have at least two pertinent preoperative lab abnormalities, including hyponatremia, there was an increased risk of postoperative complications for patients over the age of 65. After adjusting for serum albumin and other confounders, preoperative hyponatremia was associated with an increased risk of hospital stay of >14 days (aOR 1.69; 95% CI 1.11-2.57) and 30 day postoperative mortality (aOR 2.37; 95% CI 1.13-4.98).

Conclusions—Hyponatremia is associated with postoperative 30 day mortality and morbidity in women with ovarian, FT, and PPC. Serum sodium in conjunction with other markers may have the potential to identify candidates for neoadjuvant chemotherapy. Additional work is needed to determine if correction of hyponatremia in the preoperative period alters outcomes.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

Background

The optimal therapy for advanced ovarian cancer includes both surgery and chemotherapy. (1) Cytoreductive surgery to a goal of minimal residual disease has been associated with improvements in disease-free and overall survival. (2) Extensive surgical procedures are often required to achieve the goal of complete cytoreduction (3, 4) which can be associated with substantial morbidity as well as mortality. (5) In order to reduce the morbidity of surgery, neoadjuvant chemotherapy (NAC) may be used prior to cytoreductive surgery (PCS) to reduce the risk of complications, and has been found to have similar outcomes.(6) Substantial work has centered on characteristics to identify patients who may benefit from NAC (5), either to reduce surgical complications or to reduce the risk of suboptimal debulking.(7, 8)

To date, no studies have looked specifically at the association of preoperative hyponatremia and perioperative complications among women with ovarian cancer who are admitted to the hospital for primary cytoreductive surgery. Anecdotally, hyponatremia is not uncommon among patients with advanced ovarian cancer, and is likely due to the volume depletion associated with tumor burden.(9) Hyponatremia has been found to be associated with all-cause mortality (10–12) and perioperative complications including 30-day morbidity and mortality (13). The prevalence of hyponatremia ranges from 15-20% in hospitalized patients (12) and from 2-8% in the general population (10, 11). Patient characteristics that have been reported to be predictive of hyponatremia include increasing age, female sex, decreased oral intake, and comorbid conditions such as diabetes mellitus, chronic hypertension, and cancer (10–12).

Our objective was to perform a population-based retrospective cohort of study of women with ovarian (EOC), fallopian tube (FT), and primary peritoneal cancers (PPC) who had primary cytoreductive surgery in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database to determine if preoperative hyponatremia is associated with 30-day postoperative mortality or perioperative morbidity such as wound infection, wound dehiscence, prolonged length of hospital stay, pneumonia, and myocardial infarction.

Methods

Data Source/Study Design

ACS NSQIP is a surgical quality improvement program designed to measure and improve surgical outcomes. Currently, 699 hospitals nationwide participate in the ACS NSQIP program. The ACS NSQIP database contains variables on preoperative and intraoperative factors, and postoperative 30-day morbidity and mortality on patients who underwent major outpatient or inpatient surgical procedures. Surgical cases are selected using an 8-day cycle systematic sampling process at each site to minimize selection bias. Trained and certified reviewers are responsible for data abstraction at each hospital site. Data quality is maintained by the selective use of Inter-Rater Reliability (14). We performed a retrospective population-based cohort study of women with EOC who had primary cytoreductive surgery in the ACS NSQIP database from 2005-2013.

Population

Women were eligible for inclusion if they had a postoperative diagnosis of ovarian, PPC, or FT cancers designated by the International Classification of Diseases Ninth Revision (ICD-9) code. Women were included if they underwent a cytoreductive procedure either as the primary procedure or a concurrent procedure and if they had a preoperative serum sodium measurement within 90 days prior to surgery. Women were excluded if they were less than 18 years of age, had a preoperative serum sodium measurement that indicated hyponatremia, or had a missing preoperative sodium measurement.

Covariates

Our exposure of interest was the most recent serum sodium measured within 90 days of surgery. We categorized serum sodium as normal (135mEq/L – 142mEq/L) and hyponatremia (< 134mEq/L). We abstracted information on the following preoperative variables: age, race/ethnicity, smoking status, body mass index (BMI), chronic steroid use prior to surgery, American Association of Anesthesiologists (ASA) score, medical comorbidities, and preoperative laboratory data (serum sodium, albumin, hematocrit, and creatinine). Treatment related variables included information on cytoreductive procedures, other concurrent procedures, and perioperative blood transfusions. Given prior a priori evidence, we determined age, race, tobacco use, body mass index and medical comorbidities to be confounders.

