A prospective observational study to determine the incidence of perioperative complications during percutaneous nephrolithotomy (PCNL) surgery and the various risk factors predisposing to them.

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE RULES AND REGULATIONS FOR THE MD BRANCH X, ANAESTHESIA EXAMINATION OF THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY, TO BE HELD IN AUGUST 2010.

Certificate of Bonafide work

CERTIFICATE

This is to certify that the dissertation entitled **"A prospective observational study to determine the incidence of perioperative complications during percutaneous nephrolithotomy (PCNL) surgery and the various risk factors predisposing to them"** is the bonafide original work of **Dr. Suma Mary Thampi** towards the M.D. Branch-X (Anaesthesia) Degree Examination of the Tamil Nadu Dr. M.G.R University, Chennai, to be conducted in August , 2010.

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AIMS AND OBJECTIVES OF THE STUDY

AIM:

To assess the peri-operative anaesthetic complications of Percutaneous Nephrolithotomy (PCNL)

OBJECTIVES:

i) To detect the incidence of cardiovascular changes namely hypotension and arrhythmias during the surgery

ii) To detect the incidence of hypothermia during the surgery

iii) To detect the incidence of bleeding requiring intra-operative blood transfusion

iv) To detect the incidence of acidosis resulting from the procedure

v) To detect the incidence of any other complication that may result due to the surgery

vi) To determine risk factors associated with each of the above complication

ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is a relatively non-invasive surgical alternative available for removal of kidney stones. The traditional approach to renal stones was through open surgical procedures that required general anesthesia and long convalescence. Although, PCNL is a minimal invasive technique, it carries a potential risk of complications. These include bleeding, anaemia, hypotension, hyponatremia, hypothermia, injury to vital organs like pleural tear bowel perforation, infection, and septic shock.

PCNL is a very common surgery that is being carried out in our institution. However, till date the there has been no study on the profile of complications that have been observed perioperatively. In literature, though the listed complications do not actually quantify their incidence. Considering the frequency of cases and complications seen, we feel that it would be a very useful exercise, since knowing the relative incidence of complications will help institute the appropriate monitoring techniques and so, in the better perioperative management.

Methods: Data was collected on 60 patients who underwent elective PCNL surgery. This included monitoring of blood pressure, heart rate, nasopharyngeal temperature, saturation, end-tidal carbon-di-oxide, arterial blood gas (ABG), the volume and temperature of irrigation fluid, the temperature in the operating. The collected data was

analyzed to find out the complications that occur during the procedure and to determine their incidence and risk factors associated with them. Data was analyzed using SPSS version 16. Chi-square test was the test of significance in the study. Odds Ratio was calculated and a p-value less than 0.05 was considered statistically significant.

Results: A total of 60 patients were studied of whom 42 were females and 18 males.40 patients were ASA grade 1 and 20 were ASA grade 2.The incidence of hypothermia and acidosis was 60% and 26.7%, respectively. The incidence of hypothermia and temperature of the irrigating fluid had statistically significant association with a p-value of 0.026.The incidence of acidosis was significantly associated with the volume of irrigating fluid with a p-value 0.025.The risk of acidosis was increased with hypothermia (p-value 0.02 and OR 7.00)

Conclusion: The most common complication observed intraoperatively was hypothermia, followed by acidosis and sepsis. Other complications that occurred were excessive bleeding and hydrothorax. Electrolytes imbalance and cardiovascular changes were not observed as major complications. The most significant risk factor associated with hypothermia was found to be the usage of cold irrigating fluid.

LITERATURE REVIEW

URETERIC CALCULI-AN INTRODUCTION

Urinary calculi are solid particles in the urinary system. They may cause pain, nausea, vomiting, hematuria, and, possibly, chills and fever from secondary infection. Diagnosis is based on urinalysis and radiological imaging, usually noncontrast helical CT. Treatment is with analgesics, antibiotics for infection, and, sometimes, extracorporeal shock wave lithotripsy or endoscopic procedures.

About 1/1000 adults is hospitalized annually in the US because of urinary calculi, which are also found in about 1% of all autopsies. Up to 12% of men and 5% of women will develop a urinary calculus by age 70. Calculi vary from microscopic crystalline foci to calculi several centimeters in diameter.(Figure 1) A large calculus, called staghorn calculus, can fill an entire renal calyceal system.

Etiology

About 85% of calculi in the US are composed of Ca, mainly Ca oxalate. 10% are uric acid; 2% are cystine; and the remainder is Mg ammonium phosphate (struvite).

Pathophysiology

Urinary calculi may remain within the renal parenchyma or renal pelvis or be passed into the ureter and bladder. During passage, calculi irritate the ureter and may become lodged, obstructing urine flow and causing hydroureter and sometimes hydronephrosis. Common areas of lodgment include the ureteropelvic junction, the distal ureter (at the level of the iliac vessels), and the ureterovesical junction. Typically, a calculus must have a diameter > 5 mm to become lodged. Calculi ≤ 5 mm are likely to pass spontaneously.

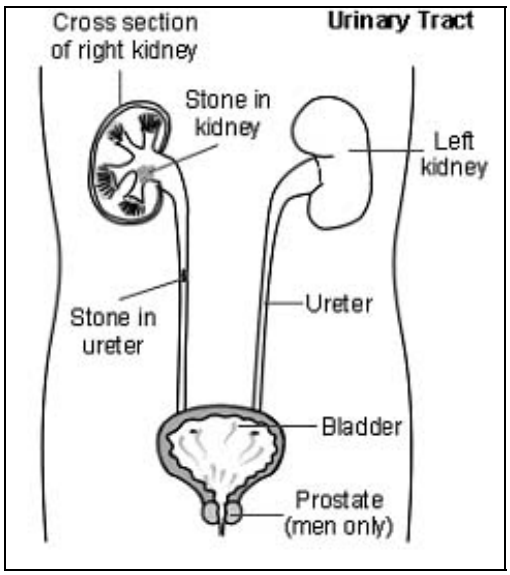


Figure 1 : Pictorial representation of sites of renal and ureteric stones.

Table 1 : Composition of Urinary Calculi.

Composition	Percentage of All Calculi	Common Causes
Calcium oxalate	70	Hypercalciuria Hyperparathyroidism Hypocitruria Renal tubular acidosis
Calcium phosphate	15	Hypercalciuria Hyperparathyroidism Hypocitruria Renal tubular acidosis
Cystine	2	Cystinuria
Magnesium ammonium phosphate (struvite)	3	UTI caused by urea-splitting bacteria
Uric acid	10	Hyperuricosuria Increased urine acidity

Even partial obstruction causes decreased glomerular filtration, which may persist briefly after the calculus has passed. With hydronephrosis and elevated glomerular pressure, renal blood flow declines, further worsening renal function. Generally, however, permanent renal dysfunction occurs only after about 28 days of complete obstruction.

Secondary infection can occur with long-standing obstruction, but most patients with Ca-containing calculi do not have infected urine.

Symptoms and Signs

Even large calculi remaining in the renal parenchyma or renal pelvis are usually asymptomatic unless they cause obstruction. Symptoms, such as severe pain, often accompanied by nausea and vomiting, and sometimes gross hematuria, usually occur when calculi pass into the ureter, cause obstruction, or both. Pain (renal colic) is of variable intensity but is typically excruciating and intermittent, often occurs cyclically, and lasts 20 to 60 min. Nausea and vomiting is common. Pain in the flank or kidney area that radiates across the abdomen suggests upper ureteral or renal pelvic obstruction. Pain that radiates along the course of the ureter into the genital region suggests lower ureteral obstruction. Suprapubic pain along with urinary urgency and frequency suggests a distal ureteral, ureterovesical, or bladder calculus.

On examination, patients may be in obvious extreme discomfort, often ashen and diaphoretic. Patients with renal colic may be unable to lie still and may pace, writhe, or constantly shift position. The abdomen may be somewhat tender on the affected side as palpation increases pressure in the already-distended ureter, but peritoneal signs

(guarding, rebound, rigidity) are lacking. For some patients, the first symptom is hematuria or either gravel or a calculus in the urine. Other patients may have symptoms of a UTI, such as fever, dysuria, or cloudy or foul-smelling urine. For most stones < 2 cm in diameter, ESWL may be the procedure of choice because morbidity as measured by blood loss, pain, fever, and postoperative stay was significantly less with ESWL.

TREATMENT-OPTIONS AND INDICATIONS

Some stones < 2 cm in diameter should still be considered for PCNL.(TABLE 2A,2B and 2C). These include cystine stones > 1 cm in diameter (especially if multiple), because cystine is not easily fragmented with ESWL. In addition, some stones residing in dependent calices may be better candidates for PCNL. If the calyx is dilated, the likelihood of residual fragments following ESWL is high [25]. Thus, if rendering the patient entirely stone-free is a high priority (such as for struvite) PCNL should be performed instead of ESWL.

Very few stones larger than 3 cm can be treated successfully with ESWL alone. This includes most staghorn calculi. Paik *et al,* in their study, reported of 13 non-staghorn cases in this category, 77070 required further treatment, only 29070 were rendered stone-free, and 57070 had to be considered treatment failures. For these reasons, large stones and especially staghorn calculi are initially best approached percutaneously.(1) The most important indications of PCNL are stone size >2.5cm, resistance to ESWL, lower pole calyx stones with long and thin infundibulum and oblique infundibulo-pelvic angle. (2)

TABLE 2A : TREATMENT RECOMMENDATIONS

Renal stones	Ureteral stones
Shock wave lithotripsy (SWL)	SWL
Percutaneous nephrolithotripsy (PCNL)	Ureteroscopic procedures (URS)
Retrograde intrarenal surgery (RIRS)	- Retrograde - Antegrade
Laparoscopic Surgery	
Open Surgery ureterolithotomy	Laparoscopic

TABLE 2B : TREATMENT RECOMMENDATIONS

AUA nephrolithiasis clinical guidelines (1994)Treatment recommendations for calculi in non-dilated non-obstructed adult collecting systems			
Stone size	**Surface area**	**Treatment**	**Exceptions**
>1 cm	<100 mm2	SWL	-
1.1- 2 cm	100-500 mm2	SWL	PCNL for cystine calculi, lower caliceal calculi
2.1 - 3 cm	500-1000 mm2	PCNL	SWL for soft calculus in pelvis or upper pole
>3cm	> 1000 mm2	PCNL	-

Management of Renal Calculi

- > 2.5 cm PCNL
- < 2.5 cm ESWL
- PCNL: 95% success rate
- ESWL: 65-75%
  - < 1cm: 64-92%
  - 1-2 cm: 59-89%
  - > 2 cm 39-70%

AUA Guidelines 1997
EAU Guidelines 2007

TABLE 2C : TREATMENT RECOMMENDATIONS

Performing the percutaneous procedure first is advisable for a number of reasons.

Advances in ESWL and expertise in endourological procedures have diminished the role of open surgery in the management of patients with renal and ureteral calculi. The indications for open surgery in the 1990s included complex stone burden, failure of ESWL or endourological treatment, anatomic abnormalities such as infundibular stenosis, renal calyceal diverticulum or concomitant ureteropelvic junction obstruction requiring surgery and morbid obesity.(1)

Indications for PCNL

-Renal calculi greater than 2.5 cms in diameter.

-stone with composition inappropriate for ESWL

-Complete or partial staghorn calculus.

-Renal malformations like, pelvi - ureteric junction, infundibular stenosis obstruction

-cystine calculi greater than 1.5 cm

-Failure of ESWL.

-Body habitus unsuitable for ESWL like morbid obesity.

An ideal patient for PCNL is one who has two functioning kidneys and 2 cm stone in one of the kidneys with extra renal pelvis with mild to moderate hydronephrosis.

History of PCNL

The approach to upper urinary calculi has been revolutionized since the early 1980s with the introduction of ESWL and the popularization of PCNL. Percutaneous stone extraction was first described in 1941 by Rupel and Brown after a surgical nephrostomy was created(3). Subsequently, in the late 1970s, however, PCNL, a

minimally invasive technique for the treatment of renal calculi, was introduced.(4) PCNL as a primary procedure was described by Fernstrom and Johannson in 1976(5). However, PCNL was not widely accepted until the mid-1980s.(3, 5). Although this technique also relied on general anesthesia, it allowed effective and safe removal of most renal and some ureteral stones with shorter postoperative recovery times, and quickly became a widely accepted treatment option for renal calculi(6). However, PCNL frequency diminished with the introduction of extracorporeal shock wave lithotripsy (ESWL) in the early 1980s(7). In recent years, as clinical experience with ESWL revealed its limitations, the role of PNL for treating urolithiasis was redefined (8, 9).

Today, ESWL represents the initial treatment modality in approximately 90% of patients with urinary tract stones, and is done predominantly on an outpatient basis. Although ESWL has eclipsed all other methods of treatment for urinary tract stones, there are situations in which it may not be beneficial. Nearly 6% of patients experience an inadequate ESWL result, and may require endourologic or operative stone removal. Pregnancy and the presence of a coagulopathy are contraindications to ESWL. Large calculi and patients with distal ureteral stricture or obstruction may not be candidates for ESWL monotherapy. Patients with calcium oxalate monohydrate, calcium phosphate, or cystine calculi, which are resistant to fracture with ESWL, may require alternate techniques. PCNL alone or and open surgical intervention remain alternative treatment options for these patients with ESWL.(4)

RECENT TRENDS

The approach to upper urinary tract stones has changed from the sandwich PCNL and SWL combination therapy to PCNL monotherapy.(3) In recent years, evolving trends in the endoscopic management of complex renal calculi have resulted in improved stone free status of patients treated with PCNL at our institution.

One of the trends has been increased usage of upper-pole access to obtain better visibility of the collecting system, as upper-pole access gives better alignment with the renal axis. The other advantage of the upper-pole approach is that it gives better access to the UPJ and the upper third of the ureter when necessary. In the event that the stone is in a horseshoe kidney, upper-pole access is crucial, as the abnormal anatomic reflection of the peritoneum results in bowel positioning around the lower pole, making lower-pole access dangerous.

The second trend in technique has been that all percutaneous access is obtained by the urologist as part of a single-stage procedure. The urologist is most familiar with intrarenal anatomy and the capabilities and limitations of available surgical instruments. Furthermore, if additional access is necessary, the urologist will not have to depend on the availability of a radiologist to create a second access.

The third trend in the technique has been the use of flexible nephroscopes after the rigid nephroscope with ultrasonic lithotripsy has reached its limits in removing the stone. Flexible nephroscopy allows the urologist to inspect the entire collecting system as well as to remove residual stone debris using various endourologic adjuncts such as stone-retrieval baskets, graspers, wires, and high-pressure irrigants. On occasion, laser

lithotripsy has been used through the flexible nephroscope to fragment a larger residual stone. Generally, residual stones >2 cm in transverse diameter would require an additional access and tract dilation for removal.

The fourth trend in PCNL in our institution has been the increased usage of secondary PCNL, performed at the time of nephrostomy tube removal, to ensure stone-free status.

The fifth and last trend has been the decreased reliance on SWL after PCNL. With more thorough stone removal by endoscopic means, the role of SWL after PCNL has decreased significantly. In our earlier reported series,16 41.4% of our patients required SWL post-PCNL, but in our current series, only 21% required SWL. This trend has resulted in fewer procedures, shorter hospitalization, and less cost to our patients.(3)

ADVANTAGE S OF PCNL

Most urologists believe that this operation is better than open surgery due to decreases the length of stay, less morbidity, less pain and more preserved kidney function(10).When compared to traditional open stone surgery, PCNL is associated with lower morbidity and mortality and heightened patient acceptance because of its less invasive nature (11-13) This technique has been demonstrated to be applicable to the removal of a wide variety of upper urinary tract calculi, including staghorn calculi(12, 14), and may also be utilized for the treatment of obstructive lesions in the upper urinary tract such as ureteropelvic junction (UPJ) narrowing and ureteral strictures [13]. The technique has been used to remove calculi from calyceal diverticula and allows for simultaneous obliteration via fulguration of these cavities [14].

TECHNIQUE OF PCNL

Initial step of PCNL is cystoscopy and placement of an open ended or ureteric catheter on the side of the stone and injecting dye which will give the configuration of the pelvi-calyceal system. The patient is placed in prone position. Proper PCN tract is critical to the success in removing stones. Two important considerations are safety and access. Always use a posterolateral approach. Use middle or inferior calyx for pelvic or upper calyceal stone or direct access to a calyceal diverticular stone. Do not make a tract directly into the pelvis but to go through posterior calyx end on so that parenchymal hold helps in maintaining the tract.

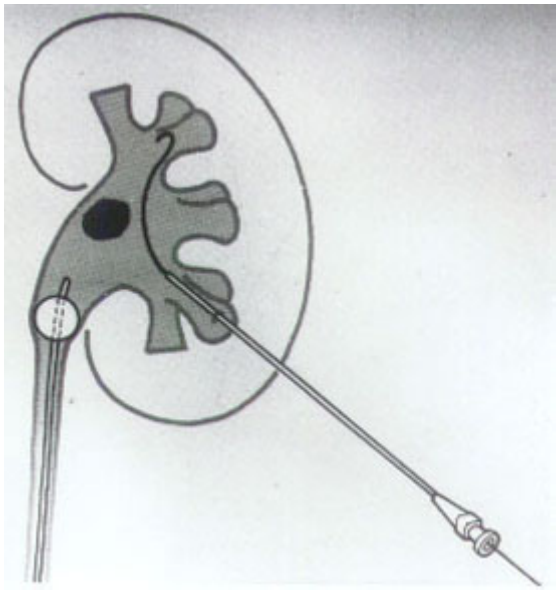
Standard Puncture (Fig. 2)

The puncture is made with needle and help of "C" Arm. Once the needle is in pelvicalyceal system, a J tipped, Teflon coated movable core guide wire is negotiated into the renal pelvis and across the pelviureteric Junction into the ureter, a second guide wire called the "safety wire" is also passed into ureter, if wire can not be passed into ureter than it can be coiled into the calyces so that the guide wire does not get pulled out of the kidney accidentally.

Tract Dilatation (Fig. 3)

To check if guide wire is in proper position with the rigid portion of wire across the renal parenchyma, fascia and the body layers. Dilatation need to be done under fluoroscopy to see that it is along the guide wire and it should not be bent during the process of dilatation. Several options are available to enlarge the tract to a size of about 34 FR.

