ORIGINAL RESEARCH

Analysis of Risk Factors for Developing Sepsis in Patients Who Underwent Percutaneous Nephrolithotomy at the National Kidney and Transplant Institute: A Retrospective Study

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Objective: This study aimed to identify the different risk factors for developing sepsis in patients undergoing percutaneous nephrolithotomy
Methods: This is a case-control study of all patients who underwent percutaneous nephrolithotomy in the National Kidney and Transplant Institute from 2017 to 2021. Demographic, stone characteristics, perioperative data and post-operative parameters were recorded. The association of clinical variables and sepsis was determined using logistic regression analysis.
Results: A total of 586 patients who underwent percutaneous nephrolithotomy were included in the study with 58 of them suffering from sepsis with a prevalence rate of 9.9%. The majority [392 (67.82%)] of the patients were 31-59 years old. Majority of patients suffering from sepsis also belonged to the same age group were predominantly male [33 (56.9%)], mostly diabetic [15 (26.32 %)] and hypertensive [14 (24.56%)] and underwent previous PCNL [49 (8.45%)]. Imaging of patients who had sepsis showed staghorn calculus [30 (51.72%)] with mild [20 (34.48%)] and moderate hydronephrosis [23 (39.66%)] seen on imaging. Patients who were requiring transfusion post operatively (Grade II Clavien-Dindo Classification) were seen to have sepsis.
Conclusion: The following factors are contributory to the development of sepsis: a high Guy's stone score, high degree of obstruction or hydronephrosis, previous stone surgery and a higher volume of blood loss.

Key words: Guy stone score, nephrolithomy, sepsis, hydronephrosis

Introduction

Sepsis is a life-threatening multi organ dysfunction caused by a dysregulated host response to infection. It presents as a clinical deterioration of common and preventable infections. It is a medical emergency and over the years, technological advancements have led to a better understanding and management.[1] Despite advances in medicine, sepsis remains one of the major causes of morbidity and mortality especially in critically-ill patients. Nephrolithiasis is one of the most common benign urologic diseases and classified by composition, size, location and stone hardness. Percutaneous Nephrolithotomy, a minimally invasive procedure, has become the gold standard in eradicating stone burden more than 2 cm and provides a better clinical outcome for the patient. However, it carries a risk of developing septic complications. Factors found to have caused increase in the incidence of urosepsis include diabetes mellitus, high stone burden, prolonged operative time and

preoperatively positive urine culture. Other factors include presence of multiple tracts and significant blood loss. Other methods in relieving stone burden besides doing percutaneous nephrolithotomy include. Retrograde Intrarenal Surgery (RIRS) and Extracorporeal Shockwave Lithotripsy (ESWL). There are also acceptable means of rendering the patients stone free but can also cause sepsis due to manipulation.

Pre-op evaluation is important and Yang et al noted that patients with recurrent urinary tract infection have a higher risk of developing SIRS after percutaneous nephrolithotomy.[2] Urinary tract infection was commonly seen in patients with renal stones especially those with struvite stones. Studies have shown that bacteria grow slowly in infection calculi and form a biofilm which makes the antibiotics less effective in eliminating infection. During the surgical procedure, bacteria and endotoxins are released upon disintegration of the stone which causes fever. The timeliness and effective treatment of sepsis in the first 6 hours which includes effective antibacterial treatment and maintenance of circulatory perfusion, can significantly reduce the lethal rate of urosepsis[3]. Fever is one of the most common symptoms of sepsis and in a study done by Rashid et al, fever was documented to have originated from the release of systemic inflammatory mediators, noted after surgical manipulation.[4] In another study by Shoshany et al., it was noted that there was a high probability of sepsis in patients with a larger stone burden and a history of recurrent urinary tract infection.[5] Fan et al studied the factors that can cause septic shock in patients undergoing percutaneous nephrolithotomy and they noted that prolonged operating time hydronephrosis and presence of nitrite on urinalysis are factors in causing sepsis.[6] Similarly, Chugh et al showed that the most common factors that cause septic complications in patients undergoing percutaneous nephrolithotomy include a higher Charlson comorbidity index, procedure time, patients with Double J stents and female gender.[7] Liang et noted that those who have obstructing lithiasis were at the greatest risk because of the urgency of the surgery to relieve obstruction which puts the judgement of the urologist in the spotlight. In the same study, they also took into account the timing of surgery since patient would likely be subjected to insufficient preparation which leads to septic complications.[8] Part of the pre-operative preparation is doing a pre-operative urine culture since it is important to give culture guided antibiotics to help lessen occurrence of septic complications. This was proven in a study done by Lai & Assimos in which administration of culture guided antibiotics pre operatively helped lessen the occurrence of SIRS in patients with culture positive urine who underwent surgery.[9]