Our primary outcome variable was 30-day postoperative mortality (categorized as yes/no). Our secondary outcomes included 30 day postoperative complications such as wound infection (including superficial and deep wound infections), wound dehiscence, length of hospital stay > 14 days, pneumonia, and myocardial infarction. Additionally, we examined a composite outcome of any postoperative complication within 30 days of surgery (wound infection, wound dehiscence, pneumonia, myocardial infarction, LOS >14 days, or 30-day mortality) categorized as yes/no.

Statistical Analysis

Demographic characteristics and treatment factors were compared between groups using Chi-squared or the Fisher's exact tests for categorical variables and the Mann-Whitney U test for continuous variables. Confounders were chosen A priori and were considered to be serum albumin, serum creatinine, age, body mass index, race, tobacco use within the past year, chronic obstructive pulmonary disease, ascites, congestive heart failure, chronic hypertension, diabetes, and blood transfusion within 72hrs of surgery. Multivariate logistic regression adjusted for confounders was used to determine 95% confidence intervals and adjusted odds ratios for each outcome.

Results

Four thousand seven hundred eighty-eight women with ovarian, PPC, and FT cancers were identified in the ACS NSQIP database from 2005 – 2013. Subjects with a missing preoperative serum sodium measurement (n=354), hyponatremia (n=350) and those that did not have a cytoreductive procedure (n=75) were excluded. This left 4009 evaluable women.

Women who were excluded for a missing preoperative serum sodium were more likely to be younger and were less likely to have preoperative weight loss, dyspnea, ascites, hypertension, and diabetes. Those with preoperative hyponatremia (n=365) were older (median age 66 vs 61 years) and more likely to have disseminated cancer, ascites, chronic hypertension, elevated serum creatinine, and hypoalbuminemia than women with normal serum sodium (Table 1). Operative factors such as length of surgery and surgical approach were similar for both groups (Table 2). Those with hyponatremia were more likely to experience a length of stay > 14 days, 30 day postoperative mortality, and myocardial infarction compared to patients with normal sodium levels (Table 2). On univariate logistic regression, preoperative hyponatremia was significantly associated with a length of hospitalization > 14 days, postoperative myocardial infarction, 30 day mortality.

We assessed the incidence of postoperative complications based on preoperative laboratory abnormalities, including hypoalbuminemia, hyponatremia, thrombocytosis and high serum creatinine (Table 3). Each of these lab abnormalities was noted to be more frequent in women over 65. Patients over the age of 76 were noted to have an increased risk of complications in the setting of hypoalbuminemia and of hyponatremia. When patients of any age were noted to have any two of these lab abnormalities, there was an increased risk of postoperative complications for patients over the age of 65 (patients 66-76 years of age, OR 3.92; patients 76 years of age and older, OR 2.97). Additionally, we looked at the association between any postoperative complication and hyponatremia with each of the other lab abnormalities (Table 3). We found a statistically significantly increased risk for any postoperative complication when both hyponatremia and hypoalbuminemia were present among women over 65 (patients 66-76 years of age, OR 5.33 ; patients 76 and older, OR 4.27).

After adjusting for serum albumin, serum creatinine, age, body mass index, race, tobacco use within the past year, chronic obstructive pulmonary disease, ascites, congestive heart failure, chronic hypertension, diabetes, and blood transfusion within 72hrs of surgery, preoperative hyponatremia was significantly associated with an increased risk of hospital stay of >14 days (adjusted OR (aOR) 1.69; 95% CI 1.11-2.57), myocardial infarction (aOR 6.31 1.18-33.57), 30 day postoperative mortality (aOR 2.37; 95% CI 1.13-4.98), and any postoperative complication (aOR 1.48; 95% CI 1.05-2.07).