Figure 2 : ***Standard Puncture***



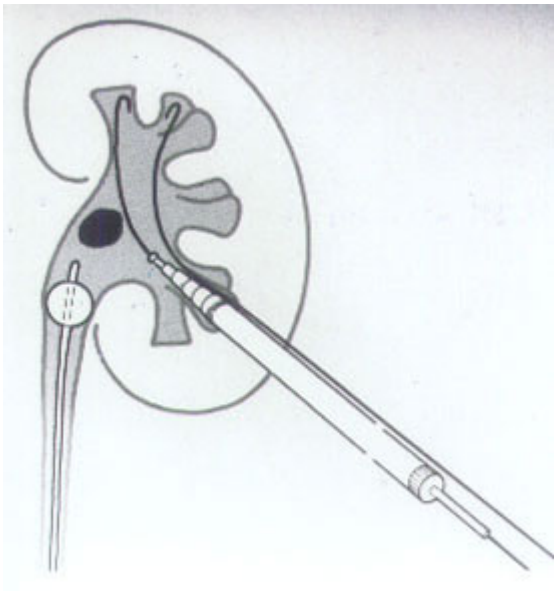


Figure 3 : Tract Dilatation

Sequential Amplatz dilators, telescopic metal dilators or high pressure balloon. Balloon dilation is less traumatic and results in less bleeding but expensive. At the end Amplatz sheath is positioned over the last dilator to the appropriate site as this will be the conduit for further instrumentation.

Stone Removal (Figs. 4,5)

As with all types of surgery, a clear field is a prerequisite to definitive treatment, after the dilatation visibility may be poor due to blood clots. Renal pelvis is flushed with irrigant through the sheath or from below by open ended catheter. Once the stone is visible, endoscopy and fluoroscopy are used to decide how it should be removed. If stone is small it can be grasped with rigid forceps and extracted intact. Larger stones require fragmentation before removal and various techniques are available - electrohydrolic, ultrasonic and laser lithotripsy. *Electrohydraulic* is a bipolar probe that creates a spark when fired, which will vaporize liquid, producing a gas bubble and shock wave that fragments the calculi. *Ultrasonic lithotripsy* uses mechanical vibrations at a frequency above 17 cycles/Sec or 17 KHZ. Vibrations are created by applying alternating current to a ceramic crystal which then expands and contracts; this vibration is transmitted to the tip of probe where it causes formation of bubbles and produce cavitation on contact with stone. Suction on the back of the probe removes small fragments. Ultrasound probe does not damage renal tissue if it accidentally touches it. These probes are rigid hence cannot be used with flexible instruments.

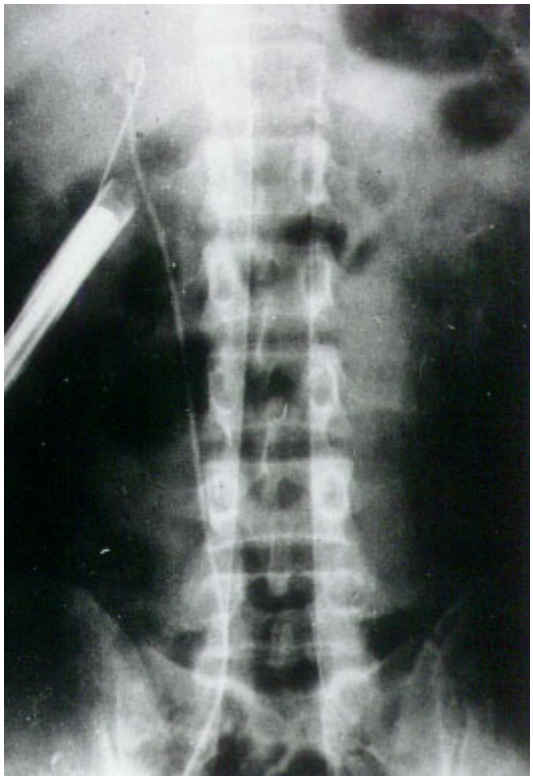
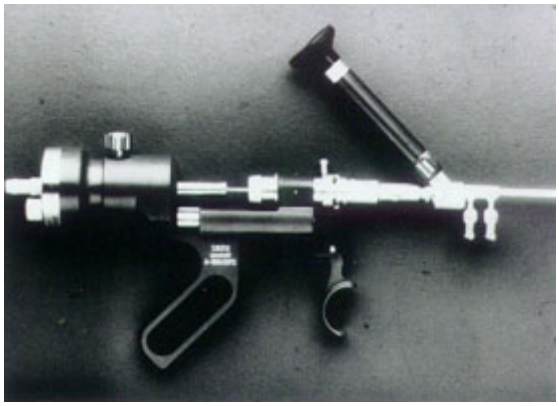


Fig. 4: X-ray with Amplatz sheath in position.

Fig.5: Nephroscope



Laser lithotripsy: Recently Holmium laser has been used to fragment stone, due to its cost it is not used in all the centers. Laser is capable of fragmenting even the hardest calcium oxalate m monohydrate and cystine calculi. In some cases where the stone is large or has extension into different calyces than additional tract may be required in about 15% of cases. Multiple tracts help to achieve stone free Kidney.

COMPLICATIONS OF PCNL (Table 3,4)

PCNL has acceptably low morbidity. Michel *et al* presented a total complication rate of up to 83% following PNL (15). Overall significant complications associated with PCNL include acute loss of kidney, colon injury, hydrothorax, pneumothorax, prolonged leak, sepsis, vascular injury, and has an estimated rate of 15%(7-27%,CI 95%)(16) Complications during or after PNL may be present with an overall complication rate of

up to 83%, including extravasation (7.2%),transfusion (11.2–17.5%), and fever (21.0–32.1%), whereas major complications, such as septicemia (0.3–4.7%) and colonic (0.2–0.8%) or pleural injury (0.0–3.1%) are rare.(15) The most common minor complications of PCNL are pain (49%), fever (30%), urinary infection (11%), and renal colic (4%).The most common major complications of PCNL are septicemia (4.1%) and bleeding requiring blood transfusion (2.7%)(17, 18)

Similarly, Tefekli *et al,* in a retrospective review of 811 PCNL reported a total of 255 perioperative complications (29.2%)(19) This is the first published series trying to classify PNL complications according to the modified Clavien system.

The modified Clavien system(Table 3) has been proposed to grade perioperative complications. According to the modified Clavien classification system, perioperative

complications were stratified into five grades. Grade 1 defined all events that, if left untreated, would have a spontaneous resolution or needed a simple bedside intervention. Grade 2 complications required specific medication, including antibiotics and blood transfusion. Grade 3 complications necessitated surgical, endoscopic, or radiological intervention (3a without general anesthesia, 3b under general anesthesia). Neighboring organ injuries and organ failures were classified as grade 4, and death was considered a grade 5 complication (19, 20)

Table 3:Classification of surgical complications according to the modified Clavien system

Grade 1 : Any deviation from the normal postoperative course without the need for pharmacologic treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.

Grade 2 : Complications requiring pharmacologic treatment with drugs other than such allowed for grade 1 complications. Blood transfusions and total parenteral nutrition are also included.

Grade 3 : Complications requiring surgical, endoscopic, or radiological intervention.

Grade 3a : Intervention not under general anesthesia

Grade 3b : Intervention under general anesthesia

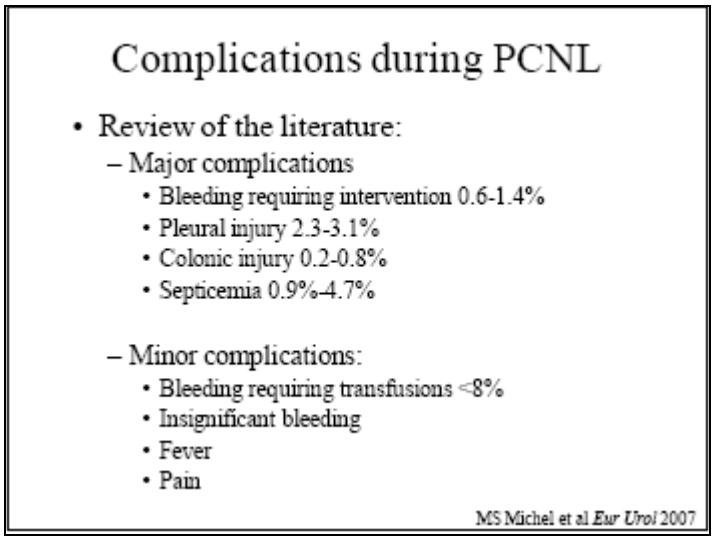
Grade 4 : Life-threatening complications (including central nervous system complications) requiring intensive care unit stay

Grade 4a: Single organ dysfunction (including dialysis)

Grade 4b: Multiorgan dysfunction

Grade 5 : Death of the patient

Table 4 Complications during PCNL.



Sepsis

Incidence

In the immediate postoperative period after percutaneous stone removal, body temperature elevations are common and often attributed to the release of inflammatory mediators. Fever is one of the most worrisome and serious complications of PCNL because of the high possibility of bacteremia or endotoxemia. Postoperative fever defined the body temperature ‡38_C persisting still after 48 h

postoperatively (21).The incidence of fever has been reported as21–32.1% of the cases (15)

In the setting of percutaneous nephrolithotomy (PCNL), concern is heightened because bacteremia can be induced by the surgical manipulation and stone

fragmentation.(22) The incidence of postoperative fever and infection after PCNL has been well documented

in various studies. In these studies, the postoperative fever and bacteriuria was reported between 20–35% and 0–19%, respectively(22, 23) In fact, reports of both postoperative fevers and bacteremia are as high as 37% in some series(24, 25).However, some series report a much lower incidence of sepsis ranging from 0.3% to 4.3%(15, 26)

Diagnosis of sepsis

Bacteremia is the presence of pathogenic microorganisms in the blood, which can lead to septicemia, which is the clinical syndrome caused by bacterial infection in the blood, confirmed by positive blood cultures, and accompanied by systemic response to the infection. SIRS is defined by at least two of the following:

-fever (>38c) or hypothermia (<36c)

-tachycardia >90bpm on non- beta blocked patients

-tachypnoea > 20 respiratory rate or PaCO2 >

-WBC count >12,000/mm3 or <4000/ mm3 or >10% band forms (oxford hand book of urology)

Pathophysiology

The source of infection always comes from the stone itself(27). The incidence of fever is significantly higher in cases with infected urinary stones than in those with sterile stones (28).Most fever developed within 24 hours following the operation although all of the patients had preoperative and postoperative prophylaxis antibiotics. Predisposing factors to fever and sepsis include a preexisting untreated UTI, renal insufficiency, sturvite or staghorn calculi, long-lasting operation and high amount or high pressure of irrigation fluid used during PNL.(29)

Rao *et al* confirmed a statistically significant association between pre-operative bacteriuria and the development of postoperative bacteraemia (bacteraemia in 37% of patients with a positive MSSU compared to 8% in those with a negative urine culture pre-operatively)(24, 30)The degree of bleeding from PCNL showed more injured renal parenchyma or tear of vessels that increased the risk of bacteremia or endotoxemia. Leakage of infected fluid from the kidney into the retro peritoneum can also be reabsorbed slowly back into circulation and may cause infection in postoperative period(31, 32)

Bleeding

Incidence

Bleeding is a major concern during percutaneous nephrolithotomy (PCNL), especially with the use of multiple tracts. Although most bleeding associated with PCNL

can be managed conservatively, approximately 0.8% of patients require angioembolization to control intractable bleeding (18, 33)

Etiology

The causes of bleeding were direct injury to blood vessels, laceration of the kidney during operation especially with the technique of percutaneous tract creation(34),multiple nephrostomy tracts and size of the tract as reported by Kukreja R (34, 35) Injury to blood vessels could occur at anytime so intraoperative bleeding in the presented patients seemed to relate with intraoperative hypothermia, duration of operation and volume of irrigation fluid.(26) Excessive bleeding can occur during needle passage, tract dilation, and nephroscopy or during the postoperative period.

Stoller *et al*, in their study on 127 PCNL patients estimated that the average blood loss for uncomplicated 1-stage single puncture percutaneous nephrolithotomy was 2.8 gm./dl. Kukreja et al reported an average hemoglobin drop of 1.68 +/- 1.23 g/dLhemoglobin(36). Blood transfusions and a postoperative decrease in hemoglobin level were combined to estimate total blood loss. Multiple punctures and/or renal pelvic perforation were associated with a 2-fold greater blood loss. Half of the expected blood loss occurred in patients with a preexisting nephrostomy tract. Diabetes, multiple-tract procedures, prolonged operative time, and the occurrence of intraoperative complications are associated with significantly increased blood loss.(34).Calculus morphology, location, composition and length did not affect total blood loss, nor did the number of fragments or stone-containing calices. Other factors, such as puncture site, type of fascial dilation, hypertension, renal insufficiency, infection, previous open renal surgery or previous

extracorporeal shock wave lithotripsy, also did not affect total estimated blood loss. Factors such as age, hypertension, renal insufficiency, urinary infection, the degree of hydronephrosis, stone bulk, and the function of the ipsilateral renal unit did not have any effect on the blood loss (34, 36)

Associated arteriosclerosis in patients with diabetes and hypertension may make such patients more prone to bleeding after the initial trauma of tract formation. However, hypertension was not associated with hemorrhage in our series. Although multivariate analysis revealed that the presence of diabetes caused significant blood loss, univariate analysis did not reveal any statistically significant difference between those with and without diabetes. This paradox can be explained by either the small number of diabetic patients in our series or the interaction of diabetes with other significant variables on multivariate analysis.(18)

Bleeding during PCNL results from injury to the renal vessels. Venous bleeding occurring during these procedures can usually be eradicated by transient balloon tamponade of the tract. Arterial bleeding presents with different characteristics than venous bleeding. The reported incidence of arterial injuries ranges from 0.9% to 3% after percutaneous procedures.(37).If arterial bleeding does not subside after tamponade measures, these patients can be treated successfully with angioembolization.

Blood transfusion

The rate of blood transfusion has been previously reported in various studies with data ranging from 7%–23% (34, 36, 38). Stoller et al reported an incidence of 4% in non-anemic patients(36). Srirangam *et al* supported the principle that patients having multiple punctures are more likely to require a blood transfusion.(30, 34) . Preoperative hemoglobin, multiple tracts, stone size, and total blood loss were significant in predicting perioperative blood transfusion requirement (34, 36) On the basis of this evidence, maneuvers that may reduce blood loss and transfusion rate include ultrasound-guided access, use of Amplatz or balloon dilatation systems, reducing the operative time, and staging the procedure in cases of a large stone burden or intraoperative complications(34)

Puncture site

The site of kidney puncture is a vital part of a successful PCNL. The choice of access tract is based on the ability to provide good visibility of the stone bearing area and a point of entry with minimal risk of injury to adjacent organs. Additionally, the access tract should provide a trajectory projecting without torque or angulation into the infundibulum and renal pelvis.(39) Typically, a subcostal puncture is used; however, in certain circumstances, a supracostal approach may be desirable for improved access, *e.g*. with staghorn and proximal ureteric stones Access via the superior posterior calyx offers optimal exposure to staghorn calculi as well as multiple calculi in the superior and inferior calyceal groups, renal pelvis, and upper ureter, and is therefore generally preferred by urologists (Figures-2 and 3).However, prior publications on the subject have suggested a higher rate of complications with 11th and 12th intercostal approach (39, 40) .

The drawback of supracostal punctures is an increased incidence of intrathoracic complications as well as a higher rate of spleen and hepatic injury (41,42). Supracostal

approach is favorable in the therapy of upper calices calculi, but the risk of pneumothorax and hydrothorax should be considered. Hydrothorax and pneumothorax can be hard to recognize in these patients mainly because of the prone position(43)

Access to the posterior upper pole calyx affords an almost straight path to the renal pelvis, upper ureter and both anterior and posterior inferior calyceal groups (Figures-1 to 4). Even the posterior interpolar calyx may be accessible via this path without significant angulation.(39) Access via the posterior superior calyceal group makes calculi in the renal pelvis, upper ureter, and anterior and posterior inferior calyceal groups accessible, and thus makes this an almost universal access route. Only the superior anterior calyceal group and anterior and sometimes posterior interpolar calyceal groups cannot be reached easily via this entry and hence may mandate separate punctures and access routes if calculi are harbored in these regions(44, 45) . Lang *et al,*in their study on routes of access, reported that access to the upper pole by the intercostal route resulted in 1 pneumothorax, 1 arterio-calyceal fistula and 3 AV fistulae in 111 patients (Table-3). Via a subcostal access route, we recorded 2 pneumothoraces, 1 AV fistula, 1 pseudoaneurysm, 1 ruptured UPJ, and 4 perforated ureters in 119 patients (Table-5). The ratio of complication to no complication was significant ($p = 0.0395$). A high incidence of atelectasis ($n = 13$) in the subcostal access group was also noted (Table-6).(39)

Intercostal access via the posterior superior calyx offers the best trajectory via infundibulum to pelvis, UPJ and inferior calyx. The supra 11th rib approach has a particularly high rate of complications. Munver *et al.* reviewed their complications from supracostal punctures for PNL access in 240 patients. The overall complication rate for

supracostal access tracts was 16.3% compared with 4.5% for infracostal access. Punctures above the 11th rib resulted in a tremendously higher intrathoracic complication rate (34.6%) compared to the supra 12th rib access (1.4%), a fact that corroborates the strategy of avoiding this high approach if possible Pneumo and hemothorax, and calyceal-pleural fistulae have been reported in up to 23.1% (46) The possibility of both a transthoracic and transpleural trajectory of this type of access tract, despite attempts to attain a high position of the lung by puncturing during the expiration phase, predisposes to these complications(40, 46) . The incidence of hydropneumothorax occurring with intercostal access has been reported at a rate of 4% to 15.3 %, with subcostal access, 0% to 1.4% (46, 47). Similarly, large pleural effusions were reported in 8% to 12.5% with intercostals approach, but virtually absent with subcostal access (40, 45, 47) . Moreover, on the basis of anatomic considerations, the intercostal access route might have a higher chance for injury to anterior segmental vessels or even anterior and posterior divisional arteries(48)

Table 5: Major complications at various access sites.

Table 3 *– Major complications at various access sites.*

	Intercostal			Subcostal		
Location	UP	MP	LP	UP	MP	LP
No. Punctures	111	12	4	119	63	333
Complications						
Pneumothorax	1 (1%)			2 (1.7%)		
Hemothorax					1 (1.6%)	
Colo-caliceal fistula					1 (1.6%)	
Arterio-caliceal fistula	1 (1%)					
AV fistula	3 (2.7%)			1 (1%)	1 (1.6%)	
Pseudoaneurysm				1 (1%)		
Ruptured UPJ				1 (1%)		1 (0.3%)
Perforated ureter				4 (3.4%)	2 (3.2%)	2 (0.6%)
Septic shock						2 (0.6%)

UP = upper pole; MP = mid pole; LP = lower pole; UPJ = ureteropelvic junction.