Most patients diagnosed with renal stones and who underwent percutaneous nephrolithotomy were elderly. They were diagnosed to have calcium oxalate stones which are a lot harder and take a longer operative time due to difficulty in rendering the patient stone free. This was confirmed in the study of Fan et al. in which patients who underwent percutaneous nephrolithotomy, had septic shock and significantly large stone burden, longer operative time and lower postoperative white blood cell count. A study conducted by Nakamon et al showed that patients aged 60 and above were more at risk in terms of having septic complications. Patient comorbidities, cardiac reserve and stone burden, are more evident in this set of patients as compared to the pediatric population.[10] However, despite all these complications, PCNL is still a relatively safe procedure in the hands of experts. Dela Rosette, et al. proved that patients undergoing PCNL have low Clavien scores and major complications have <3% risk of occurring.[11]

Methods

Research Design

This research outlines a retrospective case-control study conducted at the National Kidney and Transplant Institute (NKTI), focusing on identifying risk factors for sepsis and analyzing complications in patients with nephrolithiasis undergoing percutaneous nephrolithotomy (PCNL). The study compared patients who developed postoperative sepsis with a control group who did not, examining various pre-operative, intraoperative, and post-operative factors. Demographic (Age, sex, BMI, comorbidities); Stone characteristics (Guy's stone score, Hounsfield Unit, stone size and location, urine culture), Perioperative data (Operative time,

blood loss, irrigant volume, number of tracts), post-operative parameters (Blood Units transfused, Changes in hemoglobin levels, length of hopsital stay, ICU admission, pain control and antibiotics) were recorded.

Sampling

Patients 18 years old and above who underwent Percutaneous Nephrolithotomy for Nephrolithiasis at the National Kidney and Transplant Institute were considered. All patients had pre-operative imaging study done and patients who were diagnosed with sepsis based from SIRS criteria and were evaluated during their post-operative course were selected for this study during period 2017-2021.

Data Collection & Analysis

This statistical methodology outlines a robust analysis of patient characteristics and sepsis risk factors, utilizing descriptive statistics (mean/SD, median/range, frequencies) to summarize data. Comparative analyses were performed using appropriate parametric (T-test) or nonparametric tests (Mann-Whitney/Wilcoxon), with logistic regression defining associations (odds ratios).

Ethical Consideration

This research adhered to the International ethical standards of research involving human subjects. Privacy and confidentiality were safeguarded during the research by assigning alphanumeric codes and putting records and other data in a secure cabinet that only the researcher and members of the REC have access. The study commenced under the guidance and approval of NKTI-REC.

Results

The prevalence of sepsis in percutaneous nephrolithotomy patients was 58 in 586 or 9.9% (95% CI) as shown in table 1.

A total of 586 PCNL patients were analyzed for this study, 528 and 58 without and with sepsis, respectively (Table 1). With male dominance (51.19% vs 48.81%), majority (67.82%) were from age group of 31-59 years. The median BMI was 24.883 kg/m2 (IQR 22.039-28.194) [n=534]. The two most common comorbidities were hypertension (34.53%) and diabetes mellitus (22.05%). Majority (77.24%) had no history of stone treatment (n=580), and all of them were non-septic ($p < .001$). For those who had history of PCNL, about 49 (90.74%) were septic ($p < .001$).

Table 2 shows the stone features such as stone burden, degree of hydronephrosis, stone size in Hounsfield units (HU). Guy's stone score of each patient were investigated for their relationship to sepsis. Only the degree of hydronephrosis indicated a statistically significant relationship with sepsis ($p < .001$). Sepsis was more prevalent in those who had severe hydronephrosis.

Many (46.26%) had an operative time duration of 1-2 hours (n=521). A blood loss of more than 500 ml was seen in the septic group (48.98% vs 12.41%, $p < .001$) [n=460].

More patients had Clavien-Dindo classification of surgical procedure of grade 2-3A in the non-septic group (82.95% vs 72.73% and 7.20 vs 3.64%, respectively) while there were more patients with grade 1, 3b and 5 in the septic group (12.73 % vs 8.14%; 5.45% vs 0.95% and 5.45% vs 0.76%, respectively) [$p = .003$].