Discussion

Hyponatremia is the most common electrolyte abnormality among hospitalized patients. We found that women with preoperative hyponatremia undergoing cytoreductive procedures for ovarian, PPC, and FT were more likely to experience 30-day postoperative complications such as prolonged hospital stay and 30-day mortality. Few studies have examined the association between preoperative hyponatremia and perioperative complications. The most notable was a large population-based study that used the NSQIP database to examine approximately 900,000 patients who had undergone general, cardiovascular, vascular, or orthopedic surgeries from 2005-2010 (15). They found that preoperative hyponatremia was associated with perioperative complications such as 30-day mortality, increasing length of hospital stay, pneumonia, and wound infections.

We found that after adjusting for significant factors, including albumin and ascites, that hyponatremia was associated with an increased risk of any postoperative complication, including increased 30-day mortality, prolonged hospitalization and myocardial infarction. When patients were noted to have at least two preoperative lab abnormalities, including hyponatremia, patients over the age of 65 were three times as likely to have any postoperative complication. Furthermore, when patients had both hyponatremia and hypoalbuminemia and were older than age 65 they had at least a 4 fold increased risk of any postoperative complication. Our findings support the inclusion of preoperative hyponatremia in the assessment of surgical risk for ovarian cancer surgery.

At this time, it is not known whether hyponatremia is a direct cause of morbidity and mortality or if it is a surrogate marker for medical comorbidities or an underlying pathological process. A population-based cross-sectional study using the National Health and Nutrition Examination survey determined that hyponatremia was more common in those with medical comorbidities such as diabetes, hypertension, and chronic obstructive pulmonary disease (11). In this analysis, after adjusting for medical comorbidities there was still a significant association between hyponatremia and postoperative complications.

The prevalence of hyponatremia in women with ovarian, PPC, and FT at the time of cytoreductive surgery is unknown. A retrospective cohort study, designed to determine the significance of preoperative laboratory testing in gynecology patients, found the prevalence of hyponatremia to be 4.6% in endometrial, ovarian, and cervical cancers. We found in the NSQIP data that the prevalence of preoperative hyponatremia was 8.4% in women with ovarian, PPC, and FT cancer undergoing cytoreductive surgery. (16) Prior studies of patients with malignant ascites have suggested that malignancies secrete factors that increase vascular permeability, leading to fluid accumulation.(17) This could create hypovolemic hyponatremia due to the leaching of fluid into the peritoneal cavity in the context of increased satiety and decreased oral intake, symptoms commonly seen with advanced ovarian cancer.

Multiple studies have sought to determine preoperative and intraoperative characteristics of patients that are not only ideal candidates for optimal cytoreduction but are at minimal risk for perioperative complications. In a recent multi-institutional review, a subgroup of patients were identified in whom the morbidity of surgical debulking was greater than 60%; this included patients 75 years of age with poor performance or nutritional status, and evidence of high tumor dissemination on surgical exploration.(7) However this triage strategy incorporated surgical findings of disease dissemination; ideally a strategy to minimize surgical complications and maximize the likelihood of optimal ovarian cancer debulking would avoid unnecessary surgery. Barber et al recently reviewed the NSQIP database and identified developed a model incorporating preoperative factors into predicting the risk of perioperative complications.(18) However, their analysis did not incorporate sodium and was limited to patients over the age of 65.

The limitations of this work include the lack of current knowledge regarding the biologic plausibility between hyponatremia and postoperative complications. Additionally, in the ACS NSQIP database there is only one preoperative serum sodium value. Therefore, we

cannot quantify if patients were treated for hyponatremia prior to surgery, and whether treatment affects outcomes. We did not have information on preoperative serum glucose and it is well known that hyperglycemia can cause dilutional hyponatremia. Lastly, the NSQIP does not include information regarding the outcome of surgery for ovarian cancer as to the volume of residual disease, nor the time to initiation of chemotherapy.

Hyponatremia in women with ovarian, PPC, and FT cancers undergoing surgery appears to be associated with postoperative complications. Hyponatremia should be considered as an additional factor when considering patients for either primary debulking surgery or neoadjuvant chemotherapy in the treatment of advanced ovarian cancer. Hyponatremia can be incorporated into the composition of a decision-making model regarding the risks of surgery for this patient population. This model would be particularly helpful for medical oncologists when encountering a patient with ovarian cancer, and discussing treatment options prior to referral to gynecologic oncology. Future work on quantifying the true prevalence of hyponatremia, the perioperative complication risk, and potential areas for intervention are needed.