Table 6: Minor complications at various access sites.

Table 4 *– Minor complications at various access sites.*

	Intercostal	Subcostal				
Location	UP	MP	LP	UP	MP	LP
No. Punctures	111	12	4	119	63	333
Complications						
Atelectasis	3 (2.7%)			13 (11%)		1 (0.3%)
Fever	2 (1.8%)			2 (1.7%)	2 (3.2%)	13 (3.9%)
Obstruction	1 (1%)		1 (25%)	3 (2.5%)	2 (3.2%)	15 (4.5%)
Tract bleeding		1 (8.3%)	1 (25%)	2 (1.7%)	2 (3.2%)	8 (2.4%)
RA/RV thrombus	1 (1%)				1 (1.6%)	3 (09%)
Renal infarct				1 (1%)	1 (1.6%)	3 (0.9%)
Blood transfusion		2 (16.7%)		2 (1.7%)	4 (6.3%)	1 (0.3%)

UP = upper pole; MP = mid pole; LP = lower pole; RA = renal artery; RV = renal vein.

Fluid absorption

Mechanism

The procedure of PCNL requires the use of large amounts of irrigating fluids continuously. Systemic absorption of this fluid can occur when there is disruption of the pelvicaliceal system(49).Absorption can also occur via the vessels that open up during tract dilatation or also during stone disintegration. Another route for fluid absorption is leakage of fluid into peritoneal space(50).

Estimation (Table 7)

Fluid absorption can be estimated by measuring the expired breath ethanol concentration (EBEC) with the help of Alcosensor, a device that is directly connected to the endotracheal tube. EBEC can be converted to the amount of irrigating fluid absorbed using a standard formula(32).Routine hemogram and electrolyte examination will also help in assessing the amount of fluid absorbed.(32)

Table 7 :Formula for calculating the irrigating fluid absorbed.

$$(2140 + 3430 \times \text{Eb-Ethanol I}) \times EB$$

$$+$$

$$(44 + 806 \times \text{Eb-Ethanol I})$$

EB = Change in Ethanol concentration during a 10 min period

Eb-Ethanol I = Ethanol at beginning of 10 min period

Factors affecting fluid absorption.

The volume of fluid absorbed increases with the amount of irrigation and duration of procedure. Placement of an Amplatz sheath with subsequent reduced pressure in the pelvicaliceal system reduced the amount of fluid absorption.(32)

Malhotra SK, et al reported that fluid absorption occurred in 78% of the PCNL patients and 28% had volume absorption more than 1 liter. The study also showed that volume of fluid absorption depended on volume of irrigation fluid, irrigation time and rate of irrigation. Mean of fluid absorption was 696.7 + 603 (0-1916.2) ml, absorption volumes were over 1 liter when the patients received more than 20 liters of irrigation fluid(51)

Methods to reduce fluid absorption include reducing the height of the irrigating bag, and use of Amplatz open drainage sheath to keep the pelvicaliceal pressure low.Large stones, if done in a staged manner also reduce the amount of fluid absorbed(49).

Hypothermia

Hypothermia is defined as a core temperature of $< 36^{o}$ C. Normal core is temperature is 37 C; maintained within $\pm$0.2C (interthreshold range) by an efficient thermoregulatory system; sweating at upper end and vasoconstriction at lower end.

Peripheral temperature of the limbs and skin is considerably less than the core; the difference maintained by vasoconstriction. Anaesthesia adversely affects system and interthreshold range increases from 0.2 to 4^{o} C & patient cools. It mainly results from anaesthetic-induced inhibition of thermoregulatory control and exposure to cold operating room environment. High volume fluid administration also accelerate loss of heat to the environment(52).

Hypothermia may be classified as mild (32°C – 35°C), moderate (28°C – 32°C) and severe (<28°C) (52, 53)

Perioperative hypothermia develops in three distinct phases: (1) anaesthetic-induced vasodilatation during induction of anaesthesia results in core-to-peripheral redistribution of body heat and decreases core temperature 1–1.5°C during the first hour of general anaesthesia; (2) subsequently core temperature decreases linearly as heat loss to the environment exceeds metabolic heat production; (3) after 3–5 h of anaesthesia, core temperature often stops decreasing. This core temperature plateau results from reactivation of thermoregulatory vasoconstriction which decreases cutaneous heat loss and constrains metabolic heat to the core thermal compartment.

Using a high volume of room temperature irrigation fluids could produce heat loss in the presented patients by some intravascular absorption through open injured vein and some from soaking internal organs after leakage into the perinephric space. Forced air warming blankets did not reduce hypothermia due to the small area of effective contact with the bodies. the major side effect of hypothermia in the presented patients was slow recovery from anesthesia and muscle relaxant.(26) Hypothermia might also

cause postoperative shivering, cardiovascular complication, wound healing, infection and bleeding (54, 55)

Cardiovascular changes

Vorrakitpokatorn *et al* reported cardiovascular changes (more than + 20% of the base line) in 57.1% of the patients during the perioperative period(26). Hypertension caused by hypervolemia from irrigation fluid absorption and/or from hormonal changes was found in 29.4% (51, 56). The report of Atici *et al* showed significant increase in ACTH, renin and aldosterone during surgery of PCNL that might cause an increase in blood pressure(57)

Organ injury

Pleural injury

Vorrakitpokatorn *et al* found 3/128 (2.3%) of the patients developed dyspnea in the early postoperative period. All of these patients were suspected pleural tear by the surgeon intraoperatively(26). In another study to assess retrospectively the safety and efficacy of the supracostal approach in percutaneous nephrolithotomy (PCNL) by Kekre *et al*, among 862 patients who underwent PCNL, supracostal puncture was performed in 102 patients. They reported an incidence of 9.8% of pleural violation in the form of

hydrothorax, pneumothorax, or hydropneumothorax. All of these patients were managed successfully by intercostal chest tube drainage(58)

Splenic injury

Splenic injury in the course of percutaneous nephrolithotomy is extremely rare. It occurs in cases of stone in the left kidney (59).Shah et al reported two cases of splenic injury that occurred during puncture of the 10th intercostal-space for PCNL. One of these patients presented with hypotension on day 5 after discharge from the hospital. Both patients needed emergency laparotomy, and one of them required splenectomy for management of the injury(60).

Intestinal injuries

Iatrogenic colon injury is an uncommon but serious complication. Diagnosis is sometimes delayed, and treatment strategies are still controversial, including conservative management, colostomy, or primary repair. The incidence of intestinal injuries in PCNL has been reported to vary from 0.35% to 1%.(61) High risk patients for colon injuries are young, lean males with minimal retroperitoneal fat, in whom a retro renal colon is more likely(62).

Electrolyte imbalances

Electrolyte imbalance in the postoperative period was reported as a minor complication without statistical significance ($p > 0.05$) by Vorrakitpokatorn *et al* and not related to the volume of irrigation fluid(26). Similar results were also observed by Koroglu A *et al*, Atici S, *et al* and Moorthy *et al* (10, 57, 63). These mechanisms are still not clear, they may be caused by complicated factors result from hormonal changes during operation(57),homeostasis of the body or anything else that should be followed by further study. Extravasation of irrigant fluid and infection, may predispose to electrolyte imbalance which can be life threatening. Ghai *et al* reported a case of massive extravasation of irrigant fluid producing severe metabolic acidosis, with life threatening electrolyte imbalance(64)

An alternative reason for the low incidence of electrolyte imbalance maybe that the irrigating fluid used in PCNL is normally saline since diathermy is rarely used, as opposed to TURP, and as a result, electrolyte imbalances are less common than in TURP(32).

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MATERIALS AND METHODS

Type of study: A prospective cohort study.

Study setting: The study was conducted in Department of Anaesthesia, Christian Medical College Hospital, Vellore, a 2500 bedded academic medical centre in South India with an average of 1815 inpatients and approximately 4000 out- patient visits every day.

Duration of study: November 2009 to March 2010

Inclusion criteria: All ASA Grade 1 and Grade 2 patients aged between 18 and 65 years undergoing elective PCNL surgery in Christian Medical College, a tertiary care centre.

Exclusion criteria: Any patient age <17 yrs or >65 years or falling into ASA grade 3, 4, 5 or undergoing another procedure along with PCNL

Methodology: A total of 60 patients were included in the study during the study period from November 2009 to March 2010. Informed consent was taken from all patients. Intraoperative monitoring of blood pressure, heart rate, nasopharyngeal temperature, saturation, end-tidal carbon-di-oxide were done. These were observed prior to and during the procedure till the end of the surgery. A baseline arterial blood gas (ABG) sample was collected prior to start of the procedure for comparison of any changes that would occur

post operatively. Intra operatively, the volume and temperature of irrigation fluid used was noted. The temperature in the operating room was also be noted during the procedure. At the end of the surgery, patients' temperature was noted and a repeat ABG sample was collected. Changes in haematocrit, electrolytes, and lactates from baseline were noted to assess blood loss, dilutional anaemia, dilutional hyponatremia, and acidosis.

Sample size:

Was calculated based on the formula $n = (4pq)/d^2$, where

p, the expected prevalence

q=100- p

and d, the precision of study.

The value of "p" was determined as 57 from a previous study reported in literature. The precision of the study was fixed at 10. Applying the numbers, a sample size of 98 was reached. However, only 60 patients were enrolled in the study.

Data analysis: Data entry was done using the Statistical Package for the Social Sciences (SPSS) software package (version 16). Data is presented as mean $\pm$ standard deviation, frequency percentages or median and range. Descriptive statistics were calculated using SPSS software. Univariate analysis was performed between categorical variables using Chi-square test. Confidence intervals (CI) were calculated. Continuous variables were compared using T-test. Odds ratio (OR) was presented as measures of risk. All reported p

values are two-sided and a ‘p’ value less than 0.05 was considered statistically significant.

The study design and methods were approved by the Fluid Research Committee, Christian Medical College, Vellore

Standardisation of anaesthesia: All patients were brought into the operating room and a wide-bore peripheral intravenous access was established. After preoxygenation, all patients were induced with 5mg/kg body wt of thiopentone, 2mg/kg body wt of fentanyl and 1mg/kg body wt of vecuronium. Intubation was done using appropriate size cuffed oral endotracheal tubes and fixed after confirming equal air entry. Anaesthesia was maintained using a 50-50 mixture of air-O2 and isoflurane. Intra-operative analgesia was using morphine upto 0.15mg/kg body wt. Fluid management was guided by fasting and maintenance requirements, patient’s vital signs and the attending anaesthetist’s assessment of bloodloss. At the end of the procedure anaesthetic gases were discontinued, and patient reversed with neostigime and glycopyrrolate and extubated.

Data sources and measurements:

***i) Arrhythmia*:** continuous three lead ECG monitoring was done during the procedure and determined as defined above

***ii) Hypotension*:** continuous invasive arterial blood pressure monitoring was done during the procedure

***iii) Hypothermia*:** temperature was measured via a nasopharyngeal temperature probe inserted after the induction of anaesthesia and kept in place till extubation

v) Sepsis: the parameters defining sepsis were monitored and a diagnosis of sepsis was made if any two of the four criteria we***vi) Blood loss*** was calculated from the difference in hemoglobin calculated from the pre procedure baseline ABG and post procedure ABG

vii) Volume *of irrigation fluid*: was measured as number of bags of fluid used multiplied by 2 litres, which is the volume of one bag

viii) Temperature *of fluid* used: was determined as cold or warmed fluids

Definitions:

i) Arrhythmia was defined as bradycardia: heart rate <60 bpm,

tachycardia: heart rate>100 bpm.

Or any other rhythm changes noted on ECG monitoring

ii) Hypotension was defined as a fall in mean blood pressure to less than 15% of the baseline value.

iii) Hypothermia was defined as a nasopharyngeal temperature recording of < 35 °C.

iv) Sepsis was defined as when two or more of these criteria are present:

a)Body temperature <36°C or >38°C

b)Heart rate > 90 beats per minute

c)Tachypnoea > 20 breaths per minute; or, an arterial PCO2 < 32 mmHg

d) WBC less than 4000 cells/mm³ (4 x 10^9 cells/L) or greater than 12,000 cells/mm³ (12 x 10^9 cells/L); or the presence of greater than 10% band forms

***v) Blood loss*:** as amount of blood lost during the procedure.

RESULTS

1) **Population Demographics:**

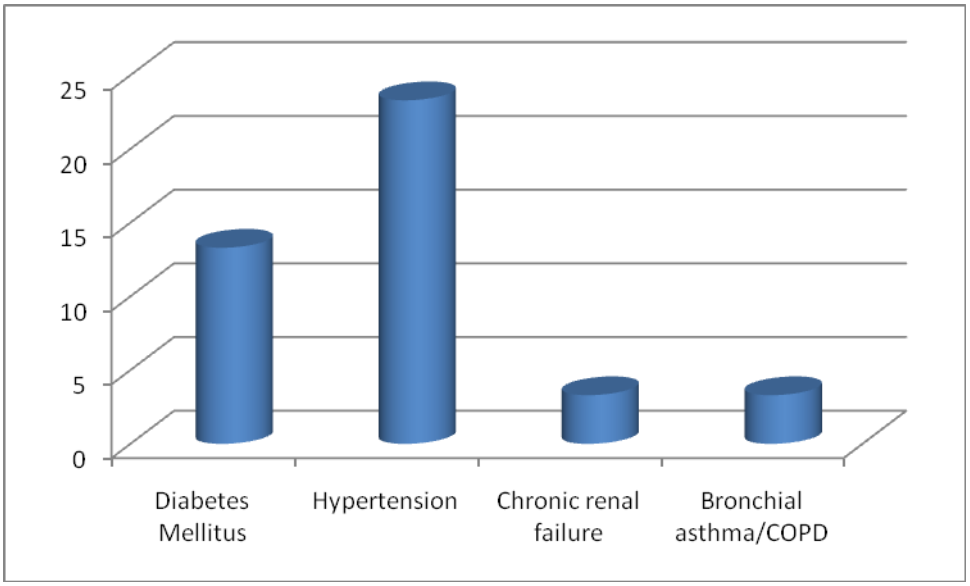
Population Demographics	(N=60)
Mean Age(SD)	39.9(10.53)
Males(%) Females(%)	42(70%) 18(30%)

The mean age of the population studied was 39.90 years with a standard deviation ± 10.53 years.

The patients ranged from a minimum age of 15 years to a maximum age of 65 years.

Of the 60 patients in the study, 18 were females (30%) and 42 were males(70%)

2) Co-morbidity Profile

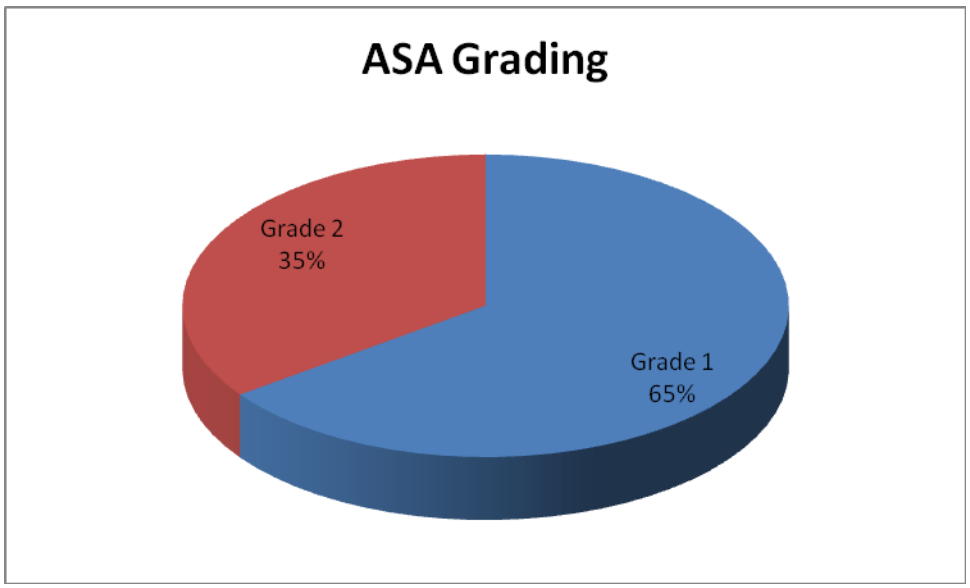


40 out of 60 patients(66.7%) had no comorbid conditions existing.

The most common comorbid condition present was hypertension with 14 out of 60 patients(23.3%).The others were Type 2 Diabetes Mellitus 8 out of 60(13.3%),chronic renal failure and bronhial asthma/COPD both with a prevalence of 3.3%(2 out of 60).None of the patients had Ischaemic heart disease.

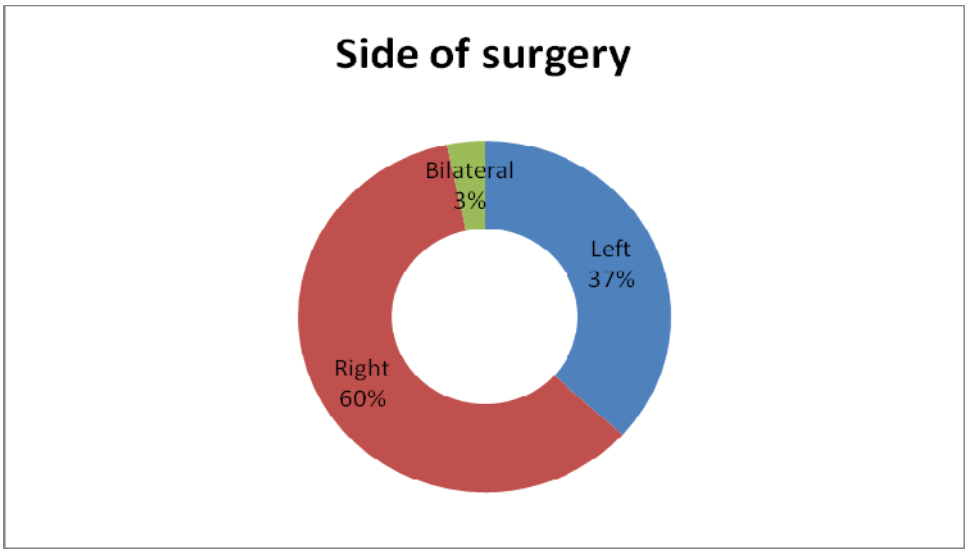
16 patients had only any one comorbid illness while 4 patients had multiple comorbid illness (presence of 2 or more than 2 comorbid illness) existing.