Table 3 shows the postoperative parameters of the patients, which are classified according on whether or not they had sepsis. Patients with sepsis had a substantially longer hospital stay (median of 9 days) than those without sepsis (median of 7 days) ($p < .001$). In both groups, ICU admission was infrequent, with no statistically significant difference detected between patients with and without sepsis ($p > .999$).

In total, 96.18% of the patients did not require any blood transfusions, although only a small percentage did ($p = .327$). The overall group's median hemoglobin level is 11.75 (IQR: 10.10-13.30). Patients who do not have sepsis have a median hemoglobin level of 11.80 (IQR: 10.20-13.30). Patients with sepsis, on the other hand, have a considerably lower median hemoglobin level of 10.55 (IQR: 8.825-12.475, $p = .001$). White blood cell count (WBC) and serum creatinine levels were among the blood test data examined. There were no statistically significant differences in WBC levels between patients with and without sepsis ($p =$

Table 1. Incidence of sepsis in PCNL patients.

	n/N	Incidence (95% CI)
Sepsis in PCNL patients	58/586	9.90 (7.60-12.61)

Table 2. Demographic and clinical profile of patients.

	Total (n=586)	Without Sepsis (n=528)	With Sepsis (n=58)	p-value
	Frequency (%); Median (IQR)			
Age, years [n=578]		[n=523]	[n=55]	.447‡
18 - 30	26 (4.50)	22 (4.21)	4 (7.27)	
31 - 59	392 (67.82)	357 (68.26)	35 (63.64)	
60 above	160 (27.68)	144 (27.53)	16 (29.09)	
Sex				.427†
Male	300 (51.19)	267 (50.57)	33 (56.90)	
Female	286 (48.81)	261 (49.43)	25 (43.10)	
BMI, kg/m^2 [n=534]	24.883 (22.039 - 28.194)	24.977 (22.10 - 28.209)	24.22 (21.23 - 26.30)	.115§
Comorbidities [n=585]				
Diabetes mellitus	129 (22.05)	114 (21.59)	15 (26.32)	.516†
Hypertension	202 (34.53)	188 (35.61)	14 (24.56)	.129†
Others	65 (11.11)	58 (10.98)	7 (12.28)	.941†
Previous stone tx [n=580]		[n=526]	[n=54]	**<.001**‡
PCNL	49 (8.45)	0	49 (90.74)	
Open stone surgery	10 (1.72)	8 (1.52)	2 (3.70)	
ESWL	1 (0.17)	1 (0.19)	0	
Laser lithotripsy	47 (8.10)	45 (8.56)	2 (3.70)	
Others	25 (4.31)	24 (4.56)	1 (1.85)	
None	448 (77.24)	448 (77.24)	0	
Stone burden				
Staghorn calculus [n=566]	289 (51.06)	259 (50.98)	30 (51.72)	>.999†
Superior calyceal calculus [n=566]	13 (2.30)	10 (1.97)	3 (5.17)	.139‡
Inferior calyceal calculus [n=566]	113 (19.96)	104 (20.47)	9 (15.52)	.471†
Pelvolithaisis [n=565]	74 (13.10)	67 (13.21)	7 (12.07)	.968†
Middle calyceal calculus [n=565]	28 (4.96)	27 (5.33)	1 (1.72)	.344‡
Others [n=567]	142 (25.04)	128 (25.15)	14 (24.14)	.994†
Degree of hydronephrosis [n=548]		[n=490]	[n=58]	**<.001**†
None	255 (46.53)	252 (51.43)	3 (5.17)	
Mild	107 (19.53)	87 (17.76)	20 (34.48)	
Moderate	107 (19.53)	84 (17.41)	23 (39.66)	
Severe	79 (14.42)	67 (13.67)	12 (20.69)	
Laterality [n=585]		[n=527]	[n=58]	
Left	214 (36.58)	193 (36.62)	21 (36.21)	>.999†
Right	229 (39.15)	203 (38.52)	26 (44.83)	.428†
Bilateral	141 (24.10)	130 (24.67)	11 (18.97)	.423†
Guy's stone score [n=300]	3 (2-3)	3 (2-3)	3 (2-3)	.220§
Houndsfield units [n=218]		[n=175]	[n=43]	.127†
<500 HU	39 (17.89)	35 (20)	4 (9.30)	
501 – 999 HU	64 (29.36)	47 (26.86)	17 (39.53)	
>1000 HU	115 (52.75)	93 (53.14)	22 (51.16)	

