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REVIEW

Post-operative urinary retention: Review of literature

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Abstract

Postoperative urinary retention (POUR) is one of the postoperative complications which is often underestimated and often gets missed and causes lot of discomfort to the patient. POUR is essentially the inability to void despite a full bladder in the postoperative period. The reported incidence varies for the wide range of 5%-70%. Multiple factors and etiology have been reported for occurrence of POUR and these depend on the type of anaesthesia, type and duration of surgery, underlying comorbidities, and drugs used in perioperative period. Untreated POUR can lead to significant morbidities such as prolongation of the hospital stay, urinary tract infection, detrusor muscle dysfunction, delirium, cardiac arrhythmias *etc*. This has led to an increasing focus on early detection of POUR. This review of literature aims at understanding the normal physiology of micturition, POUR and its predisposing factors, complications, diagnosis and management with special emphasis on the role of ultrasound in POUR.

Key words: Postoperative urinary retention; Urinary retention; Postoperative bladder dysfunction; Urinary retention and anaesthesia; Prevention postoperative urinary retention

Core tip: Postoperative urinary retention is considerable concern inpatients after the surgical intervention. It not only dissatisfies the patient but also confounds many serious concerns in immediate postoperative period. It is reported variably with many etiological factors. Its understanding, recognition using suitable assessment/tools and suitable timely management remains paramount and can avoid many untoward outcomes.

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INTRODUCTION

Postoperative period is a critical period which can witness numerous complications including pain, respiratory and/or haemodynamic disturbances, nausea, and vomiting *etc*. Postoperative urinary retention (POUR) is another such complication which is often underestimated and often gets missed. POUR refers to patients' inability to void urine in spite of full bladder after the surgical intervention in the postoperative period. The reported incidence varies for the wide range of 5%-70%. This wide range may be due to absence of a uniformly accepted definition for POUR along with its multifactorial etiology[1-3]. Occurrence of POUR may depend on the various reasons like the type of anaesthesia, type and duration of surgery, underlying comorbidities, and drugs used in perioperative period. Untreated POUR can lead to significant morbidities such as prolongation of the hospital stay, urinary tract infection, detrusor muscle dysfunction, delirium, cardiac arrhythmias *etc*[4,5]. This has led to an increasing focus on early detection of POUR. The use of ultrasonography to diagnose POUR has gained popularity in recent years. The various advantages of ultrasound as a diagnostic tool include its non-invasive technique, high accuracy, and absence of any risk of trauma or infection. This review aims at understanding the normal physiology of micturition, POUR and its predisposing factors, complications, diagnosis and management with special emphasis on the role of ultrasound in POUR.

This review is being written with an objective to summarize the literature related to POUR. The literature search was done from various search engines including PubMed, Cochrane Library, and Google Scholar. The search words included "postoperative urinary retention", "urinary retention", "postoperative bladder dysfunction", "micturition physiology", "risk factors", "urinary retention and anaesthesia", "postoperative voiding dysfunction", "complications urinary retention", "diagnosis postoperative urinary retention", "catheterization complications", "ultrasound urinary retention", "three-diameter ultrasound", and "prevention postoperative urinary retention".

The published literature related to POUR has been included and all study designs including systematic reviews and editorials were studied. During the search, any published literature not related to POUR were excluded. The literature published till June 2018 were included in this review.

MECHANISM OF MICTURITION

Normal physiology

Bladder is supplied with sympathetic, parasympathetic and efferent somatic fibres. Visceral afferent fibres, also called stretch receptors, arise from bladder wall. Micturition is a complex process which can be divided into two phases viz storage phase and voiding phase. Storage phase is mediated through sympathetic innervation whereas voiding phase by parasympathetic fibres. Overall, micturition is a spinal reflex which is further governed by brainstem centres. The bladder wall is a compliant muscular organ and can accommodate increasing volume of urine without much increase in pressure till a particular volume. The capacity of the normal bladder is 400-600 mL. The first urge to void occurs when the bladder volume is approximately 150 mL whereas the sensation of fullness occurs at 300 mL. The pelvic splanchnic nerves carry the reflex from the stretch receptors to the brainstem through afferent fibres when the bladder contains urine more than 300 mL. This activates the voiding phase and the parasympathetic fibres conduct the efferent pathway. Detrusor muscle contraction by parasympathetic fibres and removal of inhibition of motor cortex is required for voiding of urine. As soon as urine enters the posterior urethra this motor cortex inhibition is removed by pudendal afferents which results in relaxation of pelvic floor, descent of levator ani muscle and voiding of urine[1,6].