3) ASA Grade:



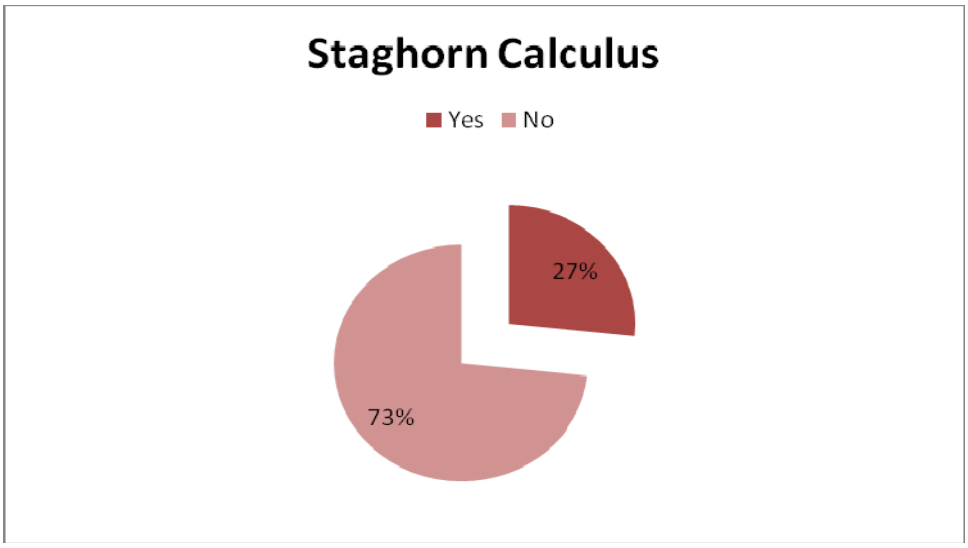
40 patients were catergorised as ASA grade 1 while 20 patients belonged to ASA grade 2.

4) Side of surgery



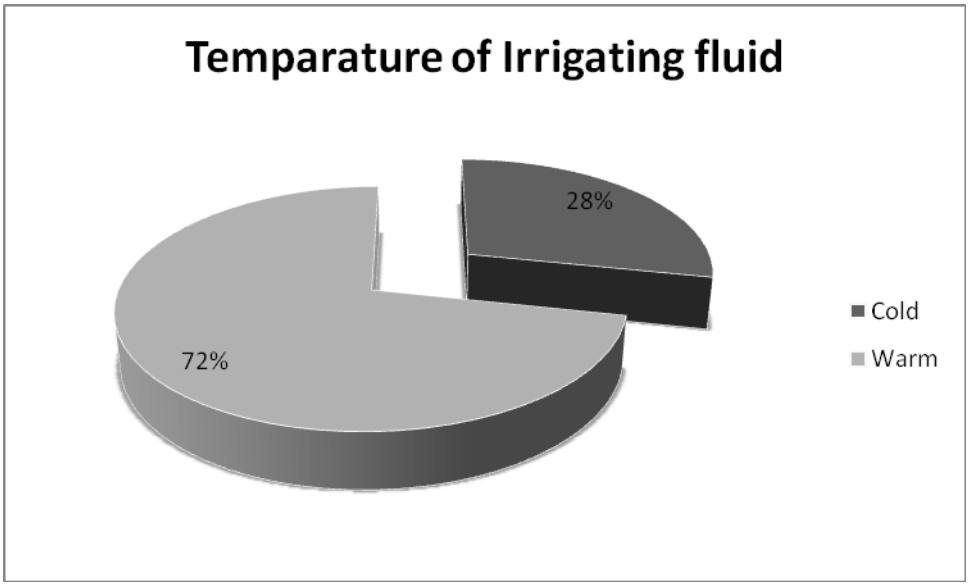
Of the 60 patients who underwent PCNL surgery, 22 patients underwent left-sided surgery, 36 underwent right-sided surgery while 2 patients underwent bilateral surgery.

5) Staghorn Calculus



16 out of 60 patients were diagnosed to have staghorn calculus.

6) Temparature of Irrigating Fluid:



The irrigating fluid was warmed and used in 72% of the cases(43 out of 60),while cold irrigating fluid was used in 28% of the cases(17 out of 60 patients)

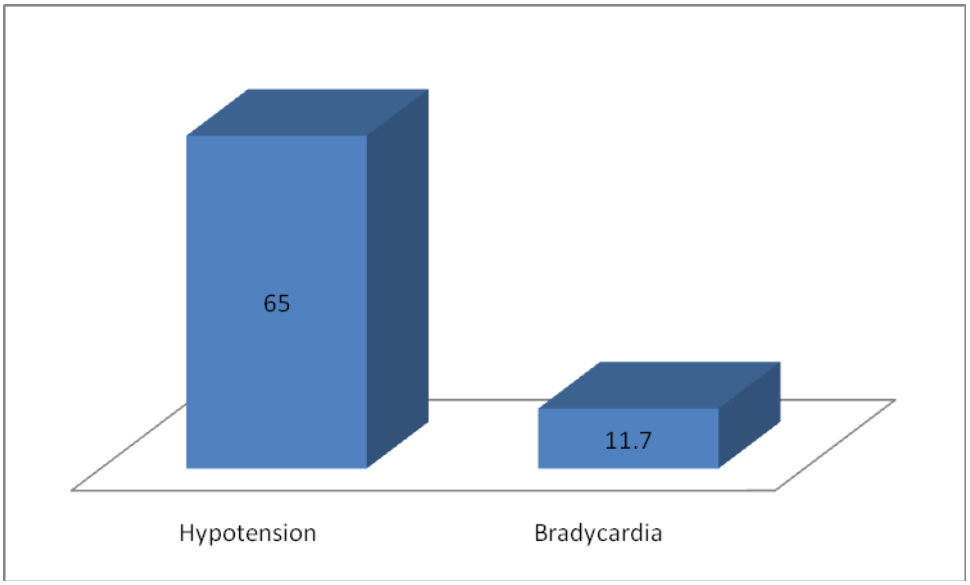
7) Perioperative period characteristics.

Characteristic	**Mean(SD)**
Mean Blood pressure(mmHg)	86.27(16.14)
Mean temperature(Celsius)	36.08(.41)
Mean heart rate(bpm)	82.27(16.48)
Mean Haematocrit(%)	38.38(7.68)
Mean Ambient temperature in theatre(Celsius)	22.62(1.18)
Mean duration of surgery (hrs)	2.30(.833)
Mean volume of Intravenous fluid used(litres)	1.52(.84)
Median volume of Irrigating fluid used(litres)	24(13.87)

The mean baseline blood pressure was 86.27 mmHg with a std deviation of 16.14mmHg and the mean baseline heart rate was 82.27bpm with a std deviation of 16.48bpm.The mean baseline temperature was 36.08 degree Celsius with a standard deviation of 0.41degree Celsius.The mean haematocrit was 38.38 % with a standard deviation of 7.68%.The mean duration of surgery was 2.30 hours with a standard deviation of 0.83 hours.The mean volume of intravenous fluid used was 1.52 litres with a standard deviation of 0.84.The volume of irrigating fluid used ranged from 6 litres to 84 litres with a median value of 24 litres

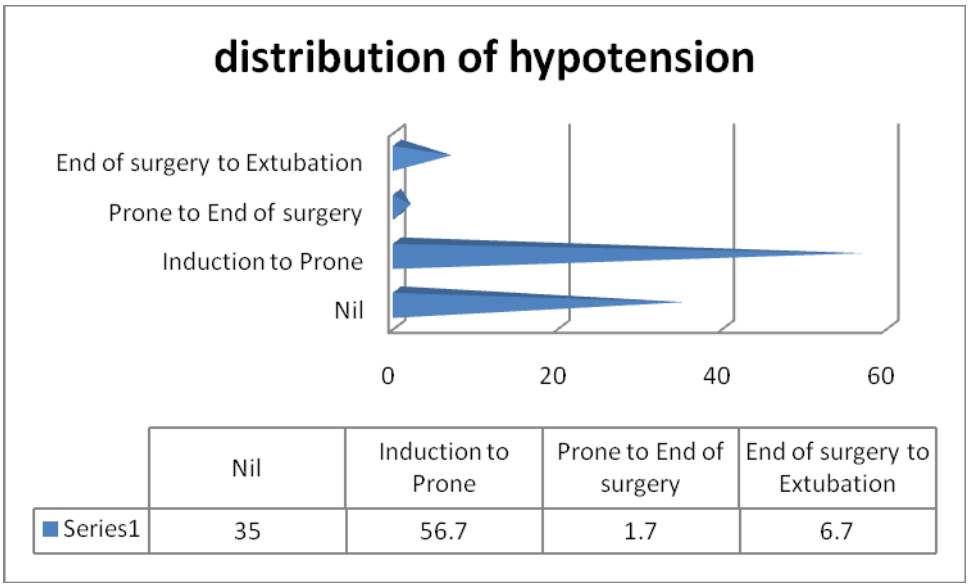
B) OUTCOME MEASURES

Hypotension and Bradycardia



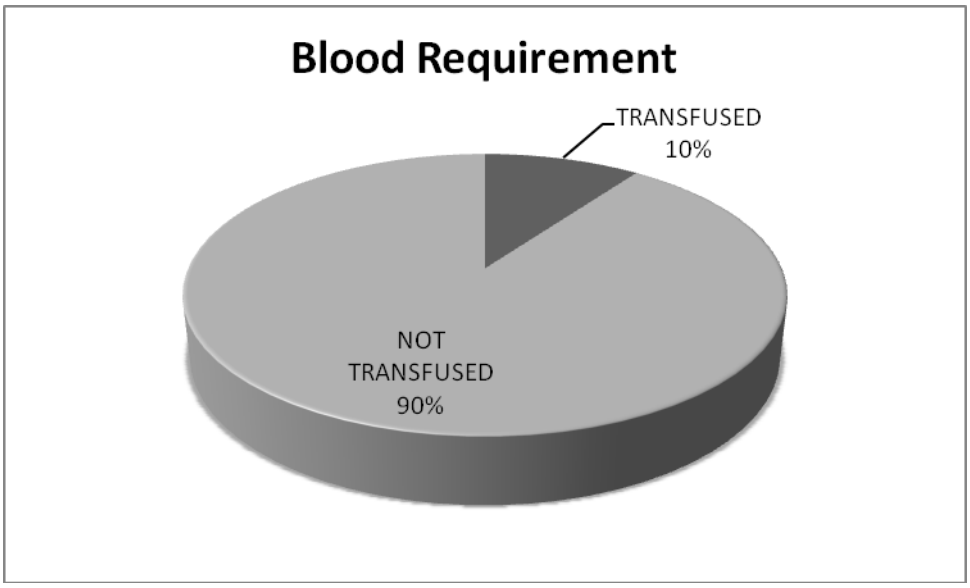
Of the 60 patients,only 7 patients patients had documented bradycardia intraopeartively.None of the patients had and episodes of arrythmia.

On the other hand,39 out of 60 patients(65%) had a drop in blood pressure at some point of time intraoperatively,while 21 patients (35%) never had any hypotension.



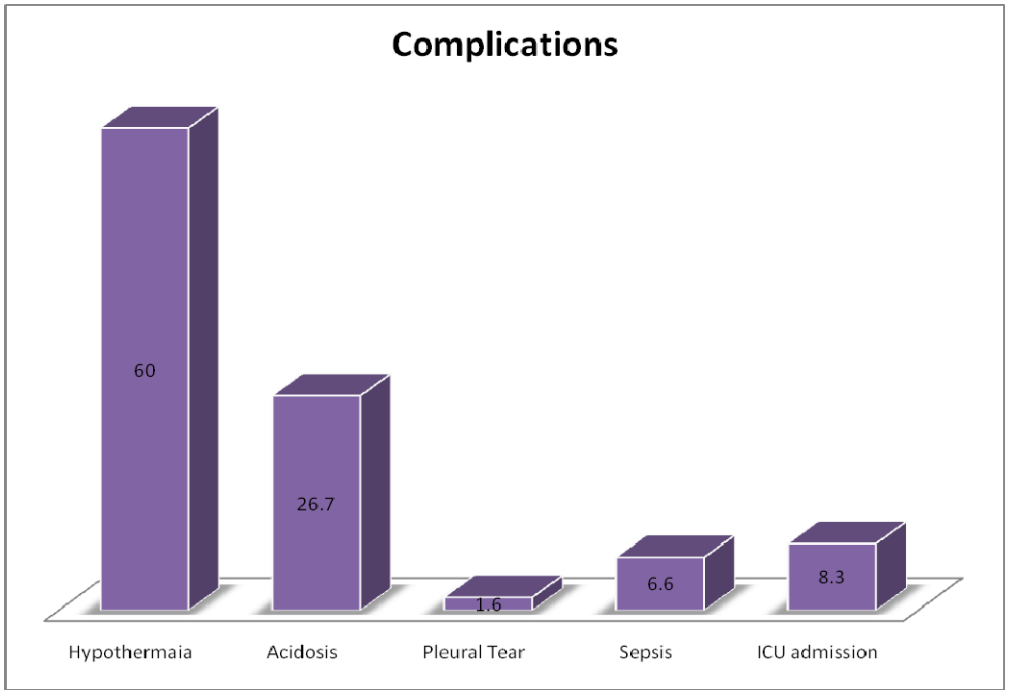
Of those who had intraoperative hypotension,the majority of patients,56.7%(34 of 60)had hypotension after induction till the time of turning prone.Only 1 patient had hypotension lasting through the duration of the surgery.4 patients had hypotension even after the surgery was over till the time of extubation.

Blood requirement



6 out of 60 patients (10%) had recieved intraoperative transfusion,while 90% of patients(54 out of 60) did not require transfusion .

Other Complications



The most common complication that occured intraoperatively was noted to be hypothermia with 60%(36 out of 60) of patients becoming hypothermic during the surgery.

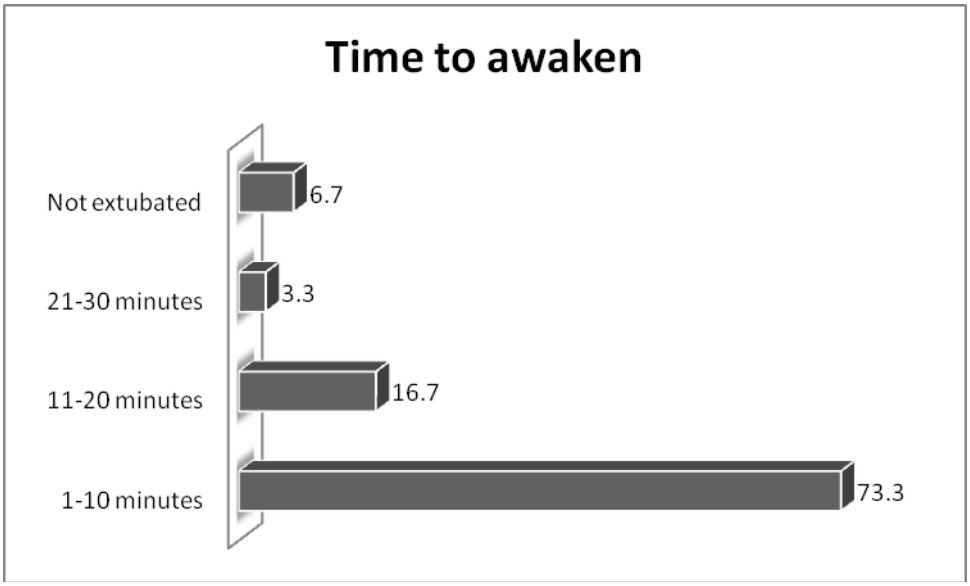
The next most common complication was acidosis with 16 out of 60 aptients(26.7%) observed to be acidotic by the end of the surgery.

4 out of 60 patients(6.6%) developed perioperative sepsis

1 patient (1.6%)sustained a pleural tear and developed hydrothorax.

5 out of 60 patients(8.3%) needed postop ICU care for their complications of sepsis and hydrothorax.

Time to awakening



Most of the patients woke up within ten minutes of cessation of anaesthesia.(73.3%,ie 44 out of 60 patients).

16.7% of patients(10 patients) took upto 20 minutes for awakening.

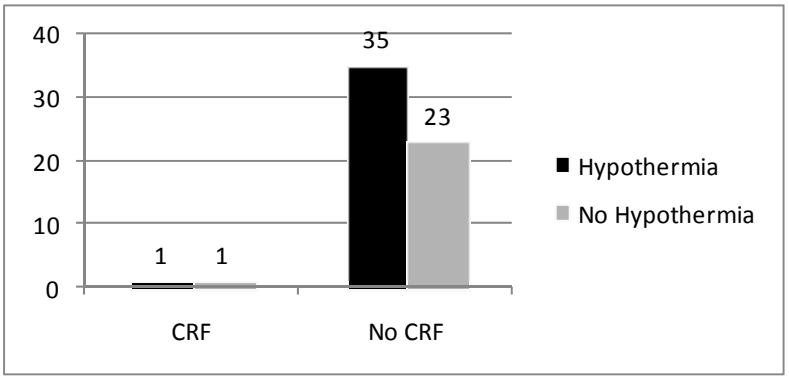
2 patients (3.3%) woke up only after 20 minutes of anaesthesia.

4 patients were not extubated in view of complications.

C) RISK FACTORS

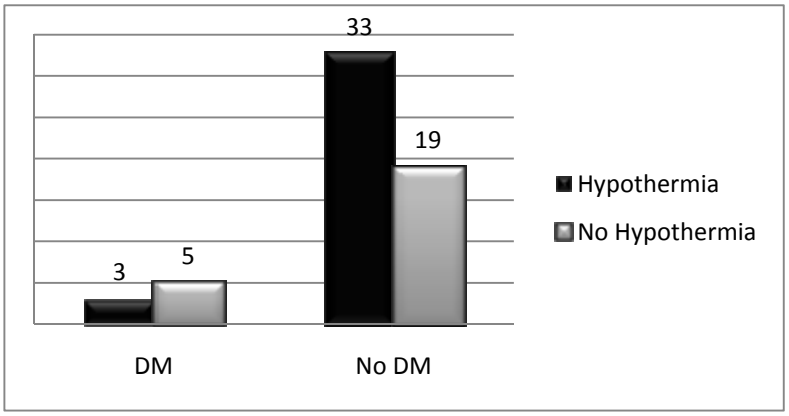
I)HYPOTHERMIA

Hypothermia and CRF



Of 2 pateints who had Chronic Renal Failure,1 developed intraoperative hypothermia while the other did not. As such,the results were not statistically different.p-value 0.76.