Mean Stone HU [n=302]	982.40 (650-1220)	1008 (650-1250)	821.50 (650.60-1141.50)	.145§
Urine culture, mL [n=566]	1200 (900-1598)	1200 (900-1580)	1200 (770-1780)	.726§
Operative time [n=521]		[n=467]	[n=54]	.106†
<1 hr	167 (32.05)	155 (33.19)	12 (22.22)	
1 - 2 hrs	241 (46.26)	216 (46.25)	25 (46.30)	
>2 hrs	113 (21.69)	96 (20.56)	17 (31.48)	
Estimated blood loss [n=460]		[n=411]	[n=49]	**<.001**‡
<500 cc	385 (83.70)	360 (87.59)	25 (51.02)	
501 – 999 cc	49 (10.65)	32 (7.79)	17 (34.69)	
>1000 cc	26 (5.65)	19 (4.62)	7 (14.29)	
Irrigant volume, cc/hr [n=583]	100 (80-100)	100 (80-100)	100 (80-107.50)	.999§
Number of tracts [n=583]		[n=525]	[n=58]	.405†
Single	443 (75.99)	402 (76.57)	41 (70.69)	
Multiple	140 (24.01)	123 (23.43)	17 (29.31)	
Urine CS [n=586]		[n=527]	[n=58]	.073†
Positive	280 (47.86)	244 (46.30)	36 (62.07)	
Negative	119 (20.34)	110 (20.87)	9 (15.52)	
None	186 (31.79)	173 (32.83)	13 (22.41)	
Clavien-Dindo classification [n=583]		[n=528]	[n=55]	**.003**‡
GR 1	50 (8.58)	43 (8.14)	7 (12.73)	
GR 2	478 (81.99)	438 (82.95)	40 (72.73)	
GR 3A	40 (6.86)	38 (7.20)	2 (3.64)	
GR 3B	8 (1.37)	5 (0.95)	3 (5.45)	
GR 4A	0	0	0	
GR 4B	0	0	0	
GR V	7 (1.20)	4 (0.76)	3 (5.45)	

Statistical tests used: §–Mann-Whitney U test; †–Chi-square test; ‡–Fisher's exact test.

.623). Serum creatinine levels, on the other hand, were significantly higher in patients with sepsis compared to those without (p = .001).

The use of different pain control and antibiotics did not show significant differences between the two groups. Septic complications, such as septic shock, death, and recovery, were investigated. Out of 227 patients with septic complications, five were diagnosed with sepsis, and all five recovered. In either group, there were no incidences of septic shock.

Age, sex, BMI, and various comorbidities were all evaluated, but none of them were statistically significant predictors of sepsis (Table 3). It was discovered that previous stone therapy has a significant impact on the risk of sepsis. Patients who had PCNL, open stone surgery, ESWL, laser lithotripsy, or other treatments were much more likely to develop sepsis than those who had no previous stone therapy. Stone burden, which includes several types of kidney stones, was not found to be associated with sepsis. Sepsis was substantially associated with the degree of hydronephrosis. Patients with mild, moderate, or severe hydronephrosis were much more likely to develop sepsis than those with no hydronephrosis.

Stone size, laterality, and Guy's stone score were not statistically associated with sepsis however, a higher Guy stone score is associated with patients who underwent percutaneous nephrolithotomy. Hounsfield units (HU) of kidney stones showed a borderline association with sepsis. Patients with kidney stones ranging from 501 to 999 HU had a higher ratio of developing sepsis, although the association was not statistically significant (p = .054).

When compared to operations lasting less than one hour, operations lasting more than two hours were associated with a considerably higher risk of sepsis. Estimated blood loss during the surgery was found to be significantly associated with sepsis. Patients who lost more than 1000 cc of blood had

Table 3. Postoperative parameters.