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Highlights

- Preoperative hyponatremia is associated with postoperative complications in patients undergoing surgery for ovarian cancer
- This association remains significant after adjusting for ascites and albumin.
- Hyponatremia may be used with other preoperative lab abnormalities to predict perioperative risk and triage patients to the appropriate care.

Table 1

Preoperative characteristics by serum sodium category for ovarian cancers

Preoperative characteristics		Normal (135-142 mEq/L) n=3644	%	Hyponatremia (<134 mEq/L) n=365	%	p-value
Age						p<0.001
18-44		377	10.35%	22	6.03%	
45-64		1831	50.25%	149	40.82%	
65-79		1208	33.15%	157	43.01%	
80+		228	6.26%	37	10.14%	
missing		0	0.00%	0	0.00%	
Race/Ethnicity						p=0.717
Non-Hispanic White		2655	72.86%	270	73.97%	
Non-Hispanic Black		246	6.75%	20	5.48%	
Hispanic		250	6.86%	28	7.67%	
Other (non-Hispanic)		157	4.31%	14	3.84%	
missing		336	9.22%	33	9.04%	
Body mass index (kg/m²)						p=0.208
Underweight (<18.5)		83	2.28%	8	2.19%	
Normal (18.5-24.9)		1183	32.46%	138	37.81%	
Overweight (25-29.9)		1076	29.53%	111	30.41%	
Obese class I (30-34.9)		636	17.45%	48	13.15%	
Obese class II (35-39.9)		337	9.25%	30	8.22%	
Obese class III (>40)		296	8.12%	27	7.40%	
missing		33	0.91%	3	0.82%	
Tobacco use w/in 1 year						p=0.945
yes		514	14.11%	51	13.97%	
missing		0	0.00%	0	0.00%	

Preoperative characteristics		Normal (135-142 mEq/L) n=3644	%	Hyponatremia (<134 mEq/L) n=365	%	p-value
Functional status before surgery						
p=0.068						
Independent		3564	97.80%	352	96.44%	
Partially dependent		57	1.56%	12	3.29%	
Totally dependent		13	0.36%	1	0.27%	
Missing		10	0.27%	0	0.00%	
Preoperative Dyspnea						
p=0.002						
None		3316	91.00%	312	85.48%	
Yes, at rest		36	0.99%	8	2.19%	
Yes, w/exertion		292	8.01%	45	12.33%	
missing		0	0.00%	0	0.00%	
Chronic obstructive pulmonary disease						
p=0.716						
Yes		98	2.69%	11	3.01%	
missing		0	0.00%	0	0.00%	
Ascites						
p<0.001						
Yes		756	20.75%	138	37.81%	
missing		0	0.00%	0	0.00%	
Congestive heart failure						
p=0.652						
Yes		14	0.38%	2	0.55%	
missing		0	0.00%	0	0.00%	
Acute renal failure history						
p=0.023						
Yes		1	0.03%	2	0.55%	
missing		0	0.00%	0	0.00%	
Hypertension on medication						
p<0.001						

Preoperative characteristics		Normal (135-142 mEq/L) n=3644		Hyponatremia (<134 mEq/L) n=365		p-value
		%		%		
Yes		1507		41.36%		55.89%
missing		0		0.00%		0.00%
Dialysis 24 hours preoperatively						p=0.488
Yes		6		0.16%		1 0.27%
missing		0		0.00%		0 0.00%
Diabetes						p=0.108
Yes		365		10.02%		46 12.60%
missing		42		1.15%		7 1.92%
Ventilator dependent						p=0.380
yes		4		0.11%		1 0.27%
missing		0		0.00%		0 0.00%
Steroid 30 days preoperatively						p=0.759
Yes		138		3.79%		15 4.11%
missing		0		0.00%		0 0.00%
Weight loss within 60 days preoperatively						p=0.046
Yes		173		4.75%		26 7.12%
missing		0		0.00%		0 0.00%
Preoperative Blood Transfusion						p=0.200
Yes		52		1.43%		11 3.01%
missing		0		0.00%		0 0.00%
Preoperative Chemotherapy						p=0.885
Yes		135		3.70%		15 4.11%
missing		2378		65.26%		219 60.00%