Hypothermia and Diabetes Mellitus



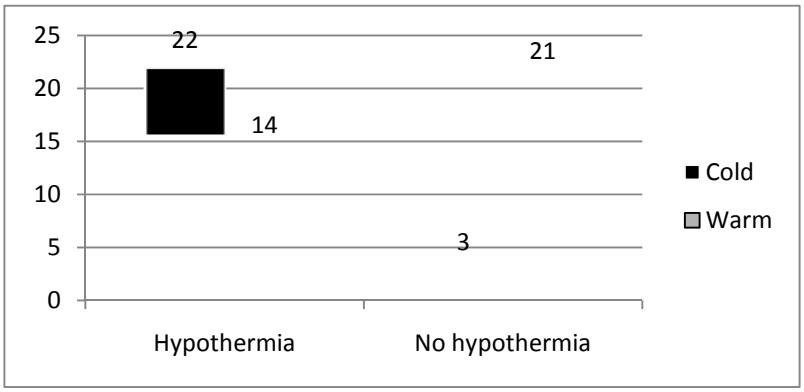
Of 8 patients who had Diabetes, only 3 developed intra-operative hypothermia. With a p-value of 0.163, this association was not significant.

Hypothermia and duration of surgery

	Hypothermia		P value
	Present	Absent	.077
Duration of surgery(hours)	2 hrs 45 min	2 hrs 6 min	

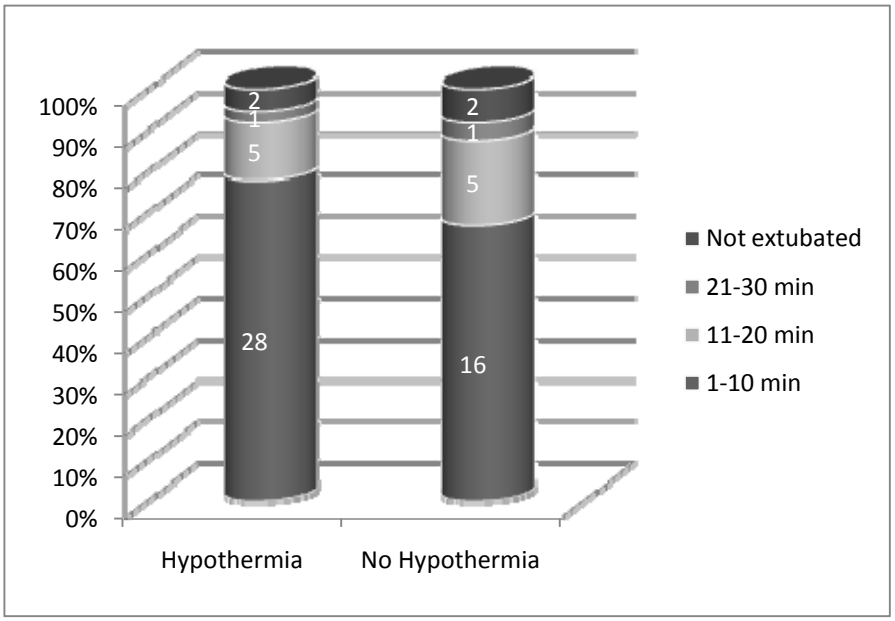
The mean duration of surgery in those patients who developed hypothermia was 2.45 hrs as compared to 2.06 hrs in those who did not. With a p-value of 0.077, this was not significant.

Hypothermia and Temperature of Irrigating fluid



Of 36 patients who developed hypothermia, 22 patients had been irrigated with cold fluids. Of the 24 patients who were irrigated with warm fluid, only 3 developed hypothermia. With a p-value of 0.026 and an Odds Ratio (OR) of 0.22, this result was statistically significant; indicating that the risk of hypothermia was increased when cold irrigating fluid was used as opposed to warm fluid.

Hypothermia and delayed awakening



There was no statistically significant difference in the awakening time between those who had hypothermia and those who did not. P-value 0.82

Hypothermia and volume of irrigating fluid

	Hypothermia		P value
	Present	Absent	.083
Volume of irrigating fluid(Mean) in Litres	29.42	23.08	

The mean volume of irrigating fluid used in patients who had hypothermia was 29.42 litres while it was 23.08 litres in those who did not. With a p-value of 0.083, this was not significant.

Hypothermia and ambient temperature

	Hypothermia		P value
	Present	Absent	.193
Ambient temperature of theatre(°C)	22.46	22.87	

The ambient temperature inside the operating theatre did not have any statistically significant association with hypothermia, with a mean temperature of around 22°C in those who had hypothermia as well as those who did not. p-value 0.193

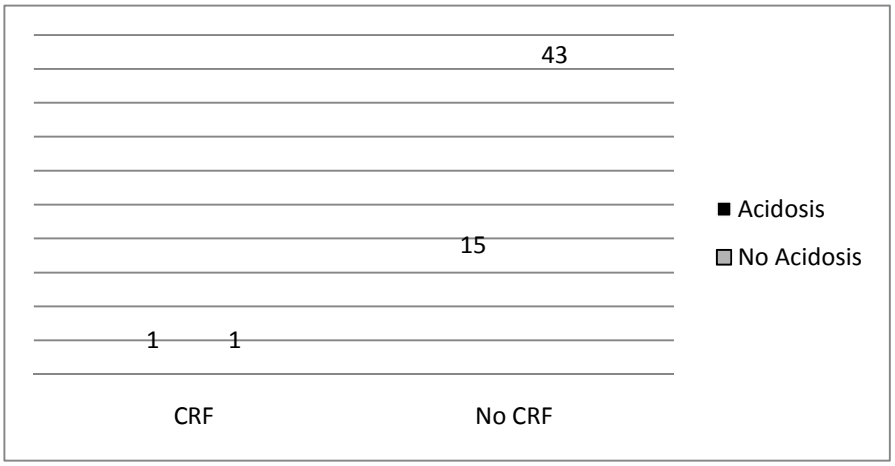
Hypothermia and volume of IV fluid

	Hypothermia		P value
	Present	Absent	.148
Total IV fluid(Litres)	1.65	1.33	

Though the total volume of Intravenous fluids administered was higher in those who developed hypothermia when compared to those who did not, this observation was not statistically significant. p-value 0.148

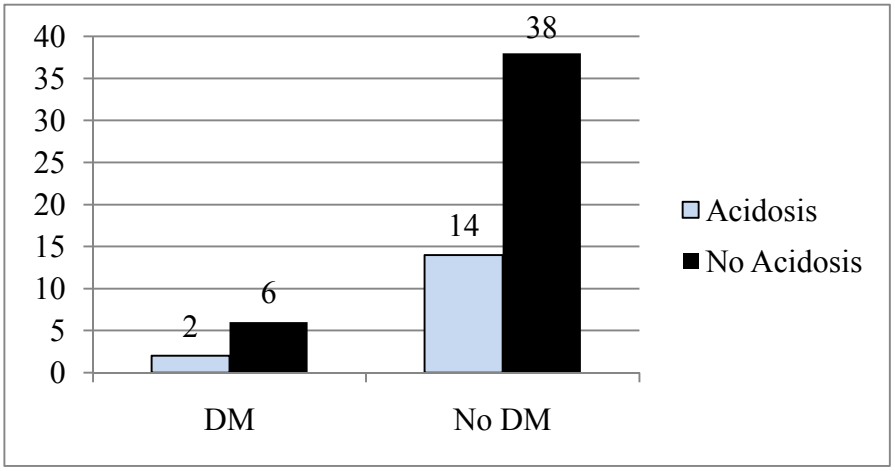
II) ACIDOSIS

Acidosis and CRF



Of the 2 patients who had CRF,1 patient developed acidosis,while the other did not.With a p-value of 0.45, this association was not significant.

Acidosis and Diabetes Mellitus



There was no statistically significant association between DM and intra-operative acidosis. p-value 0.9

Acidosis and duration of surgery

	Acidosis	No Acidosis	P value
Mean duration of surgery(hrs)	2 hrs 39 min	2 hrs 26 min	0.6

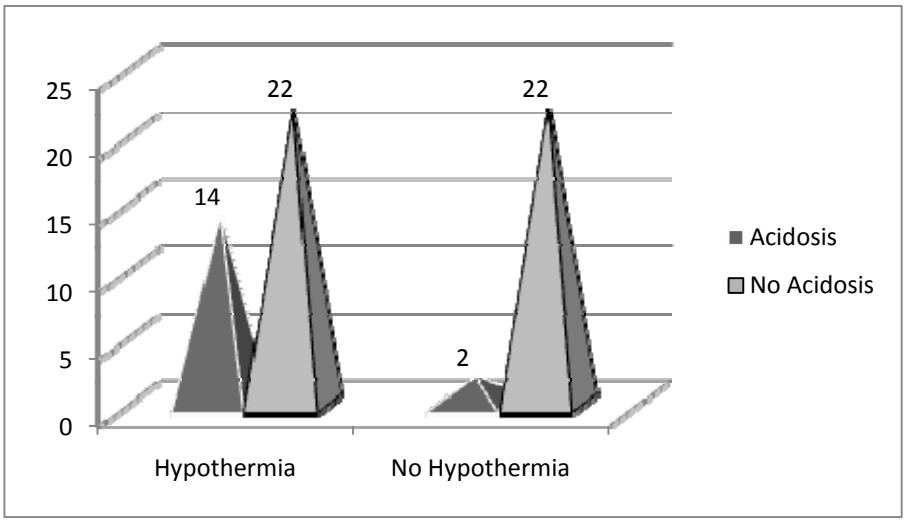
There was no significant difference among those who developed acidosis and those who did not with respect to the duration of surgery, with a mean duration of 2.39 hrs in the former group and 2.26 hrs in the latter group. p-value 0.6

Acidosis and volume of irrigating fluid

	Acidosis	No Acidosis	P value
Volume of irrigating fluid(Mean) in Litres	33.5	24.48	.025

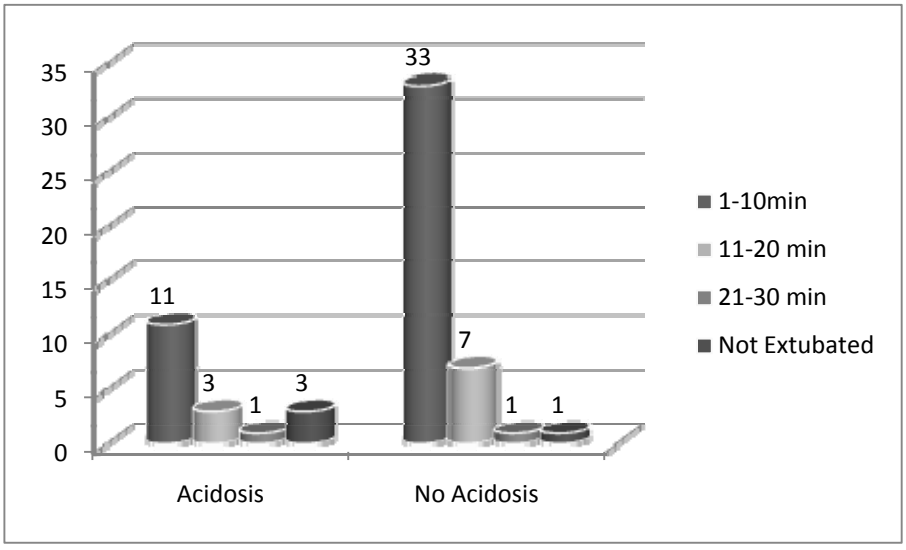
The mean volume of irrigating fluid was significantly higher in those patients who developed acidosis (33.5 litres), as compared to those who did not develop acidosis (24.4 litres).This result was statistically significant. p-value 0.025

Acidosis and hypothermia



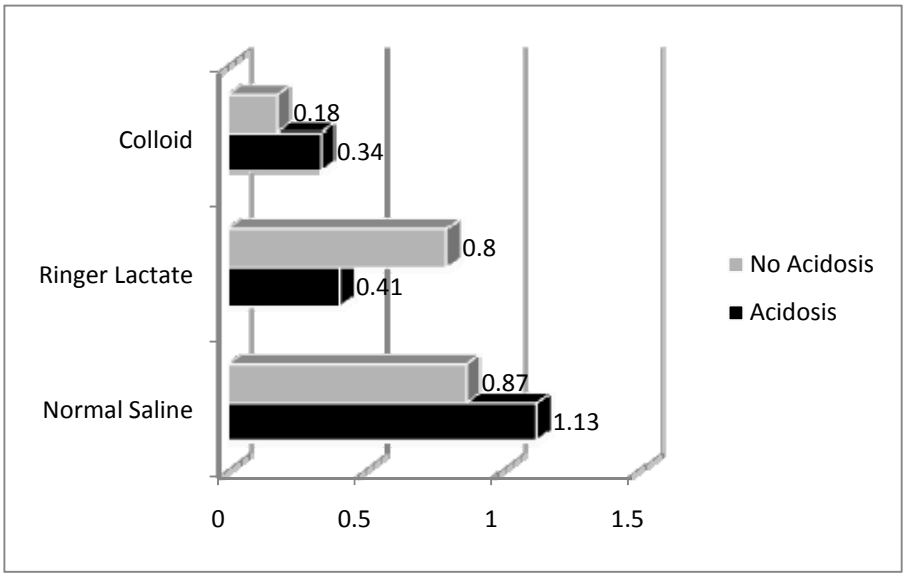
Among the 16 patients who developed acidosis, 14 also had hypothermia. This association was significant with a p-value of 0.02.An Odds Ratio of 7.00 indicated that the presence of hypothermia was a risk factor for developing acidosis.

Acidosis and delayed awakening



There was no statistically significant association between the presence or absence of acidosis and the time to awaken after anaesthesia.p-value0.88

Acidosis and volume of IV fluid

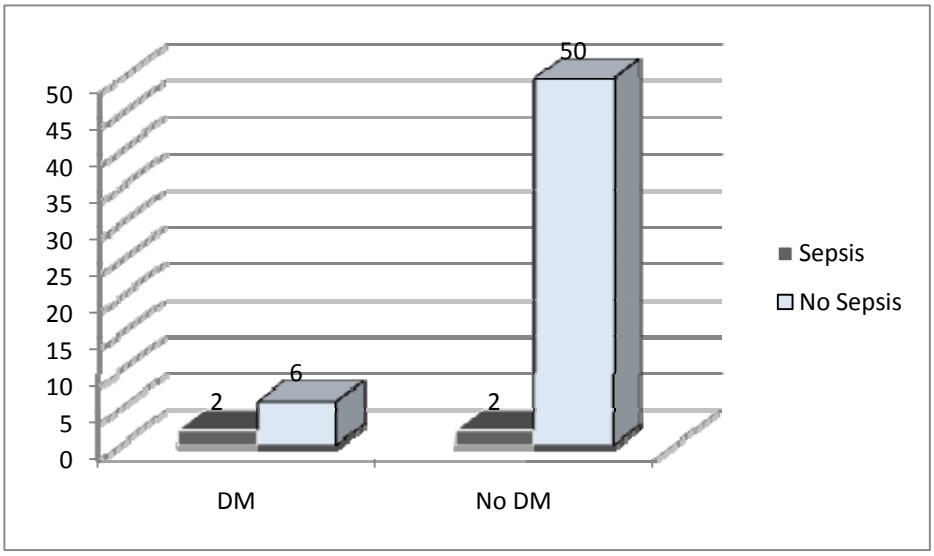


The mean volume of intravenous fluid (IVF) administered in those patients who developed acidosis was higher than in those who did not (1.65 litres and 1.33 litres respectively). However, this difference was not statistically significant.

Comparing the different IV fluids, patients who were administered more Normal Saline (NS) developed acidosis. This difference was statistically significant. P-value 0.01.Those who were given more NS-based colloids as opposed to Ringer Lactate showed a trend towards significance in developing acidosis. p-value 0.09.