Alterations in physiology in perioperative period

The perioperative period can potentially affect the normal physiology of micturition. This can be attributed to the effects of anaesthesia, the surgical procedure performed, the intraoperative physiologic stressors, drugs, pain, anxiety *etc*. Many drugs used in perioperative period such as sedatives, analgesics and anaesthetic agents are known to interfere with the micturition pathway[5,7].

Opioids, commonly used for both intraoperative and postoperative analgesia, are known to cause urinary retention by blunting the sensation of bladder fullness (due to parasympathetic inhibition) along with increasing the sphincter tone (due to augmented sympathetic activity). Neuraxial opioids have been reported to have greater incidence of urinary retention as compared to intravenous administration. General anaesthetics also predispose to urinary retention as they cause relaxation of smooth muscle and hence decrease bladder contractility. In addition, they may also cause autonomic dys-regulation of the bladder tone.

Neuraxial local anaesthetics increase the propensity for POUR by interfering with both the afferent and efferent pathways of micturition. The longer acting agents entail higher risk for causing bladder dysfunction due to prolonged over-distention[5,7,8].

Risk factors

Various authors have studied the perioperative factors which can potentially influence the occurrence of urinary retention in the postoperative period (Table 1)[9-14]. Some of these factors are well proven for causing POUR while certain other factors are less proven and need further trials to implicate their role in POUR.

Age

The incidence of POUR increases with increasing age. This possibly is related to deterioration of the neurologic pathway responsible for urination with advancing age. Increased incidence of prostatomegaly in older males could also be a contributory factor for POUR[1,3,5,9,10].

Gender

Though majority of the studies and reviews report higher incidence of POUR in males[1,3,9,15], but Toyonaga *et al*[7] found female gender to be an independent predictor of POUR.

Pre-existing neurologic abnormality

Patients with pre-existing neurologic disorders like stroke, cerebral palsy, multiple sclerosis, diabetic and alcohol neuropathy, poliomyelitis are at higher risk for urinary retention in the postoperative period[1,9].

Preoperative urinary tract pathology

The evidence on pre-existing urinary tract pathology as a potential risk factor for POUR remains equivocal. Tammela *et al*[9] studied 5220 surgical patients and reported that almost 80% of the patients who developed POUR had some form of previous voiding difficulty. Toyonaga *et al*[7] reported various factors responsible for POUR after surgical interventions like anorectal diseases. They observed that presence of pre-existing urinary tract symptoms such as frequent urination, nocturia *etc*. to be an independent predictor for POUR. However, many authors have found contradictory results where pre-existing urinary tract abnormalities did not predispose the patients to develop urinary retention postoperatively[16,17].

Bladder volume on entry to post anaesthesia care unit

The bladder volume after the surgical intervention has been related with occurrence of POUR. A prospective study conducted to determine the risk factors for predicting early POUR reported the presence of bladder volume of more than 270 mL after the surgery remain an independent predictor of POUR[3].

Surgical procedure

Certain surgical procedures entail a higher risk of POUR than other surgeries[5]. Owing to multiple reasons, anorectal, colorectal, and urogynaecolgical surgeries have been observed to have a significantly higher risk of POUR[5,11,12].

Anaesthetic technique

Literature remains equivocal on the effect of the anaesthetic technique on the incidence of POUR. A review of the perioperative factors responsible for POUR evaluated 190 studies and found that the overall incidence of POUR was higher with regional anaesthesia as compared to general anaesthesia (GA)[1]. However, when clinical diagnostic criteria(patient discomfort, distended and palpable bladder, inability to void after a defined time postoperatively) were used, the incidence was higher with GA. The authors attributed this difference to the wide variation in the clinical criteria used in the different studies. Also, the retrospective nature of the

Table 1 Various risk factors for urinary retention in the postoperative period

Definitive	Equivocal	Unrelated
Age[1,3,5,9,10]; Pre-existing neurologic abnormality (stroke, cerebral palsy, multiple sclerosis, diabetic and alcohol neuropathy, poliomyelitis)[1,9]; Bladder volume on entry to PACU[3]; Surgical procedure (anorectal, colorectal, urogynaecolgical)[5,7,11,12]; Intraoperative aggressive fluid administration[1,3,5,6,11,13]; Postoperative pain and need for postoperative analgesia[5,7,9,11,14]; Postoperative opioid use[1,5,11]	Gender[1,3,7,9,15]; Preoperative urinary tract pathology[5,7,9,16,17]; Anaesthetic technique (general anaesthesia *vs* neuraxial anaesthesia)[1,2,6,9,10,12,17]; Duration of surgery[1,3,5-7,18]	American Society of Anaesthesiologists physical status[18]; Presence of pelvic drain[18]; Pelvic infection[18]