	Total (n=586)	Without Sepsis (n=528)	With Sepsis (n=58)	p-value
	Frequency (%); Median (IQR)			
Length of hospital stay, days	7 (5-10)	7 (5-9)	9 (6-14.75)	**<.001**§
ICU admission [n=577]	1 (0.17)	1 (0.19)	0	>.999‡
Blood units transferred [n=576]				.327‡
None	554 (96.18)	497 (95.95)	57 (98.28)	
1 unit	16 (2.78)	16 (3.09)	0	
2 units	5 (0.87)	4 (0.77)	1 (1.72)	
3 units	0	0	0	
4 units	1 (0.17)	1 (0.19)	0	
Hemoglobin levels [n=582]	11.75 (10.10-13.30)	11.80 (10.20-13.30)	10.55 (8.825-12.475)	**.001**§
WBC after surgery [n=582]				.623†
< 12	393 (67.53)	356 (67.94)	37 (63.79)	
> 12	189 (32.47)	168 (32.06)	21 (36.21)	
Serum creatinine [n=576]				**.001**†
< 1	351 (60.94)	328 (63.32)	23 (39.66)	
> 1	225 (39.06)	190 (36.68)	35 (60.34)	
Pain control and antibiotics [n=396]		[n=383]	[n=13]	
Dolcet	139 (35.10)	136 (35.51)	3 (23.08)	.556‡
Tramadol	122 (30.81)	118 (30.81)	4 (30.77)	>.999‡
Paracetamol	131 (33.08)	123 (32.11)	8 (61.54)	.055†
Tramadol + Paracetamol	42 (10.61)	40 (10.44)	2 (15.38)	.638‡
Cefuroxime	140 (35.35)	135 (35.25)	5 (38.46)	>.999†
Levofloxacin	26 (6.57)	25 (6.53)	1 (7.69)	.592‡
Algesia	8 (2.02)	8 (2.09)	0	>.999‡
Co-amoxiclav	10 (2.53)	10 (2.61)	0	>.999‡
Ciprofloxacin	33 (8.33)	32 (8.36)	1 (7.69)	>.999‡
Cefixime	5 (1.26)	5 (1.31)	0	>.999‡
Ceftriaxone	45 (11.36)	43 (11.23)	2 (15.38)	.650‡
Ampicillin-Sulbactam	13 (3.28)	12 (3.13)	1 (7.69)	.357‡
Celecoxib	9 (2.27)	9 (2.35)	0	>.999‡
Morphine	8 (2.02)	8 (2.09)	0	>.999‡
Meropenem	6 (1.52)	6 (1.57)	0	>.999‡
Piperacillin Tazobactam	16 (4.04)	15 (3.92)	1 (7.69)	.420‡
Nalbuphine	12 (3.03)	12 (3.13)	0	>.999‡
Others	33 (8.33)	32 (8.36)	1 (7.69)	>.999‡
Septic complications [n=227]		[n=222]	[n=5]	>.999‡
Septic shock	0	0	0	
Death	2 (0.88)	2 (0.90)	0	
Recovered	225 (99.12)	220 (99.10)	5 (100)	

Statistical tests used: §–Mann-Whitney U test; †–Chi-square test; ‡–Fisher's exact test.

a higher risk of sepsis than those who lost less blood. The number of tracts (single or multiple) had no significant relationship with sepsis. When compared to negative urine cultures, positive urine cultures were significantly associated with an elevated risk of sepsis. The final multivariable model is shown on Table 4.

The authors performed a multivariable logistic regression to determine independent factors for sepsis. This model shows the following factors

Table 4. Factors associated with sepsis.