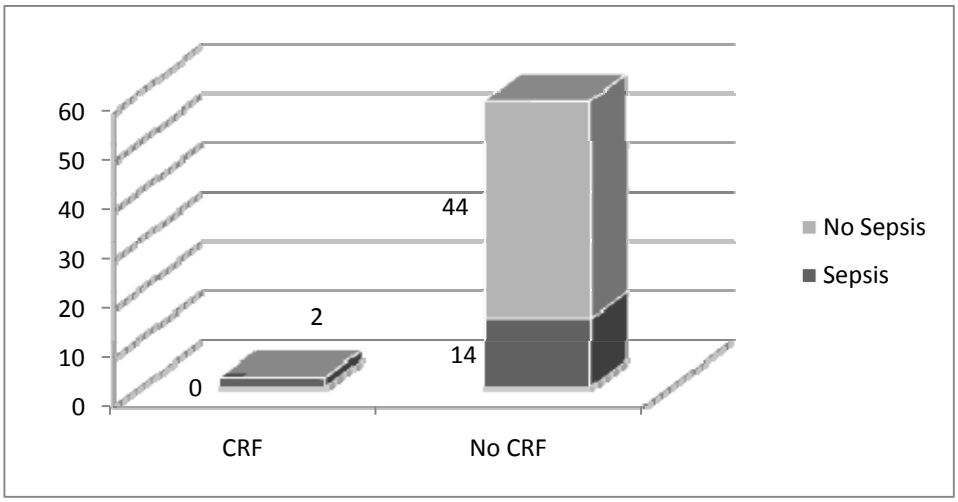
III) Sepsis

Sepsis and Diabetes Mellitus



The incidence of sepsis was significantly higher in those patients who had Diabetes Mellitus as a risk factor. With a p-value of 0.026, this result was statistically significant, with an Odds Ratio of 8.3 indicating an increased risk of sepsis associated with Diabetes

Sepsis and CRF



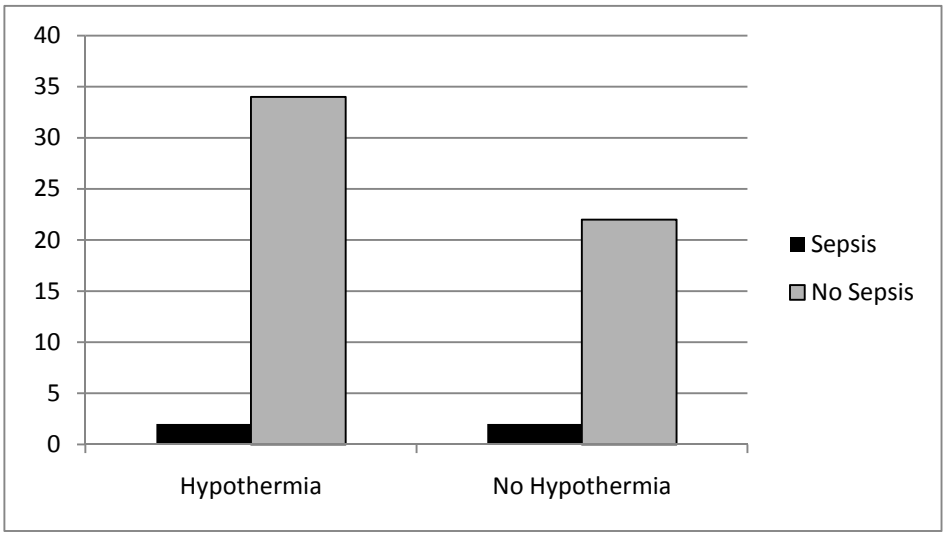
The presence of CRF was a significant predictor in the development of sepsis.p-value <0.01,with an Odds Ratio 28 indicating the increased risk of developing sepsis with CRF

Sepsis and stone size

	Sepsis	No sepsis	P value
Mean stone size(cm)	2.3	2.7	.59

There was no significant association between the size of the renal calculi and the incidence of sepsis. The mean stone size was around 2.5 cm in both the groups. p-value 0.59

Sepsis and hypothermia



There was no statistically significant association between sepsis and the presence or absence of hypothermia.p-value 0.67

IV) Blood transfusion

Blood transfusion and stone size

	Blood transfusion		P value
	Given	Not given	.55
Mean stone size(cm)	2.98	2.64	

There was no statistically significant association between the incidence of blood transfusion and the size of the calculi. p-value : 0.55

Blood transfusion and duration of surgery

	Blood transfusion		P value
	Given	Not given	.04
Mean sugery duration(hrs)	2.94	2.22	

The mean duration of surgery in those who received blood transfusion intra-operatively was 2.94 hrs and in those who did not receive blood was 2.22 hrs. This association was statistically significant with a p-value of 0.04

Blood transfusion and baseline haematocrit

	Blood transfusion		P value
	Given	Not given	<.01
Baseline hct (%)	26.5	39.7	

In the patients who received blood transfusion intra-operatively, the baseline haematocrit was 26.5%.In those patients who did not receive a transfusion, it was 39.7%.This association was statistically significant. p-value <0.01

The mean blood loss was 380ml (SD 78 ml)

The average drop in haematocrit in our study was 4.14 % (SD .64).

DISCUSSION

In the current day practice, Percutaneous Nephrolithotomy (PCNL) is a very common treatment option available in the management of renal stones. Compared to the earlier treatment option of open surgery, it is associated with less number of complications. This leads to lesser rates of morbidity and lesser hospital stay, and thus is preferred to open surgery.

However, PCNL procedure is not with out its own set of complications. All these complications, though listed out in literature, have not very well been quantified. In our institution, which is a tertiary care centre hospital, an average of 25 PCNL surgeries are being done every month. In this scenario, we felt it would be worthwhile to know the profile of complications and factors associated with them. This would help to institute appropriate measures to try and limit their incidence and thus provide better quality health care.

In our study, a total of 60 patients who underwent elective PCNL surgery was studied. Majority of patients were ASA grade 1 and there was a predominance of males in the study.

COMPLICATIONS OF PCNL

In our study the most common intraoperative complication encountered was hypothermia and the second most common complication was acidosis.60% of our patients were documented to have hypothermia and 26.7% of the patients had acidosis as evidenced by an Arterial Blood Gas at the end of the procedure. Studies done earlier have not found hypothermia or acidosis as a major complication.

In 2007, *Michel et al* presented a total complication rate of up to 83% following PCNL, in which hypothermia or acidosis did not feature at all(15).They presented their findings as major and minor complications, of which minor complications were more common. Bleeding requiring transfusion was listed as the most common complication. Others included insignificant bleeding, pain and fever(15).

Two other studies done in 1998 and 2007 by *Havel et al* and *Turna et al* respectively project most common major complications of PCNL as septicemia (4.1%) and bleeding requiring blood transfusion(2.7%)(17, 18)

HYPOTHERMIA

In our study, we found hypothermia to be the most common complication that occurred during PCNL surgery. Our study had a 60% incidence of hypothermia. We found a statistically significant positive correlation between the presence of hypothermia and the

temperature of irrigating fluid used. We also observed that there was a correlation between the volume of irrigating fluid used and duration of surgery with hypothermia. However these values were not statistically significant which could possibly be due to the small number of sample size studied.

In 1997 a study done by *Al-Shammare et al,* also found a positive correlation between hypothermia and the duration of surgery. They reported in their series of 9 children that, when the duration of surgery exceeded 150 minutes, 2 children had hypothermia. In our study the mean duration of surgery was 150 minutes (2.30 hrs).

We also compared the incidence of hypothermia with the ambient temperature in the operating room. The mean ambient temperature in the operating room in our study was 22.6°C. However, we found no positive correlation between the two. This could probably be because we took adequate measures to cover the patient well soon after induction of anaesthesia to prevent losing body temperature to the environment. We also used forced air warming devices. Inspite of this, the single most important factor that contributed to patients developing hypothermia was the use of cold irrigating fluids.

We also compared the presence of hypothermia and the volume of intravenous fluid used. There was no positive correlation. Presence of CRK or DM also did not seem to add any further risk to the development of hypothermia. Even though hypothermia is known to delay awakening from anaesthesia, in our study we found no positive correlation between

the two. One reason for this could be the time lines set for assessing time to awaken after the discontinuation of anaesthetic gases.

SEPSIS

In our study, the incidence of sepsis was 6.6%.This is comparable to earlier done studies. *Michel et al* in their series reported an incidence of 0.3%-4.7% of sepsis. *Vorrakitpokatorn* et al have reported that in their series, they encountered sepsis with an incidence of 0.9% to 4.7%. However some studies have reported a much higher incidence. *Rao et al*, in their series has reported as high an incidence as 37% for postoperative bacteremia (24).

In our study, we analysed the incidence of sepsis with respect to the presence of DM preoperatively. We found that the presence of DM had a positive correlation to the incidence of sepsis. In fact, the presence of DM tends to increase the risk of developing sepsis (Odds Ratio 8.3).

On analysis of incidence of sepsis with respect to presence of CRF preoperatively, we found a significant relationship between the two with the presence of CRF increasing the risk for perioperative development of sepsis(OR 28).This is comparable to a study done by *Skolarikos et al*, who described an increased incidence of sepsis with presence of preoperative Type II DM and renal insufficiency(29).They also reported that increased pressure of irrigating fluids increased the risk of sepsis.In our study we did not measure

the pressure of irrigating fluids. Rao *et al* also reported stone size and staghorn calculi to increase the incidence of sepsis (24). However, in our study we did not find any positive association between stone size and the incidence of sepsis.

HYPOTENSION

Earlier studies report cardiovascular changes of hypotension and hypertension as a major complication of PCNL. *Vorrakitpokatorn et al*, in their series in 2006 reported an incidence of 57.1% of intraoperative hypotension (26). In our study also, intraoperative hypotension was found to have an incidence of 65%(39 out of 60 patients).However, on further analysis, we found that the period when hypotension occurred most (in terms of frequency and degree) was soon after induction of anaesthesia. 34 out of the 39 patients had a drop in blood pressure readings during this time. This could be due to intravenous and inhalational anaesthetic agents, as well as a lack of surgical stimulus. This therefore cannot be considered as a major complication of PCNL surgery per se as this would occur during any surgery under anaesthesia.

On the other hand, hypotension due to the PCNL procedure would be expected to occur after the commencement of surgery and present till the end of surgery. The incidence of this group in our study was 6.7%.These patients had significant hypotension and only 1.7% of these reached back to normal preoperative levels for extubation.

Hypertension has also been reported as a major cardiovascular event that occurred during PCNL surgery. This has been attributed to the hypervolemia caused by absorption of irrigation fluid. However in our study we did not find any significant hypertension in patients at the end of the procedure.

BLEEDING AND BLOOD TRANSFUSION

Michel et al has reported the incidence of bleeding during PCNL surgery to vary from 0.6%-1.4% (15).In our study the blood loss was estimated from post-operative decrease in haematocrit and blood transfusion. The mean blood loss estimated was 380 ml (SD 78 ml).The average drop in haematocrit in our study was 4.14 % (SD .64). This is similar to previously done studies. *Kukreja et al* reported an average hemoglobin drop of 1.68 +/- 1.23 g / dL hemoglobin (36)

Most of the times, the bleeding that occurs during surgery have been managed conservatively. The incidence of bleeding requiring transfusion has been reported to be varying from 7%-23% in various studies (34, 36, 38).Michel et al reported an incidence less than 8% their series (15). The transfusion rate in our study was higher. 10% of our patients had received intraoperative blood transfusion. The rate of bleeding requiring interventions has been reported to be less than 1%.Though 5% of our patients could not have complete stone-free retrieval due to abandonment of surgery because of excessive bleeding; none of them needed any intervention for it other than blood transfusion.

Kukreja et al reported the incidence of blood transfusion to be related to the duration of surgery and intraoperative complications (34). We compared the incidence of blood transfusion with the duration of surgery the stone size and baseline haematocrit. We found statistically significant association between the incidence of blood transfusion and the duration of surgery as well as baseline haematocrit value. However, there was no significant association between size of the calculus and the incidences of blood transfusion. These results are comparable to reports in literature.

PLEURAL TEAR

Pleural tear has been reported as a major complication of PCNL surgery. *Michel et al*, reported an incidence of 2.3% - 3.1 %(15). In our study we had 1 patient out of 60, ie; 1.6% who developed a hydrothorax after pleural injury due to a supracostal puncture route. There were no patients who developed a pleural injury after subcostal puncture route. This is comparable to studies done in literature which report a 0%-1.4% incidence of hydrothorax or pneumothorax after subcostal access and a 4%-15% incidence with supracostal route puncture. There was also no incidence of pleural effusion after subcostal access.

OTHER ORGAN INJURY

Splenic laceration and bowel perforation are other visceral organ injuries listed as major complications of PCNL procedure in literature. In our study, none of the patients had any

visceral organ injury. Splenic laceration has been reported to be very rare after PCNL surgery and is reported to have increased likelihood after a 10^{th} rib supracostal puncture. The incidence of bowel perforation, namely colonic injuries have been reported to be 0.3%-0.8%

LIMITATIONS

1) The predominance of ASA grade 1 patients in the study itself would reduce the incidence of morbidity associated with the surgery.

2) The recommended target of sample size could not be reached during the time period of the study. This could have influenced the rate of complications in the study.

3) The amount of blood lost could not be estimated accurately because the loss is always mixed with irrigation fluid. Replacement of blood loss was guided by visual assessment of loss and by patient's vital signs.

CONCLUSIONS

1) The most common complication observed intraoperatively was hypothermia, followed by acidosis and sepsis.

2) The most significant risk factor associated with hypothermia was found to be the usage of cold irrigating fluid..

3) The presence of hypothermia and increased use of intravenous Normal Saline contributed to higher incidence of acidosis

4) Electrolytes imbalance and cardiovascular changes were not observed as major complications.

5) An increased incidence of sepsis was seen in the presence of Diabetes Mellitus ad renal insufficiency.

BIBLIOGRAPHY

1. Paik ML, Wainstein MA, Spirnak JP, Hampel N, Resnick MI. Current indications for open stone surgery in the treatment of renal and ureteral calculi. J Urol. 1998 Feb;159(2):374-8; discussion 8-9.
2. Falahatkar S KI, Roshan ZA, Golshahi M, Emadi SA. Decreasing the complications of PCNL with alternative techniques including complete supine PCNL and subcostal approach. Pak J Med Sci. 2009;25(3):353-8.
3. Wong MY. Evolving technique of percutaneous nephrolithotomy in a developing country: Singapore General Hospital experience. J Endourol. 1998 Oct;12(5):397-401.
4. Gravenstein D. Extracorporeal shock wave lithotripsy and percutaneous nephrolithotomy. Anesthesiol Clin North America. 2000 Dec;18(4):953-71.
5. Fernstrom I, Johansson B. Percutaneous pyelolithotomy. A new extraction technique. Scand J Urol Nephrol. 1976;10(3):257-9.
6. Mohta M, Bhagchandani T, Tyagi A, Pendse M, Sethi AK. Haemodynamic, electrolyte and metabolic changes during percutaneous nephrolithotomy. Int Urol Nephrol. 2008;40(2):477-82.
7. Chaussy C, Schmiedt E, Jocham D, Brendel W, Forssmann B, Walther V. First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. J Urol. 1982 Mar;127(3):417-20.
8. Segura JW. The role of percutaneous surgery in renal and ureteral stone removal. J Urol. 1989 Mar;141(3 Pt 2):780-1.
9. Rassweiler J, Sentker L, Seemann O, Hatzinger M, Stock C, Frede T. Heilbronn laparoscopic radical prostatectomy. Technique and results after 100 cases. Eur Urol. 2001 Jul;40(1):54-64.
10. Koroglu A, Togal T, Cicek M, Kilic S, Ayas A, Ersoy MO. The effects of irrigation fluid volume and irrigation time on fluid electrolyte balance and hemodynamics in percutaneous nephrolithotripsy. Int Urol Nephrol. 2003;35(1):1-6.
11. Brannen GE, Bush WH, Correa RJ, Gibbons RP, Elder JS. Kidney stone removal: percutaneous versus surgical lithotomy. J Urol. 1985 Jan;133(1):6-12.
12. Clayman RV, Surya V, Miller RP, Castaneda-Zuniga WR, Smith AD, Hunter DH, et al. Percutaneous nephrolithotomy: extraction of renal and ureteral calculi from 100 patients. J Urol. 1984 May;131(5):868-71.
13. Preminger GM, Clayman RV, Hardeman SW, Franklin J, Curry T, Peters PC. Percutaneous nephrostolithotomy vs open surgery for renal calculi. A comparative study. JAMA. 1985 Aug 23-30;254(8):1054-8.
14. Segura JW, Patterson DE, LeRoy AJ, Williams HJ, Jr., Barrett DM, Benson RC, Jr., et al. Percutaneous removal of kidney stones: review of 1,000 cases. J Urol. 1985 Dec;134(6):1077-81.
15. Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. Eur Urol. 2007 Apr;51(4):899-906; discussion

16. Vicentini FC, Gomes CM, Danilovic A, Neto EA, Mazzucchi E, Srougi M. Percutaneous nephrolithotomy: Current concepts. Indian J Urol. 2009 Jan;25(1):4-10.
17. Havel D, Saussine C, Fath C, Lang H, Faure F, Jacqmin D. Single stones of the lower pole of the kidney. Comparative results of extracorporeal shock wave lithotripsy and percutaneous nephrolithotomy. Eur Urol. 1998;33(4):396-400.
18. Turna B, Nazli O, Demiryoguran S, Mammadov R, Cal C. Percutaneous nephrolithotomy: variables that influence hemorrhage. Urology. 2007 Apr;69(4):603-7.
19. Tefekli A, Ali Karadag M, Tepeler K, Sari E, Berberoglu Y, Baykal M, et al. Classification of percutaneous nephrolithotomy complications using the modified clavien grading system: looking for a standard. Eur Urol. 2008 Jan;53(1):184-90.
20. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004 Aug;240(2):205-13.
21. O'Grady NP, Barie PS, Bartlett JG, Bleck T, Garvey G, Jacobi J, et al. Practice guidelines for evaluating new fever in critically ill adult patients. Task Force of the Society of Critical Care Medicine and the Infectious Diseases Society of America. Clin Infect Dis. 1998 May;26(5):1042-59.
22. Cadeddu JA, Chen R, Bishoff J, Micali S, Kumar A, Moore RG, et al. Clinical significance of fever after percutaneous nephrolithotomy. Urology. 1998 Jul;52(1):48-50.
23. Dogan HS, Sahin A, Cetinkaya Y, Akdogan B, Ozden E, Kendi S. Antibiotic prophylaxis in percutaneous nephrolithotomy: prospective study in 81 patients. J Endourol. 2002 Nov;16(9):649-53.
24. Rao PN, Dube DA, Weightman NC, Oppenheim BA, Morris J. Prediction of septicemia following endourological manipulation for stones in the upper urinary tract. J Urol. 1991 Oct;146(4):955-60.
25. Lee WJ, Smith AD, Cubelli V, Badlani GH, Lewin B, Vernace F, et al. Complications of percutaneous nephrolithotomy. AJR Am J Roentgenol. 1987 Jan;148(1):177-80.
26. Vorrakitpokatorn P, Permtongchuchai K, Raksamani EO, Phettongkam A. Perioperative complications and risk factors of percutaneous nephrolithotomy. J Med Assoc Thai. 2006 Jun;89(6):826-33.
27. Viville C. [Percutaneous nephrolithotomy (PCNL): evaluation of 250 PCNL by the same operator]. Prog Urol. 1993 Apr;3(2):238-51.
28. Takeuchi H, Ueda M, Nonomura M, Hida S, Oishi K, Higashi Y, et al. [Fever attack in percutaneous nephrolithotomy and transurethral ureterolithotripsy]. Hinyokika Kiyo. 1987 Sep;33(9):1357-63.
29. Skolarikos A, de la Rosette J. Prevention and treatment of complications following percutaneous nephrolithotomy. Curr Opin Urol. 2008 Mar;18(2):229-34.
30. Srirangam SJ, Darling R, Stopford M, Neilson D. Contemporary practice of percutaneous nephrolithotomy: review of practice in a single region of the UK. Ann R Coll Surg Engl. 2008 Jan;90(1):40-4.
31. Gehring H, Nahm W, Zimmermann K, Fornara P, Ocklitz E, Schmucker P. Irrigating fluid absorption during percutaneous nephrolithotripsy. Acta Anaesthesiol Scand. 1999 Mar;43(3):316-21.
32. Kukreja RA, Desai MR, Sabnis RB, Patel SH. Fluid absorption during percutaneous nephrolithotomy: does it matter? J Endourol. 2002 May;16(4):221-4.