PACU: Post anaesthesia care unit.

analysis; majority of the data being taken from the clinical records may have contributed to this discrepancy[1]. The reported incidence of POUR has been observed to be higher in patients undergoing surgery under subarachnoid block (SAB)[2,6,10,12]. Contradictory, few other studies negate the effect of type of anaesthesia on occurrence of POUR[9,17].

Intraoperative fluid administration

The volume of fluids administered intraoperatively can have a significant impact on the occurrence of POUR. The aggressive fluid management can lead to over distension of the urinary bladder and more possibility of POUR[1,5,9]. However, there is no clear consensus as to the cut-off limit for volume of intraoperative fluids with various authors using different values *e.g.*, 750 mL[3,7], 1000 mL[13], and 1200 mL[11].

Duration of surgery

Longer duration of surgery can be a contributing factor for POUR; possibly due to more fluid administered and higher amount of opioids used[1,6]. Various studies have confirmed this association[3,5-7,18].

Postoperative pain

Postoperative pain can cause higher incidence of POUR by causing inhibition of the micturition reflex due to increased sympathetic discharge[5,9]. Many authors have documented a higher incidence of POUR in patients experiencing more postoperative pain[7,11,14].

Postoperative opioids

Despite the fact that increased pain and need for postoperative analgesia are known predisposing factors for POUR; use of postoperative opioids can itself lead to a higher incidence of POUR[1,5,11].

Concerns related to POUR

Pour can have multiple impacts on the patients in the postoperative period. Urinary retention in the postoperative period can potentially delay the discharge from hospital leading to increase in the health costs[9,19]. Apart from causing prolonged hospitalization, POUR is also a source of significant discomfort and morbidity to the patient. An over-distended bladder can cause severe suprapubic pain, nausea and vomiting. Bladder distension and the resulting pain can result in sympathetic over-activity leading to haemodynamic disturbances such as hypertension, cardiac dysrhythmias *etc*[20].

Incomplete emptying of the bladder due to retention of urine also predisposes the patient to urinary tract infections (UTI) in the postoperative period. Urethral catheterization itself, done for the management of POUR, can also increase the risk for UTI[1]. Even a single brief catheterization has the propensity to introduce infection into the urinary tract[21].

Over-distension of the bladder, especially if prolonged, can cause long-term changes in bladder contractility and elasticity due to detrusor muscle dysfunction. Even a transient over-distension of the urinary bladder can have deleterious effects on the detrusor muscle and bladder wall[22]. Lamonerie *et al*[6] reported that incidence of bladder distension to be 44% in 177 adult patients after a variety of elective surgical procedures. Stretching of bladder beyond its maximum capacity of 400-600 mL has potential to cause ischemic damage and irreversible insult to the contractile elements of the detrusor muscle and the associated motor end-plates[23,24]. This can lead to long-term micturition difficulties, higher post-voiding residual volumes and thereby further increased predisposition to UTIs.

Diagnosis of POUR

POUR usually is a transient complication which gets relieved spontaneously in majority of the patients. However, in some cases, especially in those with high risk factors, prolonged retention can cause significant morbidity. Screening of high-risk patients and aiming for an early diagnosis of POUR are critical in averting the detrimental effects of over-distension on bladder morphology and function subsequently. Diagnosis of POUR has been done by three basic methods viz clinical signs and symptoms, bladder catheterization and ultrasound assessment (Table 2)[25-51].

Clinical signs and symptoms

The traditional technique for identification of urinary retention and bladder distension after surgery was by assessing the patient for suprapubic pain and discomfort, difficulty or inability to void, presence of suprapubic dullness, and palpable bladder[11,13,25,26]. However, clinical assessment by patients, nurses or physicians is fraught with inaccuracies. Pavlin *et al*[12] assessed 334 patients undergoing different types of day-care surgeries for occurrence of POUR by clinical assessment and by ultrasound. They reported that clinical estimation of postoperative bladder volume was incorrect in 54% and 46% cases when done by patients and nurses respectively. Additionally, manual estimation of bladder size may be difficult in patients with obesity or having previous abdominal surgery; often resulting in failure to recognize a distended bladder[27].