	Crude Odds Ratio (95% CI)	p-value
Age, years		
18 - 30	Reference	-
31 - 59	0.54 (0.19-1.92)	.280
60 above	0.61 (0.20-2.28)	.415
Sex		
Male	Reference	-
Female	0.77 (0.44-1.34)	.361
BMI, kg/m^2	0.96 (0.90-1.01)	.137
Comorbidities		
Diabetes mellitus	1.30 (0.67-2.37)	.415
Hypertension	0.59 (0.30-1.08)	.099
Others	1.13 (0.45-2.47)	.768
Previous stone treatment		
PCNL	88803 (4493.60- 27420160)	**<.001**
Open stone surgery	263.82 (19.60- 37506.24)	**<.001**
ESWL	299 (1.40- 66463.13)	**.004**
Laser lithotripsy	49.29 (3.93-6838.66)	**<.001**
Others	54.92 (2.85- 8100.16)	**.001**
None	Reference	-
Stone burden		
Staghorn calculus	1.03 (0.60-1.78)	.915
Superior calyceal calculus	2.72 (0.60-9.19)	.138
Inferior calyceal calculus	0.71 (0.32-1.43)	.373
Pelvolithiasis	0.90 (0.36-1.95)	.806
Middle calyceal calculus	0.31 (0.02-1.51)	.257
Others		.866
Degree of hydronephrosis		
None	Reference	-
Mild	19.31 (6.43-83.39)	**<.001**
Moderate	23 (7.76-98.70)	**<.001**
Severe	15.04 (4.62-67.42)	**<.001**
Stone size, HU [n=302]	0.999 (0.999-1)	.224
Laterality		
Left	0.98 (0.55-1.71)	.950
Right	1.30 (0.75-2.23)	.351
Bilateral	0.71 (0.34-1.37)	.337
Guy's stone score [n=300]	0.72 (0.48-1.10)	.119
Hounsfield units		
<500 HU	Reference	-
501 – 999 HU	3.16 (1.06-11.74)	.054
>1000 HU	2.07 (0.72-7.45)	.209
Urine culture, mL [n=566]	0.999 (0.999-1)	.634
Operative time		
<1 hour	Reference	-
1 - 2 hours	1.49 (0.74-3.17)	.273
>2 hours	2.29 (1.05-5.11)	**.038**
Estimated blood loss		
<500 cc	Reference	-
501 – 999 cc	7.65 (3.71-15.62)	**<.001**
>1000 cc	5.31 (1.92-13.38)	**.001**
Irrigant volume, cc/hr [n=583]	1 (0.99-1.003)	.600
Number of tracts		
Single	Reference	-
Multiple	1.36 (0.73-2.43)	.321

Urine CS		
Positive	1.96 (1.04-3.94)	**.046**
Negative	1.09 (0.44-2.61)	.850
None	Reference	-
Clavien-Dindo classification		
GR 1	Reference	-
GR 2	0.56 (0.25-1.44)	.189
GR 3A	0.32 (0.05-1.43)	.175
GR 3B	3.69 (0.64-18.92)	.119
GR 4A	-	-
GR 4B	-	-
GR V	4.61 (0.78-25.76)	.078

Note: Multivariate analysis is not practical, due to the significant correlation between several of the variables.

Table 4.1 Factors associated with sepsis using multivariable logistic regression (n=424)

	Adjusted Odds Ratio (95% CI)	**p-value**
Age, years		
18 - 30	Reference	-
31 - 59	0.05 (0.001-0.75)	.052
60 above	0.07 (0.002-1.28)	.100
Sex		
Male	Reference	-
Female	1.27 (0.36-4.70)	.710
Previous stone treatment		
With	332.89 (44.20-42085.72)	**<.001**
Without	Reference	-
Degree of hydronephrosis		
None	Reference	-
Mild	73.58 (10.66-1573.69)	**<.001**
Moderate	64.44 (9.78-133.09)	**<.001**
Severe	28.20 (3.50-628.03)	**.006**
Estimated blood loss		
<500 cc	Reference	-
>500 cc	7.81 (2.32-32.57)	**.002**
Urine CS		
Positive	1.05 (0.30-3.68)	.934
Negative/ none	Reference	-

Blood loss was retained for the final model while we removed operative time because we cannot have correlated variables in a multivariable analysis.
R^2= 0.7071; p-value= <.001

associated with sepsis even after adjusting for covariates: previous stone treatment, presence of hydronephrosis, and blood loss > 500 cc. However, despite these findings, there is no sufficient evidence to show that there is an association with degree of hydronephrosis with sepsis who underwent percutaneous nephrolithotomy.

The most common urine culture isolates are shown in Table 5. The pathogen *Escherichia coli* was found to be the most prevalent among the patients, accounting for 18.97% of the cases. Following closely, *Proteus mirabilis* was identified in 12.07% of the samples. Other pathogens detected were Klebsiella species (6.90%), Proteus species (8.62%), Staphylococcus (10.32%), and Pseudomonas (5.17%), though at varying frequencies

Table 6 presents the common clinical presentations of sepsis. Tachycardia was the most common presentation among patients who developed sepsis, occurring in 27.59% of cases. This was followed by fever, which was reported in 18.97% of patients. Tachypnea was observed in 13.79% of patients, whereas leukocytosis, characterized by an elevated white blood cell count, was observed in 17.24%.