33. Kessaris DN, Bellman GC, Pardalidis NP, Smith AG. Management of hemorrhage after percutaneous renal surgery. J Urol. 1995 Mar;153(3 Pt 1):604-8.
34. Kukreja R, Desai M, Patel S, Bapat S. Factors affecting blood loss during percutaneous nephrolithotomy: prospective study. J Endourol. 2004 Oct;18(8):715-22.
35. Davidoff R, Bellman GC. Influence of technique of percutaneous tract creation on incidence of renal hemorrhage. J Urol. 1997 Apr;157(4):1229-31.
36. Stoller ML, Wolf JS, Jr., St Lezin MA. Estimated blood loss and transfusion rates associated with percutaneous nephrolithotomy. J Urol. 1994 Dec;152(6 Pt 1):1977-81.
37. Patterson DE, Segura JW, LeRoy AJ, Benson RC, Jr., May G. The etiology and treatment of delayed bleeding following percutaneous lithotripsy. J Urol. 1985 Mar;133(3):447-51.
38. Stoller ML, Lee KL, Schwartz BF, Viele MK. Autologous blood use in percutaneous nephrolithotomy. Urology. 1999 Sep;54(3):444-9.
39. Lang EK, Thomas R, Davis R, Colon I, Cheung W, Sethi E, et al. Risks and benefits of the intercostal approach for percutaneous nephrolithotripsy. Int Braz J Urol. 2009 May-Jun;35(3):271-81; discussion 81-3.
40. Radecka E, Brehmer M, Holmgren K, Magnusson A. Complications associated with percutaneous nephrolithotripsy: supra- versus subcostal access. A retrospective study. Acta Radiol. 2003 Jul;44(4):447-51.
41. Robert M, Maubon A, Roux JO, Rouanet JP, Navratil H. Direct percutaneous approach to the upper pole of the kidney: MRI anatomy with assessment of the visceral risk. J Endourol. 1999 Feb;13(1):17-20.
42. Gupta R, Kumar A, Kapoor R, Srivastava A, Mandhani A. Prospective evaluation of safety and efficacy of the supracostal approach for percutaneous nephrolithotomy. BJU Int. 2002 Dec;90(9):809-13.
43. Munshi CA, Bardeen-Henschel A. Hydropneumothorax after percutaneous nephrolithotomy. Anesth Analg. 1985 Aug;64(8):840-2.
44. Hentschel H, Janitzky V, Weirich T. [Percutaneous nephrolithotomy - always effective and free of complications?]. Aktuelle Urol. 2007 May;38(3):232-6.
45. Sukumar S, Nair B, Ginil KP, Sanjeevan KV, Sanjay BH. Supracostal access for percutaneous nephrolithotomy: less morbid, more effective. Int Urol Nephrol. 2008;40(2):263-7.
46. Munver R, Delvecchio FC, Newman GE, Preminger GM. Critical analysis of supracostal access for percutaneous renal surgery. J Urol. 2001 Oct;166(4):1242-6.
47. Yadav R, Aron M, Gupta NP, Hemal AK, Seth A, Kolla SB. Safety of supracostal punctures for percutaneous renal surgery. Int J Urol. 2006 Oct;13(10):1267-70.
48. Sampaio FJ, Aragao AH. Anatomical relationship between the intrarenal arteries and the kidney collecting system. J Urol. 1990 Apr;143(4):679-81.
49. Rao PN. Fluid absorption during urological endoscopy. Br J Urol. 1987 Aug;60(2):93-9.
50. Sinclair JF, Hutchison A, Baraza R, Telfer AB. Absorption of 1.5% glycine after percutaneous ultrasonic lithotripsy for renal stone disease. Br Med J (Clin Res Ed). 1985 Sep 14;291(6497):691-2.
51. Malhotra SK, Khaitan A, Goswami AK, Gill KD, Dutta A. Monitoring of irrigation fluid absorption during percutaneous nephrolithotripsy: the use of 1% ethanol as a marker. Anaesthesia. 2001 Nov;56(11):1103-6.

52. Abelha FJ, Castro MA, Neves AM, Landeiro NM, Santos CC. Hypothermia in a surgical intensive care unit. BMC Anesthesiol. 2005 Jun 6;5:7.
53. Kempainen RR, Brunette DD. The evaluation and management of accidental hypothermia. Respir Care. 2004 Feb;49(2):192-205.
54. Sessler DI. Complications and treatment of mild hypothermia. Anesthesiology. 2001 Aug;95(2):531-43.
55. Cereda M, Maccioli GA. Intraoperative temperature monitoring. Int Anesthesiol Clin. 2004 Spring;42(2):41-54.
56. Konrad C, Gerber H, Schupfer G, Jenzer S, Schmucki O. Detection of fluid volume absorption by end-tidal alcohol monitoring in patients undergoing endoscopic renal pelvic surgery. J Clin Anesth. 1999 Aug;11(5):386-90.
57. Atici S, Zeren S, Aribogan A. Hormonal and hemodynamic changes during percutaneous nephrolithotomy. Int Urol Nephrol. 2001;32(3):311-4.
58. Kekre NS, Gopalakrishnan GG, Gupta GG, Abraham BN, Sharma E. Supracostal approach in percutaneous nephrolithotomy: experience with 102 cases. J Endourol. 2001 Oct;15(8):789-91.
59. Kondas J, Szentgyorgyi E, Vaczi L, Kiss A. Splenic injury: a rare complication of percutaneous nephrolithotomy. Int Urol Nephrol. 1994;26(4):399-404.
60. Shah HN, Hegde SS, Mahajan AP, Sodha H, Shah R, Bansal M. Splenic injury: rare complication of percutaneous nephrolithotomy: report of two cases with review of literature. J Endourol. 2007 Aug;21(8):919-22.
61. Korkes F, Lopes Neto AC, Lucio J, 2nd, Bezerra CA, Wroklawski ER. Management of colon injury after percutaneous renal surgery. J Endourol. 2009 Apr;23(4):569-73.

ANNEXURE I

PATIENT INFORMATION SHEET

The surgery you are undergoing will be under general anaesthesia. Under anaesthesia, it is routine to monitor your heart rate, blood pressure, saturation, etc to ensure a safe recovery.

A study is being conducted here wherein a few additional monitoring will be established along with the routine ones to try and identify some complication that are expected from the sugery and anaesthesia. The complications that are being studied include changes in heart rate, blood pressure, temperature and sodium levels, bleeding injury to other organs and infection. This study is being done so that these changes can be understood better and a better level of care can be given to all the patients undergoing this procedure. For this additional monitoring of temperature and two blood samples need to be done under anaesthesia, one at the beginning of the surgery and one at the end.

By enrolling in this study, there will be no potential risk or discomfort. There will be no change in the procedure done or other treatment which may be necessary. You will not have to incur any additional cost in treatment.

Also, by refusing to be enrolled in the study, there will be no change in the level of care that will be given to you.

All the information collected during this study will be kept confidential.

ANNEXURE II

INFORMED CONSENT FORM

Study Title: prospective study on the hemodynamic and metabolic changes during percutaneous nephrolithotomy

Study Number:

Subject's Name:

Age:

(i)I confirm that I have read and understood the information sheet dated _____ for the above study and have had the opportunity to ask questions

(ii) I understand that the Sponsor of the clinical trial, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iii) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s)

(iv) I agree to take part in the above study

Signature of the Subject/Legally Acceptable Representative:
Date:
Signatory's Name:

Signature of the Investigator:
Date:
Study Investigator's Name:

Signature of the Witness:
Date:
Name of the Witness:

ANNEXURE III

DATA ENTRY PROFORMA

PERIOPERATIVE COMPLICATIONS DURING PCNL

Name: **Serial no**: **Weight:** **Height:**

Hosp no: **Age**: **Sex**::

Co-morbidities : DM / CRF / BA / COPD / HTN

BASELINE VALUES

Mean Blood Pressure(MBP):				**MBP ± 15%** : _____ to_____ (Please mention as a range -15% to +15%)					
Body Temperature :				**Heart Rate :**					
ABG value:	**pH**	**pCO_2**	**pO_2**	**HCO_3**	**BE**	**Na**	**K**	**Hct**	**Lact**

INTRA-OP VALUES

Mean BP values < or > 15% of baseline
(Please note the value each time and if vasopressor was used, the drug).
E - Ephedrine **P** -Phenylephrine **N**-Noradranaline **A**-Adranaline **D**-Dopamine

Any bradycardia(<60 bpm): (please note the lowest value in each episode and circle if treated						

Arrythmias intraop?	**Yes / No** If yes intervention done?
Temperature of irrigating fluid:	
Total no of irrigating bags used :	
Lowest body temperature noted during the procedure :	
Ambient temperature of theatre (at end of procedure before switching off AC):	
Duration of surgery(from time of RGP):	
Volume of IVF used(in litres)	**NS**: **RL**: **Colloids**:
Was blood transfused periop?	
Other complications of Surgery	Pleural tear: **Y / N** Sepsis: **Y / N** Any other:

POST-OP VALUES

ABG value:	**pH**	**pCO_2**	**pO_2**	**HCO_3**	**BE**	**Na**	**K**	**Hct**	**Lact**

ptname	Hospno	age	sex	ComoDM	ComoHTN	ComoIHD	ComoCRF	ComoBA	asa	wt	
Mohammed Nazimmudd	537174d	41	2	1	1	1	1	1	1	75	
raju borthakur	618072d	46	2	1	2	1	1	1	2	47	
dawa lama	570719d	39	2	1	1	1	1	1	1	54	
vinod lal	626315d	33	2	1	1	1	1	1	1	63	
ratna davi	619044d	55	1	2	1	1	1	1	2	69	
Raju Borthakur	618072d	46	2	1	1	1	1	1	1	47	
Mukur Chandra Das	623798d	31	2	1	1	1	1	1	1	70	
Asma Khatoon	623016d	44	1	1	1	1	1	1	1	65	
vinod	626315d	33	2	1	1	1	1	1	1	67	
bablu samantha	628241d	37	2	1	1	1	1	1	1	68	
Debashish Gope	633127d	33	2	1	1	1	1	1	1	60	
Arumugan	626372d	56	2	1	1	1	1	1	1	68	
Mahesh Kumar	617034d	32	2	1	2	1	1	1	2	70	
mahesh kumar	617034d	32	2	1	2	1	1	1	2	70	
Md Meraj alam	633124d	18	2	1	1	1	1	1	1	54	
prabati das	577913d	40	2	1	1	1	1	1	2	46	
bharath prasad	630617d	52	2	1	1	1	1	1	1	64	
vasanthi	432005c	28	2	1	2	1	1	1	2	58	
mohd badruddin	642747d	42	1	1	2	1	1	1	2	75	
nazma khan	624214d	47	2	2	1	1	1	1	2	68	
Visalatchi	062540d	44	2	2	1	1	1	1	2	55	
Rana Das	641467d	62	2	1	1	1	1	1	1	62	
Santanu Sinha	641117d	32	2	1	1	1	1	1	1	57	
Maliga	862814c	50	1	2	2	1	2	1	2	50	
Mohammed Jamaluddin	619111d	35	2	1	1	1	1	1	1	45	
Shamzuddin	634694d	38	2	1	1	1	1	1	1	60	
Cleopatra Marbaniang	649705d	49	1	1	1	1	1	1	1	40	
Bir Pratap Singh	592771d	15	2	1	1	1	1	1	1	54	
Khurshida Yesmin	562507d	46	1	1	2	1	1	1	2	55	
Salina Khatoon	587790d	38	1	1	1	1	1	1	1	67	
Anil Chandra	969791b	45	1	1	1	1	1	1	1	45	
Animesh Maiti	584390d	28	2	1	1	1	1	1	1	54	
Sameer	64138d	21	2	1	1	1	1	1	1	50	
Irom Tomba Singh	605204d	57	2	2	2	1	1	1	2	60	
Gita Das	586163d	45	1	1	1	1	1	1	1	54	

Rafikul Islam Khurun	615995d	51	2	1	1	1	1	1	1	65
Majoo Sahoo	487697b	41	1	1	1	1	1	1	1	46
Saroj Mishra	615098d	40	2	1	1	1	1	1	1	74
Sabuj Mukherjee	537186d	26	2	1	1	1	1	1	1	68
Saidul Islam	562771d	46	2	1	1	1	1	1	1	68
Purnima Hudi	506778d	33	1	1	1	1	1	2	2	54
Man bahadur	583506d	43	2	1	2	1	1	1	2	56
Usharani Mondal	532310d	25	1	1	1	1	1	1	1	46
Dawa Lama	570719d	39	1	1	1	1	1	1	1	60
Sukumar Gope	577533d	59	2	1	2	1	1	1	2	80
Subrata Malakar	515915d	65	2	1	1	1	1	1	1	65
Vajravelu	563220d	45	2	2	2	1	1	1	2	54
Bidya sagar	566337d	26	2	1	1	1	1	1	1	65
Sanjib das	503336d	36	2	1	1	1	1	1	1	64
bharati devi	585438d	38	1	1	1	1	1	1	1	52
Selima khatun	587790d	38	1	1	1	1	1	1	1	58
Mezibur Rehman	587237d	35	2	1	1	1	1	1	1	78
Satbir Singh	594195d	39	2	1	2	1	1	1	2	82
Rinku saha	598034d	30	1	1	1	1	1	2	2	67
Kaushik	602135d	36	1	1	1	1	1	1	1	70
Pratap	592377d	52	2	2	2	1	2	1	2	78
Kamala devi	573310d	44	1	1	2	1	1	1	2	68
David Tirwa	578271d	53	2	2	1	1	1	1	2	35
Ramesh chanden	567192d	28	2	1	1	1	1	1	1	54
Ajay kumar		36	2	1	1	1	1	1	1	45

sidesurgery	staghorn	basembp	basehr	basetemp	pha	pco2a	po2a	hco3a	bea	na1	k1
1	1	95	81	35.70	7.38	43.00	79.00	25.40	0.30	137	3.90
2	2	87	64	35.60	7.40	41.00	92.00	25.40	0.60	138	3.70
2	2	103	76	35.70	7.45	36.00	127.00	25.00	1.00	139	3.80
1	1	92	83	35.40	7.37	43.00	133.00	24.90	-0.60	140	3.40
1	1	91	92	36.70	7.35	41.00	95.00	28.50	4.50	135	4.00
2	2	75	106	36.40	7.44	37.00	84.00	25.80	1.10	136	3.70
2	1	75	100	36.50	7.41	46.00	90.00	27.80	3.70	135	3.70
2	1	89	83	36.50	7.28	43.00	112.00	20.20	-6.30	138	3.10
1	1	76	76	36.90	7.43	32.60	195.00	22.90	-2.20	139	3.30
1	1	66	69	36.40	7.42	40.00	188.00	26.00	1.30	139	3.40
1	2	96	78	35.40	7.40	39.00	327.00	24.20	-0.60	139	3.40
2	1	108	104	36.40	7.40	37.00	215.00	28.20	4.90	133	4.30
2	1	101	92	35.80	7.45	38.00	212.00	26.40	2.40	136	3.70
1	1	85	96	36.30	7.36	51.00	249.00	27.00	2.50	137	3.00
2	1	65	110	36.50	7.45	36.00	100.00	25.00	1.00	138	4.10
2	2	88	111	36.80	7.45	35.00	137.00	24.30	0.30	138	3.60
1	1	95	90	36.00	7.40	45.00	307.00	28.50	3.90	135	3.70
1	1	85	94	35.90	7.41	32.00	301.00	20.30	-4.30	137	3.60
1	2	97	57	36.20	7.34	40.00	268.00	21.60	-4.20	138	3.30
2	1	90	84	36.50	7.41	44.00	296.00	27.90	3.30	136	3.90
1	1	97	103	36.30	7.31	40.00	270.00	20.10	-6.20	147	3.70
2	1	90	79	36.60	7.32	44.00	106.00	22.70	-3.40	144	3.70
2	2	85	65	36.30	7.41	44.00	278.00	27.90	3.30	136	3.90
3	1	78	72	35.40	7.30	53.00	190.00	26.10	-0.30	140	4.10
1	2	79	56	35.50	7.35	35.00	269.00	19.30	-6.30	146	3.40
3	2	83	89	35.70	7.45	35.00	444.00	24.30	0.30	139	3.70
2	1	80	82	35.50	7.38	38.00	392.00	23.20	-2.30	136	4.30
1	1	89	69	35.60	7.44	40.00	95.00	27.20	2.80	137	3.60
1	2	81	94	36.10	7.40	43.00	163.00	26.60	1.50	137	4.00
2	1	112	86	37.00	7.47	39.00	69.00	28.40	4.40	137	3.80
2	2	78	73	35.60	7.39	43.00	70.00	26.00	1.00	136	3.50
2	1	123	102	35.50	7.44	40.00	103.00	27.20	3.00	136	3.70
2	1	90	105	35.60	7.37	41.00	96.00	23.70	-1.60	138	3.60
2	1	100	70	36.50	7.40	51.00	229.00	31.60	6.80	136	3.80
2	2	79	64	35.70	7.33	47.00	189.00	24.80	-1.50	142	3.40