Bladder catheterization

Catheterization of bladder can be used both as a diagnostic as well as therapeutic measure for POUR. The need to catheterize after a stipulated period of time postoperatively and/or volume of urine voided by catheterization has been employed as the diagnostic criteria for POUR in many studies[7,10,14,38,39]. However, catheterization, being an invasive procedure, itself carries many risks such as urethral trauma, discomfort, and urinary tract infection. Also, the use of catheterization for diagnosis may lead to unnecessary catheterizations, further increasing the patient morbidity[1,21].

Role of ultrasonographic assessment

Applications of ultrasound in the field of anaesthesiology have already been established in many areas and they continue to expand even now. Its role in the diagnosis of POUR has received recognition in the last decade. The appeal of bedside ultrasound as a diagnostic modality for POUR lies in its high accuracy and inter-observer reliability; even in children[G9] and obese[27]. In addition, being a non-invasive method, it carries no risk of trauma, discomfort or infection[52]. The other diagnostic methods for POUR; as elucidated previously; either lack precision or carry risk of infection and trauma. The use of ultrasound for prediction and diagnosis of POUR can help avoid unnecessary catheterizations while also preventing potential complications of bladder over-distension in high-risk patients.

Many authors have employed ultrasound for measurement of bladder volume and have established its role as a diagnostic tool for POUR. While most studies have focussed on its use in the post anaesthesia care unit (PACU), few authors have also evaluated its use in screening patients preoperatively in order to prevent development of postoperative bladder distension[2,48,49].

Grieg *et al*[27] compared manual examination of bladder volume with ultrasound and found that ultrasound was superior in identifying patients with bladder over-distension. Pavlin *et al*[12] also observed that use of ultrasound as screening tool for POUR is beneficial by avoiding unnecessary urinary catheterization. When comparing the bladder volumes measured by bladder catheterization and by portable ultrasound, ultrasound showed good accuracy and correlation with volume emptied by catheterization[50,53].

Determination of bladder volume by ultrasonography has traditionally been done by measurement of three diameters viz transverse, supero-inferior and antero-posterior[49,54]. The accuracy of a single diameter measurement was assessed by Daurat *et al*[4] measured the largest transverse bladder diameter in 100 orthopaedic patients with at least one risk factor for POUR in the PACU and evaluated its correlation with the bladder volume (estimated by automated bladder USG and by bladder catheterization). These authors reported that bladder measurement of largest transverse diameter of ≤ 9.7 cm does not require catheterization. However, patients with bladder diameter of > 10.7 cm should be catheterized. They concluded that a single measurement of the largest transverse diameter is a technically simpler method for assessment of bladder volume and can be used for prediction of POUR with good inter-observer reliability.

Widespread use of ultrasound for diagnosis of POUR however remains limited by the fact that there is no clear consensus on the bladder volume at which