Discussion

The prevalence of nephrolithiasis is common among elderly male and female over 65 years old with metabolic abnormality being the most common cause. Majority of stone formers are males within the ages of 31-59 years old. Since cardiopulmonary and renal function of these patients are compromised, along with the presence of other lifestyle diseases such as hypertension and diabetes places elderly patients are at risk of septic complications following PCNL. The most common presentation of sepsis in patients who underwent PCNL was Tachycardia while the *E. coli* was still the most common isolate seen in urine culture in patients having sepsis who underwent PCNL. This is confirmed as well in the study of Lojanapiwat and Kitinarattrakan. In their study, the most commonly identified infection is *Escherichia coli* which is treatable with culture guided antibiotic.[12] In this study, pre-operative urine culture that tested positive can induce septic shock thru the positive pressure provided which causes absorption systemically hence the importance of antibiotic treatment. However, the study done by Liu et al showed that

Table 5. Most common urine culture.

	Frequency (%)
Urine CS	
E.coli	11 (18.97)
Proteus mirabilis	7 (12.07)
Klebsiella Sp	4 (6.90)
Proteus Sp	5 (8.62)
Staphylococcus	6 (10.32)
Pseudomonas	3 (5.17)

Table 6. Most common presentations of sepsis (n=58).

	Frequency (%)
Fever	11 (18.97)
Tachycardia	16 (27.59)
Tachypnea	8 (13.79)
Leukocytosis	10 (17.24)

a standard urine culture has rather low predictive value for an infection complication and that a direct culture from the renal pelvis and stone culture are better predictors of infection.[13] All patients undergoing PCNL did have basic laboratory work up but septic work up is not routinely requested. Despite its fatal complications, PCNL is one of the important treatment options in the management of nephrolithiasis. PCNL is a relatively safe procedure in the hands of trained urologist in the treatment of nephrolithiasis >2cm. Given the risks of complications in doing percutaneous nephrolithotomy, how safe really is performing percutaneous nephrolithotomy in patients with nephrolithiasis? In a study conducted by Darabi et al, patients who underwent this procedure were at risk of having massive blood loss, colon perforation, pneumothorax and hydrothorax. These were the common complications observed on top of sepsis which is common in patients undergoing this procedure.[14] Studies have shown that previous stone surgeries, degree of hydronephrosis on CT scan, prolonged operative time and blood loss are associated with sepsis among patients who underwent percutaneous nephrolithotomy which is equivalent to a longer hospital stay. In the study of Michel et al., general complications are classified into access and those related to stone removal.[15] Parenchymal bleeding from laceration for access, development of pseudoaneurysm and arteriovenous fistula are some of the more common complications experienced. Correct patient selection is important for all percutaneous endourologic procedures. This study also showed that any age or gender with comorbidities are at risk for septic complications. Previous stone treatment, degree of hydronephrosis and blood loss are all interrelated as one leads to another in developing complications across all age groups. This study showed that majority of the patients who suffered from sepsis are those patients who had moderate to severe hydronephrosis on CT scan with previous stone surgery with a blood loss of more than 500 cc can cause sepsis. This was in contrast to the study of Wang et al which stated that percutaneous nephrolithotomy can be safely carried until 90 minutes.[16] The current study showed that majority of the population who had sepsis belonged to the patients with Guy stone score of I however it had no significant correlation. Patients with Guy stone score of II-IV were statistically significant showing that patients with a rather complex stone anatomy caused sepsis in patients who underwent percutaneous nephrolithotomy. Majority of the reported complications needed blood transfusion (Clavien II) which is can happen in these kinds of surgeries. In a study done by Khalil et al., patients with Guy stone score of II-IV showed correlation with complications of the surgery particularly in patients with staghorn calculus or guy stone score IV.[17] Degree of hydronephrosis, higher volume of blood loss, previous stone surgery and higher Guy's stone core all point to a significant stone burden that is the man attribute of patients that developed sepsis. Although, the blood loss may also reflect the skill level of the surgeon which was not delineated in this study. It would have been interesting to note whether majority of the cases that developed sepsis were done by residents who were still negotiating their learning curve or were performed by consultant who are supposed to be more experienced and competent.

Conclusion

This study was able to identify through regression analysis that the following factors are contributory to the development of sepsis: a high Guy's stone score, high degree of obstruction or hydronephrosis, previous stone surgery and a higher volume of blood loss. This should serve as cautionary indicators in the evaluation who patients who will undergo PCNL treatment. Once these are criteria are identified in patients who are candidates for surgery then preparations should be done to mitigate the risk of sepsis.

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