Preoperative characteristics					
	Normal (135-142 mEq/L) n=3644	%	Hyponatremia (<134 mEq/L) n=365	%	p-value
Preoperative Radiation					
Yes	2	0.05%	0	0.00%	p=0.633
missing	2386	65.48%	222	60.82%	
Sepsis/Shock preoperatively					
None	3557	97.61%	332	90.96%	p<0.001
SIRS	70	1.92%	24	6.58%	
Sepsis	12	0.33%	8	2.19%	
Septic shock	0	0.00%	1	0.27%	
missing	5	0.14%	0	0.00%	
Serum Creatinine					
Normal	3494	95.88%	328	89.86%	p<0.001
Elevated	114	3.13%	31	8.49%	
missing	36	0.99%	6	1.64%	
Serum Albumin					
Normal (≥ 3.5)	2114	58.01%	153	41.92%	p<0.001
Low (<3.5)	598	16.41%	130	35.62%	
missing	932	25.58%	82	22.47%	
Serum Hematocrit					
Normal	3318	91.05%	301	82.47%	p<0.001
21-29	281	7.71%	60	16.44%	
<21	5	0.14%	0	0.00%	
missing	40	1.10%	4	1.10%	
ASA * score					
No disturb	0	0.00%	0	0.00%	p<0.001

Preoperative characteristics	Normal (135-142 mEq/L) n=3644		Hyponatremia (<134 mEq/L) n=365		p-value
		%		%	
Mild disturb	1573	43.17%	107	29.32%	
Severe disturb	1824	50.05%	230	63.01%	
Life threatening	139	3.81%	19	5.21%	
Moribund	0	0.00%	1	0.27%	
missing	108	2.96%	8	2.19%	
Emergent surgical case					
p<0.001					
Yes	60	1.65%	17	4.66%	
missing	0	0.00%	0	0.00%	
Wound Classification					
p<0.001					
Clean	194	5.32%	17	4.66%	
Clean/Contaminated	3232	88.69%	309	84.66%	
Contaminated	176	4.83%	24	6.58%	
Dirty/Infected	42	1.15%	15	4.11%	
missing	0	0.00%	0	0.00%	

* American Society of Anesthesiologists Physical Classification System Score

Table 2

Intraoperative and postoperative outcomes by serum sodium category

	Normal (135-142 mEq/L)	%	Hyponatremia (≤ 134 mEq/L)	%	p-value
Operative factors	n=3644		n=365		
Operative time					p=0.310
<4hrs	2700	74.09%	265	72.60%	
4-8hrs	881	24.18%	97	26.58%	
more than 8hrs	63	1.73%	3	0.82%	
missing	0	0.00%	0	0.00%	
Primary gyn CPT procedure					p=0.036
Laparoscopy	79	2.17%	2	0.55%	
Open	3565	97.83%	363	99.45%	
missing	0	0.00%	0	0.00%	
RVU *					p=0.153
Median(range)	26.22 (4.79-59.48)		27.29 (1.53-49.33)		
#Concurrent procedures by another team *					p=0.597
Median(range)	1 (0-10)		1 (0-7)		
Postoperative outcomes					
Superficial wound infection					p=0.222
yes	159	4.36%	11	3.01%	
missing	0	0.00%	0	0.00%	
Deep Wound infection					p=0.998
yes	20	0.55%	2	0.22%	
missing	0	0.00%	0	0.00%	

	Normal (135-142 mEq/L)	%	Hyponatremia (< 134 mEq/L)	%	p-value
Organ space infection					
p=0.088					
yes	106	2.91%	5	1.37%	
missing	0	0.00%	0	0.00%	
Wound dehiscence					
p=0.325					
yes	40	1.10%	2	0.55%	
missing	0	0.00%	0	0.00%	
Pneumonia					
p=0.500					
yes	71	1.95%	9	2.47%	
missing	0	0.00%	0	0.00%	
Pulmonary embolism					
p=0.657					
yes	59	1.62%	4	1.10%	
missing	0	0.00%	0	0.00%	
Stroke					
p=0.229					
yes	2	0.55%	1	0.14%	
missing	0	0.00%	0	0.00%	
Myocardial infarction					
p=0.005					
yes	5	0.14%	3	0.82%	
missing	0	0.00%	0	0.00%	
Length of stay					
p<0.001					
<14 days	3436	94.29%	317	86.85%	
14-30	166	4.56%	42	11.51%	
>30days	41	1.13%	6	1.64%	
missing	1	0.03%	0	0.00%	
Mortality					
p<0.001					