Table 2 Diagnostic modalities for postoperative urinary retention

Method of diagnosis	Ref.	Objective	Sample population	Results
Clinical examination				
Palpable bladder distension	Bailey *et al*[25] (1976)	To study effect of fluid restriction on incidence of POUR	500 patients undergoing anorectal surgeries	Significant reduction in POUR with fluid restriction
Palpable bladder or patient discomfort	Petros *et al*[11] (1991)	To determine incidence of and factors influencing POUR after herniorrhaphy	295 patients who had undergone herniorrhaphy	Factors affecting POUR included age, fluid restriction, type of anaesthesia
Palpable/distended bladder or patient discomfort	Petros *et al*[13] (1990)	To determine factors affecting POUR after surgery for benign anorectal diseases	111 patients who had undergone surgery for benign anorectal diseases under spinal anaesthesia	Using long-acting local anaesthetic (bupivacaine) and use of > 1000 mL fluid increased risk of POUR
	Waterhouse *et al*[26] (1987)	To identify patients at risk of POUR	103 patients undergoing total hip replacement	At-risk patients included those with inability to pass urine into bottle while lying supine, with history of voiding difficulty, and with urinary peak flow rate suggestive of obstruction
Clinical assessment by patient or nurses	Pavlin *et al*[12] (1999)	To compare patient outcome after ambulatory surgery with or without USG monitoring of bladder volume	334 patients undergoing outpatient surgeries	USG monitoring was beneficial in patients at high-risk for POUR
Manual palpation and percussion of bladder	Greig *et al*[27] (1995)	To compare bladder volume by manual and USG examination	90 patients undergoing laparoscopic surgery	Manual assessment of bladder failed to detect urinary retention especially in obese patients
Painful urinary retention or manual palpation of bladder	Stallard *et al*[28] (1998)	To measure incidence of POUR	280 patients undergoing general surgical operations	Incidence of POUR was 6% and was attributed to decreased awareness of bladder sensation
Failure to void till 8 h postoperatively and distended bladder/patient discomfort	Cataldo *et al*[29] (1991)	To study role of prazosin for prevention of POUR after anorectal surgeries	51 patients undergoing elective anorectal procedures	Prophylactic use of prazosin did not decrease incidence of POUR
Failure to void postoperatively	Pawlowski *et al*[30] (2000)	To compare the time for discharge after use of two doses of mepivacaine in ambulatory SAB	60 patients undergoing ambulatory surgery for anterior cruciate ligament tear under spinal anaesthesia	None of the patient in either group had difficulty in voiding
Distended bladder	Esmaoglu *et al*[31] (2004)	To compare time for hospital discharge for knee arthroscopies under unilateral *vs* bilateral SAB	70 patients undergoing elective outpatient knee arthroscopy	Urinary retention was present in bilateral SAB group with longer time to discharge
Distended/palpable bladder and failure to void postoperatively	Evron *et al*[32] (1985)	To assess urinary retention after epidural methadone and morphine	120 females scheduled for caesarean section under epidural anaesthesia	Lower incidence of urinary complications with use of epidural methadone
Failure to void spontaneously within 8 h of removal of urinary catheter	Paulsen *et al*[33] (2001)	To compare postoperative recovery after bowel resection with thoracic epidural *vs* patient-controlled analgesia	49 patients undergoing elective bowel resection	Patients with thoracic epidural had lower pain scores but higher incidence of POUR and other complications
Urinary retention graded as: 0 = none; 1 = mild hesitancy; 2 = straight catheter required; and 3 = Foley catheter required	Baron *et al*[34] (1996)	To evaluate effect of addition of epinephrine on postoperative requirement of epidural fentanyl	38 patients undergoing elective posterolateral thoracotomy	Addition of epidural epinephrine decreased fentanyl requirement with no significant change in POUR incidence
Delayed spontaneous micturition	Lanz *et al*[35] (1982)	To study effect of epidural morphine on postoperative analgesia	174 patients receiving lumbar epidural anaesthesia orthopaedic procedures	Better postoperative analgesia but higher incidence of POUR with epidural morphine
Failure to void till 12 h postoperatively	Dobbs *et al*[36] (1997)	To compare postoperative outcomes in continuous bladder drainage *vs* in-out catheterization during total abdominal hysterectomy	100 females scheduled for total abdominal hysterectomy for non-malignant cause	Significantly higher incidence of POUR after in-out bladder catheterization