2	1	2	86	35.90	7.43	39.00	245.00	25.90	1.50	135	3.80
2	2	93	98	36.00	7.37	39.00	178.00	22.00	-2.80	140	3.60
2	2	91	84	36.50	7.34	44.00	209.00	23.70	-2.10	139	3.60
2	1	104	86	36.50	7.43	38.00	119.00	25.70	1.00	136	3.60
1	2	87	82	35.70	7.43	42.00	98.00	27.90	3.60	139	3.70
2	1	83	109	36.70	7.43	36.00	109.00	24.90	0.10	137	3.40
2	1	78	78	36.00	7.37	32.00	205.00	22.00	1.00	138	3.50
2	1	95	93	36.60	7.44	38.00	91.00	25.80	1.60	136	3.60
2	2	101	56	36.20	7.42	37.00	112.00	24.00	-0.50	138	2.50
1	1	103	68	36.20	7.37	35.00	212.00	23.00	-0.30	139	3.40
2	1	85	78	35.60	7.38	40.00	91.00	23.70	-1.30	138	3.80
2	1	104	11	36.20	7.42	41.00	82.00	26.60	1.90	136	3.10
1	1	67	72	36.10	7.37	35.00	150.00	24.00	0.40	139	3.70
2	1	78	86	35.90	7.38	42.00	124.00	23.00	0.20	140	3.80
1	1	64	92	36.50	7.39	44.00	195.00	22.00	-0.50	136	3.40
2	1	74	88	36.00	7.43	37.00	163.00	27.00	0.30	139	3.70
1	1	84	78	36.10	7.41	38.00	250.00	25.00	-0.20	137	3.90
2	1	98	80	35.80	7.37	35.00	140.00	22.00	0.40	140	3.30
2	1	78	88	36.10	7.39	42.00	167.00	25.00	0.20	138	3.60
2	1	82	70	35.90	7.40	36.00	183.00	26.00	2.00	136	3.80
2	1	94	76	35.90	7.29	36.00	190.00	28.00	-3.00	135	4.50
2	1	90	90	35.80	7.37	43.00	280.00	23.00	0.80	139	4.00
1	1	84	80	36.10	7.36	38.00	95.00	24.00	0.80	138	3.70
1	1	72	68	36.20	7.38	42.00	120.00	22.00	0.60	137	3.50
1	1	82	84	36.00	7.39	42.00	167.00	25.00	0.20	138	3.60

hct1	lac1	stoneloc	stonesize	route	bradycardia	hypotension	arrythmia	fluidtemp	litres	bodytemp	ambienttemp
46.00	0.80	1	2.50	1	1	1	1	1	14	34.90	20.00
37.00	0.60	1	2.00	1	1	2	1	1	28	33.00	20.90
33.00	0.40	1	2.00	1	1	1	1	1	10	35.10	22.00
42.00	1.30	1	1.00	1	1	1	1	1	44	33.10	22.00
35.00	1.80	1	3.00	1	1	1	1	1	26	35.80	23.00
24.00	0.50	1	5.00	1	1	2	1	1	18	34.20	20.00
45.00	0.80	1	2.00	1	1	2	1	1	12	34.10	20.00
37.00	1.10	2	5.40	1	1	1	1	1	9	35.70	22.00
24.30	0.80	3	2.40	1	1	1	1	1	18	35.50	24.00
40.00	1.10	1	7.00	1	1	1	1	1	32	35.70	25.00
38.00	2.10	1	3.00	1	2	1	1	1	16	35.60	23.00
47.00	1.10	1	2.40	1	1	2	1	1	20	36.20	22.00
28.00	2.20	1	2.00	1	2	2	1	1	20	33.70	22.00
35.00	2.10	1	2.00	1	1	2	1	1	30	34.60	25.00
50.00	1.30	1	3.00	1	1	2	1	1	24	35.60	22.00
30.00	1.10	1	2.00	1	1	1	1	1	20	35.50	24.00
35.00	2.90	1	2.00	1	1	2	1	1	20	35.00	20.40
30.00	1.30	1	1.50	1	1	1	1	1	24	34.60	24.00
39.00	1.20	1	5.00	1	1	2	1	1	84	33.60	24.00
40.00	0.60	1	2.00	1	1	2	1	1	26	36.10	22.00
38.00	2.00	1	1.80	1	1	2	1	1	16	35.50	22.50
52.00	0.80	1	2.00	1	1	2	1	1	22	35.90	22.50
49.00	1.00	1	1.00	1	1	1	1	1	20	35.80	22.50
30.00	0.60	4	2.00	1	1	4	1	1	70	35.10	21.00
44.00	0.70	1	7.00	1	1	2	1	1	46	34.80	23.00
42.00	0.80	1	3.00	1	1	2	1	1	34	34.40	23.00
30.00	0.40	1	2.00	1	1	2	1	1	22	35.00	23.50
49.00	0.70	1	1.50	1	1	1	1	1	34	35.00	22.00
37.00	0.60	1	4.50	1	1	2	1	1	36	35.90	23.00
11.80	0.80	1	2.50	1	1	2	1	1	40	36.40	22.00
51.00	1.10	1	2.50	1	1	2	1	1	18	35.00	20.00
46.00	1.90	1	1.80	1	1	4	1	1	20	35.10	22.00
42.00	1.70	1	2.00	1	1	1	1	1	20	35.60	23.00
41.00	1.30	1	1.50	1	2	2	1	1	40	34.20	24.00
39.00	0.80	1	2.50	1	2	4	1	1	20	34.70	22.00

39.00	1.20	1	2.00	1	1	2	1	1	20	34.70	24.00
39.00	1.30	1	2.50	1	1	2	1	1	28	35.30	24.00
55.00	1.50	1	2.00	1	1	2	1	2	38	34.30	23.00
49.00	0.80	1	1.90	1	1	1	1	2	30	34.50	22.00
45.00	0.70	1	1.00	1	1	2	1	1	36	34.20	24.00
38.00	1.20	1	3.00	1	1	2	1	1	46	33.80	23.00
40.00	0.90	1	3.00	1	2	2	1	2	12	34.70	22.00
34.00	0.40	1	1.50	1	1	1	1	2	22	36.00	23.00
35.00	0.70	1	2.80	1	2	2	1	1	38	34.30	21.30
42.00	0.50	1	2.50	1	1	2	1	2	7	35.50	24.00
44.00	1.00	1	2.80	1	1	2	1	1	36	35.60	24.00
45.00	1.20	1	2.00	1	1	2	1	1	6	35.80	22.40
42.00	0.20	1	1.50	1	1	1	1	2	10	35.40	24.00
40.00	0.50	1	1.50	2	2	3	1	2	33	33.20	23.00
33.00	0.50	1	5.00	1	1	2	1	1	40	33.30	22.50
36.00	0.20	1	2.50	1	1	2	1	2	18	34.60	23.00
41.00	0.10	1	3.00	1	1	1	1	2	32	34.00	23.00
39.00	0.60	1	3.00	1	1	2	1	2	26	34.20	22.00
34.00	0.10	1	3.50	1	1	1	1	2	30	34.30	23.00
36.00	0.50	1	2.00	1	1	1	1	2	14	35.00	23.00
27.00	1.00	2	3.00	1	1	4	1	2	34	33.40	22.00
30.00	0.40	1	4.20	1	1	2	1	2	38	34.00	24.00
34.00	0.60	1	5.00	1	1	2	1	2	24	34.20	23.00
35.00	0.20	1	1.00	1	1	1	1	2	12	35.00	22.00
34.00	0.10	1	3.50	1	1	1	1	2	30	34.30	23.00

dursurgery	ivfns	ivfrl	ivfcolloid	blood	pltear	sepsis	icu	phb	pco2b	po2b	hco3b
2.00	1.00	0.50	0.00	1	1	1	1	7.39	39.00	226.00	23.90
2.40	1.00	0.00	0.50	1	1	1	1	7.32	40.00	245.00	20.60
2.00	1.00	0.00	0.00	1	1	1	1	7.38	44.00	313.00	26.00
3.40	0.50	0.50	1.00	1	1	1	1	7.25	48.00	331.00	21.00
2.30	1.00	0.00	0.00	1	1	1	1	7.40	40.00	181.00	2.90
3.48	1.00	0.50	0.50	2	1	1	1	7.31	42.30	137.00	20.60
3.00	1.00	0.00	0.00	1	1	1	1	7.40	43.00	234.00	26.60
1.23	1.00	0.50	0.00	1	1	1	1	7.29	36.00	256.00	17.30
2.45	1.00	0.00	0.50	2	1	1	1	7.31	42.90	188.00	21.00
2.40	0.50	1.20	0.00	1	1	1	1	7.33	52.00	338.00	25.50
2.00	0.50	0.50	0.50	1	1	1	1	7.28	52.00	435.00	22.90
2.20	1.00	0.00	0.00	1	1	1	1	7.40	32.90	239.00	24.60
2.25	2.00	1.00	0.00	1	1	1	1	7.26	56.00	401.00	25.10
3.00	0.50	1.20	0.00	1	1	1	1	7.29	51.00	335.00	23.10
2.30	0.25	0.00	0.00	1	1	1	1	7.45	32.00	260.00	22.20
2.00	1.00	0.00	0.50	1	1	1	1	7.43	36.00	269.00	23.90
1.30	1.00	5.00	0.00	1	1	1	1	7.34	51.00	419.00	25.80
1.30	1.00	0.00	0.00	1	1	1	1	7.22	51.00	388.00	20.90
4.00	1.50	0.50	0.00	1	1	1	1	7.23	49.00	214.00	20.50
3.50	1.50	0.00	0.50	1	1	1	1	7.28	55.00	155.00	25.80
1.45	2.00	0.00	0.00	1	1	1	1	7.36	41.00	242.00	23.20
1.45	0.50	0.00	0.00	1	1	1	1	7.53	32.00	28.70	26.70
1.20	1.00	0.00	0.00	1	1	1	1	7.35	50.00	219.00	27.60
4.50	1.00	0.50	0.50	2	1	2	2	7.33	42.00	185.00	22.50
3.00	1.00	0.50	0.00	1	1	1	1	7.30	46.00	98.00	22.60
2.03	0.50	1.00	0.50	2	1	1	1	7.41	37.00	256.00	23.50
1.30	2.00	0.00	1.00	1	1	1	1	7.22	52.00	430.00	20.00
3.00	1.00	0.50	0.00	1	1	1	1	7.43	32.00	332.00	23.00
2.15	1.00	0.50	0.00	1	1	1	1	7.19	67.00	77.00	25.60
2.20	0.50	0.50	0.50	2	1	1	1	7.34	45.00	220.00	24.30
2.00	0.50	0.00	0.50	1	1	1	1	7.36	41.00	127.00	23.20
3.00	1.00	0.50	0.50	1	1	2	2	7.40	39.00	367.00	24.20
1.50	1.00	0.00	0.00	1	1	1	1	7.33	41.00	284.00	21.60
2.50	1.50	0.00	0.00	1	1	1	1	7.33	51.00	261.00	26.90
1.35	0.50	0.50	0.00	1	1	2	2	7.32	45.00	271.00	23.20

2.00	0.00	1.00	0.50	1	1	1	1	7.39	43.00	532.00	26.00
1.50	0.50	0.50	0.00	1	1	1	1	7.33	39.00	293.00	20.60
2.30	1.50	0.00	0.00	1	1	1	1	7.24	53.00	279.00	22.70
1.50	1.00	1.00	0.00	1	1	1	1	7.40	37.00	120.00	25.00
1.40	0.70	0.00	0.00	1	1	1	1	7.43	42.00	98.00	27.40
2.00	0.70	0.00	0.00	1	1	1	1	7.26	46.00	283.00	20.30
1.50	0.50	0.00	0.00	1	1	1	2	7.35	33.00	290.00	21.00
1.50	1.00	1.00	0.00	1	1	1	1	7.45	32.00	304.00	22.20
2.50	2.00	0.00	1.00	1	1	1	1	7.23	49.00	213.00	20.50
2.50	0.50	0.50	0.00	1	1	1	1	7.37	35.00	212.00	22.00
1.10	0.50	1.00	0.00	1	1	1	1	7.19	61.00	458.00	20.30
2.00	0.50	0.50	0.00	1	1	1	1	7.34	49.00	239.00	26.40
1.20	0.50	0.50	0.00	1	1	1	1	7.35	37.00	340.00	22.00
3.30	1.00	0.50	1.00	1	2	1	2	7.29	54.00	100.00	36.00
4.00	1.50	0.50	0.50	1	1	1	1	7.30	35.00	350.00	20.00
2.30	0.50	0.50	0.00	1	1	1	1	7.35	32.00	287.00	24.00
3.00	1.00	0.00	0.00	1	1	1	1	7.35	30.00	265.00	24.00
3.30	0.50	0.50	1.00	1	1	1	1	7.34	38.00	259.00	22.00
3.00	0.50	0.00	0.50	1	1	1	1	7.33	42.00	300.00	21.00
1.50	1.00	0.00	0.00	1	1	1	1	7.38	43.00	290.00	23.00
3.00	1.00	0.00	0.50	2	1	2	2	7.29	38.00	254.00	16.00
4.00	1.00	0.00	0.50	1	1	1	1	7.33	40.00	190.00	20.00
2.20	1.00	0.00	0.00	1	1	1	1	7.34	40.00	204.00	23.00
1.30	0.50	0.00	0.00	1	1	1	1	7.35	42.00	280.00	24.00
3.00	0.50	0.00	0.50	1	1	1	1	7.33	42.00	300.00	21.00

beb	na2	k2	hct2	lac2	delawake	comments	diff	bloss
-1.40	136	3.80	34.00	0.80	1	uneventful	12.00	13.50
-5.50	141	3.40	23.00	0.90	1	stopped d/t excess bleeding	14.00	13.16
0.90	138	3.60	38.00	0.60	1		-5.00	-4.56
-6.10	137	3.90	29.00	2.00	1		13.00	13.84
1.40	135	4.80	32.00	2.70	1		3.00	3.71
-4.40	140	3.90	27.80	0.60	1		-3.80	-4.14
1.80	135	3.70	39.00	1.70	1		6.00	6.00
-9.30	138	3.40	39.00	1.30	2		-2.00	-2.05
-4.10	140	3.70	24.00	0.90	1		0.30	0.50
0.60	139	3.40	39.00	2.20	2	post op urine leak from nephrostomy sit	1.00	1.03
-2.30	138	3.50	32.00	1.70	1		6.00	6.17
0.10	137	4.20	42.00	1.30	1		5.00	4.58
-2.00	138	3.60	29.00	1.50	2		-1.00	-1.47
-2.50	137	4.00	35.00	4.00	1		0.00	0.00
-1.80	137	4.00	43.00	2.30	1		7.00	4.88
-0.40	137	3.90	25.00	1.30	3	prolonged waking	5.00	5.02
1.70	136	4.20	33.00	2.30	1		2.00	2.26
-6.60	137	3.30	28.00	0.90	1		2.00	2.40
-7.10	133	4.80	43.00	0.70	3	prolonged waking	-4.00	-4.39
-0.90	138	3.40	36.00	1.00	1		4.00	4.29
-2.20	134	3.80	36.00	2.00	1		2.00	1.78
4.00	134	4.00	50.00	1.30	2		2.00	1.46
2.00	136	3.90	45.00	1.30	1		4.00	2.91
-3.20	136	4.00	26.00	4.80	5	icu for hypotensio	4.00	4.29
-3.80	138	3.70	42.00	1.90	1		2.00	1.26
-1.10	138	3.90	36.00	0.80	1		6.00	5.54
-6.40	141	4.10	27.00	0.50	1		3.00	2.53
-1.80	141	3.60	13.90	1.50	1	multiple direct punctures.bloody field.sx abandone	35.10	36.16
-2.60	136	3.90	39.00	2.10	1		-2.00	-1.74
-1.40	136	4.00	24.00	1.20	1	post op fever settled with conservative mx	-12.20	-27.40
-2.20	136	4.30	38.00	1.10	1		13.00	7.89
-0.60	137	4.00	42.00	2.50	5	postop sepsis	4.00	2.95
4.30	136	4.40	37.00	2.00	2		5.00	3.80
1.00	138	4.00	39.00	1.10	1		2.00	1.80
-3.00	142	3.50	37.00	1.10	5	postop sepsis	2.00	1.71

1.00	136	4.10	38.00	1.40	1		1.00	1.01
-5.30	137	4.20	37.00	1.80	1		2.00	1.45
-4.70	140	3.50	32.00	1.20	1		23.00	23.48
2.00	140	3.60	48.00	0.80	2		1.00	0.84
3.10	139	3.70	45.00	0.70	1		0.00	0.00
-6.50	139	3.60	33.00	1.10	1		5.00	4.56
-0.60	136	3.60	35.00	-0.90	1		5.00	4.48
-1.80	137	3.50	26.00	0.50	1		8.00	7.36
-7.50	144	3.40	36.00	1.20	1		-1.00	-1.01
0.50	139	3.60	42.00	0.50	1		0.00	0.00
-6.00	135	5.50	43.00	1.40	1		1.00	0.90
0.10	137	3.20	38.00	0.90	1		7.00	5.47
-0.60	136	3.90	37.00	0.80	2		5.00	4.94
-6.00	139	4.20	33.00	2.00	5	hydrothorax ventilated for 2 days.	7.00	7.36
-4.00	138	4.50	27.00	1.60	1		6.00	6.24
-2.00	139	4.00	32.00	1.00	1		4.00	4.09
-0.80	140	4.00	38.00	1.00	1		3.00	3.55
0.60	139	3.90	35.00	1.30	1		4.00	5.32
-0.20	137	4.10	29.00	0.80	2		5.00	6.38
-0.50	139	4.30	32.00	1.60	1		4.00	4.94
-6.00	140	4.80	21.00	3.00	2	excessive bleeding intraop,sx not completed,poste	6.00	11.70
0.40	139	4.00	24.00	2.00	1		6.00	9.07
-0.60	140	3.90	29.00	1.50	1		5.00	3.33
0.20	138	3.80	33.00	0.80	1		2.00	1.91
-0.20	137	4.10	29.00	0.80	2		5.00	4.29

acidosis	hypothemia	TOTALFLU
0.00	1.00	1.50
0.00	1.00	1.50
0.00	0.00	1.00
1.00	1.00	2.00
0.00	0.00	1.00
0.00	1.00	2.00
0.00	1.00	1.00
1.00	0.00	1.50
0.00	0.00	1.50
0.00	0.00	1.70
1.00	0.00	1.50
0.00	0.00	1.00
1.00	1.00	3.00
1.00	1.00	1.70
0.00	0.00	0.25
0.00	0.00	1.50
0.00	1.00	6.00
1.00	1.00	1.00
1.00	1.00	2.00
1.00	0.00	2.00
0.00	0.00	2.00
0.00	0.00	0.50
0.00	0.00	1.00
0.00	0.00	2.00
0.00	1.00	1.50
0.00	1.00	2.00
1.00	1.00	3.00
0.00	1.00	1.50
1.00	0.00	1.50
0.00	0.00	1.50
0.00	1.00	1.00
0.00	0.00	2.00
0.00	0.00	1.00
0.00	1.00	1.50
0.00	1.00	1.00

0.00	1.00	1.50
0.00	0.00	1.00
1.00	1.00	1.50
0.00	1.00	2.00
0.00	1.00	0.70
1.00	1.00	0.70
0.00	1.00	0.50
0.00	0.00	2.00
1.00	1.00	3.00
0.00	0.00	1.00
1.00	0.00	1.50
0.00	0.00	1.00
0.00	0.00	1.00
1.00	1.00	2.50
0.00	1.00	2.50
0.00	1.00	1.00
0.00	1.00	1.00
0.00	1.00	2.00
0.00	1.00	1.00
0.00	1.00	1.00
1.00	1.00	1.50
0.00	1.00	1.50
0.00	1.00	1.00
0.00	1.00	0.50
0.00	1.00	1.00