	Normal (135-142 mEq/L)	%	Hyponatremia (≤ 134 mEq/L)	%	p-value
yes	43	1.18%	13	3.56%	
missing	0	0.00%	0	0.00%	

* median (range)

Age risk for 30-day postoperative complication by lab abnormality for ovarian, FTC and PPC in ACS NSQIP from 2005 - 2013

Table 3

Hypoalbuminemia (< 3.5mg/dL)		Hyponatremia (<=134mEq/L)		High Serum Creatinine (>=1.5mg/dL)		Thrombocytosis (>=450/mcL)		Any two *	
n=770	n=36	n=36	n=10	n=51	n=36	n=36	n=36	n=36	n=36
n	%	n	%	n	%	n	%	n	%
Age group									
<=55 (n=230)	34	14.8	15.3	7	25.0	28	14.4	18	16.8
55-65 (n=201)	53	26.4	21.1	6	31.6	33	20.5	25	23.8
66-75 (n=201)	66	32.8	20.0	16	50.0	33	28.7	42	44.2
76+ (n=138)	44	31.9	25.7	9	33.3	9	23.1	21	37.5
total (yes)	197	25.6	20.3	38	35.9	103	20.2	106	29.2
Crude									
OR									
Hypoalbuminemia (< 3.5mg/dL)		Hyponatremia (<=134mEq/L)		High Serum Creatinine (>=1.5mg/dL)		Thrombocytosis (>=450/mcL)		Any two *	
Age group									
<=55	ref	ref	0.68;3.29	1.38	0.38;5.04	ref	ref	1.55	0.79;3.04
55-65	2.06	1.28;3.33	1.48	1.38	3.00	2.40	1.36;4.24	3.92	2.05;7.49
66-75	2.81	1.76;4.50	1.38	1.50	0.46;4.84	1.79	0.77;4.17	2.97	1.41;6.22
76+	2.70	1.61;4.50	1.92						
Crude									
OR									
Hypoalbuminemia (<=134mEq/L) & Hypoalbuminemia (<3.5mg/dL)		Hyponatremia (<=134mEq/L) & High Serum Creatinine (>=1.5mg/dL)		Hyponatremia (<=134mEq/L) & Thrombocytosis (>=450/mcL)					
Age group									
<=55	ref	ref	ref	ref	ref	ref	ref	ref	ref

	Hypoalbuminemia (< 3.5mg/dL)	Hyponatremia (<=134mEq/L)	High Serum Creatinine (>=1.5mg/dL)	Thrombocytosis (>=450/mcL)	Any two*
	n=770	n=36	n=10	n=51	n=36
	n	5	6	0	3
	%	n	n	n	n
55-65	2.00	1.00	0.88		
	0.63;6.38		0.09;11.02		
66-75	5.33	1.33	1.28		
	1.75;16.24		0.11;15.70		
76+	4.27	1.50	2.75		
	1.34;13.56		0.16;14.42		
				%	%

* Any two for of thrombocytosis, high creatinine hyponatremia, or low albumin
^ Wound infection, pneumonia, prolonged hospitalization >14days, myocardial infarction, 30 day mortality, or wound dehiscence

Table 4

Multivariate logistic regression of hyponatremia on 30-day postoperative complications

<u>Outcome</u>	OR[*]	95%CI	p-value
Wound infection	0.67	0.34-1.31	0.24
Wound dehiscence	0.93	0.21 - 4.09	0.92
Pneumonia	1.05	0.45 - 2.42	0.92
Myocardial Infarction	6.31	1.18 - 33.57	0.03
[^] LOS > 14 days	1.69	1.11 - 2.57	0.01
30 day mortality	2.37	1.13 - 4.98	0.02
Any post-op complication	1.48	1.05 - 2.07	0.02

* adjusted for age, body mass index, race, tobacco use w/in the past year, chronic obstructive pulmonary disease, ascites, congestive heart failure, chronic hypertension, diabetes, blood transfusion w/in 72hrs of surgery, serum creatinine, and serum albumin

[^] Length of hospital stay