Failure to void postoperatively along with patient discomfort/palpable bladder	Kumar *et al*[37] (2006)	To evaluate the occurrence of POUR after total knee arthroplasty and role of indwelling bladder catheterization	142 patients undergoing total knee arthroplasty	19.7% patients had POUR. Authors recommended use of indwelling catheter for management of POUR
Bladder catheterization				
Requirement of bladder catheterization	Lau *et al*[10] (2004)	To ascertain optimal management of POUR (in-out catheterization *vs* indwelling catheter)	1448 patients undergoing elective inpatient general surgery	In-out catheterization recommended for POUR over indwelling catheter
Need for catheterization within 24 h postoperatively	Toyonaga *et al*[7] (2006)	Incidence and risk factors for POUR after surgery for benign anorectal diseases	2011 patients who underwent surgery for benign anorectal diseases under SAB	Incidence of POUR was 16.7%. Perioperative pain and excessive fluid administration were found to be risk factors
Need for urinary qcatheter (indweliing and/or temporary) within 24 h after surgery	Zaheer *et al*[14] (1998)	Incidence and risk factors for POUR after surgery for benign anorectal diseases	1026 patients who underwent surgery for benign anorectal diseases	Incidence of POUR was more after haemorrhoidectomy than other anorectal procedures.
Requirement of catheterization (with resulting urinary volume > 400 mL)	Faas *et al*[38] (2002)	Effect of SAB *vs* epidural anaesthesia on pain, urinary retention and ambulation in patients scheduled for inguinal herniorrhaphy	144 patients scheduled for elective inguinal herniorrhaphy	SAB resulted in more incidence of POUR and delayed ambulation
Need for catheterization (with residual volume > 500 mL)	Olofsson *et al*[39] (1996)	To compare post-partum urinary retention after epidural labour analgesia with bupivacaine and adrenaline *vs* bupivacaine and sufentanil	1000 antenatal females scheduled for epidural labour analgesia	Epidural anaesthesia led to higher risk for post-partum urinary retention
Need for catheterization	Lingaraj *et al*[40] (2007)	Incidence and risk factors for POUR after total knee arthroplasty	125 patients who underwent total knee arthroplasty	Incidence of POUR was 8%; predisposing factors being male gender and epidural anaesthesia
Need for catheterization	O'Riordan *et al*[41] (2000)	Risk factors for POUR after lower limb joint replacements	116 patients undergoing lower limb replacements	Increasing age, male gender, and use of patient-controlled analgesia (PCA) were risk factors
Need for catheterization	Jellish *et al*[42] (1996)	To compare perioperative outcomes after SAB *vs* GA for lumbar disc and laminectomy procedures	122 patients undergoing lumbar laminectomy or disc surgery	Incidence of POUR was similar in both groups
Need for catheterization	Fernandes MCBC *et al*[43] (2007)	To determine incidence of POUR in patients using postoperative opioid analgesics (PCA or epidural)	1316 patients undergoing elective surgery and using opioids for postoperative analgesia	Incidence of POUR was 22% ; with higher incidence in patients using continuous epidural analgesia
Need for catheterization	Matthews *et al*[44] (1989)	To compare efficacy of epidural *vs* paravertebral bupivacaine infusion for post-thoracotomy analgesia	20 patients scheduled for thoracotomy and pulmonary resection	Analgesia was comparable in both groups. Incidence of urinary retention was lower in paravertebral group
Need for catheterization	Peiper *et al*[45] (1994)	To compare perioperative outcomes after LA *vs* GA for inguinal hernia repair	607 patients operated for inguinal hernia repair	Patients in LA group had lower intensity of pain and had fewer complications *e.g.* POUR
Need for catheterization within 48 h postoperatively	Fletcher *et al*[46] (1997)	To study postoperative analgesia with iv paracetamol and ketoprofen after lumbar disc surgery	64 adults undergoing surgery for lumbar disc herniation	Postoperative analgesia was better in patients receiving both paracetamol and ketoprofen; with no difference in incidence of POUR
Ultrasonographic assessment				
Inability to void with residual volume ≥ 600 mL	Pavlin *et al*[12] (1999)	To evaluate the effect of ultrasonographic monitoring of bladder volume postoperatively after ambulatory surgery	334 patients scheduled for outpatient surgeries	USG assessment helped in evaluating the need for catheterization in patients at high risk for POUR
Inability to void with bladder volume ≥ 600 mL	Daurat *et al*[4] (2015)	To determine the reliability of diagnosis of POUR by a simplified USG measurement of largest transverse bladder diameter	100 patients undergoing orthopaedic surgery	Measurement of largest transverse bladder diameter using USG facilitated in diagnosing POUR

Inability to void with bladder volume > 600 mL	Lamonerie *et al*[6] (2004)	To determine the prevalence and risk factors for POUR using USG	177 patients undergoing a variety of surgical procedures	44% patients had bladder distension as measured by USG. Risk factors for POUR were increasing age, SAB, and surgical duration > 2 h
Inability to void with bladder volume > estimated bladder capacity [(30 mL/age in years) + 30 mL]	Rosseland *et al*[47] (2005)	To assess reliability of postoperative USG monitoring of bladder volume in children	48 children of 0-15 years who had undergone surgical procedure under GA	Reliability of USG monitoring was good in children above 3 years age
Inability to void with bladder volume ≥ 500 mL	Joelsson-Alm *et al*[48] (2012)	To evaluate the efficacy of preoperative USG monitoring in decreasing POUR	281 patients scheduled foremergencyorthopaedic surgery	Preoperative scanning of bladder helped in decreasing incidence of POUR
Inability to void with residual volume ≥ 600 mL	Ozturk *et al*[49] (2016)	To evaluate efficacy of preoperative and postoperative bladder scanning to decrease incidence of POUR	80 patients receiving SAB for arthroscopic knee surgery	Postoperative USG monitoring can reduce incidence of POUR
Inability to void with residual volume > 500 mL	Rosseland *et al*[50] (2002)	To compare bladder volume measured by USG with that measured after catheterization	36 patients undergoing surgical procedure under SAB	Good correlation was found between volume estimated by USG and that measured after catheterization
Inability to void within 30 min with bladder volume > 600 mL	Keita *et al*[3] (2005)	To determine risk factors for POUR	313 patients scheduled for elective surgery	Risk factors for POUR included intraoperative fluids > 750 mL, increasing age and bladder volume > 270 mL in PACU
Inability to void with bladder volume ≥ 500 mL	Gupta *et al*[51] (2003)	To compare outcome with two doses of bupivacaine (along with fentanyl) for SAB for inguinal herniorrhaphy	40 patients scheduled for outpatient inguinal herniorrhaphy	Bupivacaine 7.5 mg provide better analgesia than 6mg but led to more urinary retention and longer hospital stay

GA: General anaesthesia; LA: Local anaesthesia; POUR: Postoperative urinary retention; SAB: Subarachnoid block.

catheterization should be done. Bladder volumes ranging from 300-600 mL have been used as the criteria for diagnosing POUR and for catheterizing the bladder[1,6,12,27,50]. In addition, accuracy and reliability of ultrasonographic bladder scanning may be limited in conditions such as pregnancy, severe abdominal scars, abdominal herniation, co-existing abdominal pathology *etc*[52].

Prevention

Patients who are at high risk for POUR should be counselled preoperatively about the condition. Intraoperative preventive strategies primarily involve judicious fluid management and reduction of blood loss[3,55]. Bailey and Ferguson evaluated 500 patients after anorectal procedures and reported that patients who received less than 250 mL fluid perioperatively had significantly lower incidence of POUR[25].

Optimal management of postoperative pain also plays an important role in preventing POUR. Sympathetic stimulation secondary to pain results in decreased detrusor contraction and increased outflow resistance; thus leading to difficulty in voiding[5].

Various pharmacological methods have also been attempted for prevention of POUR. Several authors used phenoxybenzamine, an alpha adrenergic blocker, and found favourable results. Alpha-adrenergic antagonists aid micturition by increasing intravesical pressure and decreasing outflow resistance. However, phenoxybenzamine is no longer used due to its carcinogenic potential[5,56,57]. Tamsulosin, a newer alpha-adrenergic antagonist, has also been found to be effective in reducing the incidence of POUR[58,59].

MANAGEMENT

Management of POUR involves measures for decompression of the bladder. Since the degree of detrusor dysfunction is directly proportional to the duration of urinary retention and bladder over-distension, therefore early decompression should be the priority; especially in high-risk patients[6,23,60].

Patients who are at high-risk for POUR can be encouraged to void spontaneously by providing a comfortable environment for the same[23,60]. In patients who are unable to void on their own, emptying of the bladder by urethral catheterization remains the primary modality of treatment. At present, there is no clear consensus for the criteria for determining the timing for catheterization[1,6,61].

Urethral catheterization can be done by two basic approaches viz single in-and-out catheterization or use of indwelling catheter[5,55]. However, the guidelines for the most appropriate approach remain equivocal[1,5,10]. A single in-and-out catheterization or clean-intermittent-catheterization has often been preferred due to its lower risk of UTIs[10,62]. Few authors have, however, reported a higher incidence of bladder distension with this approach[17,63]. Though an indwelling urethral catheter can prevent the bladder dysfunction resulting from over-distension; but catheterization itself can be a source of significant discomfort and morbidity to the patient[1,64]. In fact, catheterization-associated UTI are one of the most common causes of nosocomial infections which may deteriorate to cause sepsis and even death. The incidence of UTI increases by 5%-7% for each day the urethral catheter is *in situ*[65].

Thus, the decision of which patients to catheterize, when to catheterize, and by which approach to catheterize remains at the discretion of the attending physician and is usually taken according to the hospital protocols. Considering the wide variability in literature regarding the diagnostic criteria for POUR, this review cannot advise definite guidelines for the same. Further large studies need to be undertaken for definite conclusion for thresholds and ultrasound based assessment of volume at which catheterization should be done.

CONCLUSION

POUR is a fairly common but an often ignored perioperative complication. Various factors such as age, type and duration of surgery, anaesthetic technique, intra-operative fluid administration can affect the occurrence of POUR. If not diagnosed and managed optimally, it can prolong hospital stay and cause significant morbidity to the patient due to pain, vomiting, UTI, and even permanent bladder dysfunction. Various methods have been used for diagnosing POUR including clinical assessment and bladder catheterization. Use of ultrasound for detection of POUR is gaining popularity in view of its ease of application, accuracy and reliability.

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ORIGINAL ARTICLE

Retrospective Cohort Study

Enhanced recovery after surgery pathway: The use of fascia iliaca blocks causes delayed ambulation after total hip arthroplasty

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Abstract

BACKGROUND
Fascia iliaca compartment blocks (FIBs) have been used to provide postoperative analgesia after total hip arthroplasty (THA). However, evidence of their efficacy remains limited. While pain control appears to be satisfactory, quadriceps weakness may be an untoward consequence of the block. Prior studies have shown femoral nerve blocks and fascia iliaca blocks as being superior for pain control and ambulation following THA when compared to standard therapy of parenteral pain control. However, most studies allowed patients to ambulate on post-operative day (POD) 2-3, whereas new guidelines suggest ambulation on POD 0 is beneficial.

AIM
To determine the effect of FIB after THA in patients participating in an enhanced recovery after surgery (ERAS) program.

METHODS
We conducted a retrospective analysis of patients undergoing THA with or without FICBs and their ability to ambulate on POD 0 in accordance with ERAS protocol. Perioperative data was collected on 39 patients who underwent THA. Demographic data, anesthesia data, and ambulatory outcomes were compared.

RESULTS
Twenty patients had FIBs placed at the conclusion of the procedure, while 19 did not receive a block. Of the 20 patients with FIB, only 1 patient was able to ambulate. Of the 19 patients without FIB blocks, 17 were able to ambulate. All patients worked with physical therapy 2 h after arriving in the post-anesthesia care unit on POD 0.

CONCLUSION
Our data suggests an association between FIB and delayed ambulation in the immediate post-operative period.

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Core tip: We evaluated the ambulatory ability of total hip arthroplasty patients in the immediate post-operative period to determine if there was an association with the use of fascia iliaca blocks and hindered ambulatory ability. We observed that in accordance with enhanced recovery after surgery protocol, which requires patients to ambulate on POD 0, there was an association with fascia iliaca block and delayed ambulation.

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INTRODUCTION

The frequency of total hip arthroplasty (THA) surgery is increasing, with the number of procedures performed in the United States being greater than 300000 annually. With such a high volume, many hospitals have implemented enhanced recovery after surgery (ERAS) protocols to help fast track these joint replacement patients, the goal being to reduce the stress response following surgery, promote early recovery, and lead to a decrease length of hospital stay without any increase in readmission rates. While the ERAS protocols still promote adequate pain control, the addition of early ambulation has resulted in changes to the anesthetic plans, to ensure that patients will be able to walk on the day of their surgery.

Adequate postoperative pain control is not only crucial for early ambulation; it is also associated with a decrease in length of hospital stay, and reductions in post-operative complications such as deep vein thrombus and pulmonary embolism[1]. The topic of what is the optimum analgesia regimen following THR is heavily debated and has yet to yield a universal consensus. With many options for pain control, including oral narcotics, local anesthetic infiltration, femoral nerve block, fascia iliaca block, patient- controlled analgesia, and intrathecal opioids, it is difficult to determine which is superior. Although it has been shown that opioids can adequately control pain, the unwanted side effects of nausea, vomiting, respiratory depression, pruritus, and urinary retention can be problematic. In addition, minimizing opioid consumption in this aging population who often have multiple co-morbidities is advantageous.

Intrathecal morphine (ITM) has fallen out of favor because of these unwanted side effects. When ITM was compared to local infiltration analgesia (LIA), it was shown that LIA provided superior analgesia effects within the first 24 h compared to ITM following total knee arthroplasty (TKA) and THA, and was associated with decreased rates of nausea, vomiting, and pruritus while having no effect of hospital length of stay[2]. While it is recognized that femoral nerve blocks (FNB) have been replaced by adductor canal blocks (ACB) for analgesia following TKA[3], there remains a lack of evidence for the best management of pain following THA. Although its effect is controversial, FIB has been utilized for procedures in hip, anterior thigh, and knee. In this block, LA is deposited in the compartment beneath the fascia iliaca ligament at the superficial fascial layer of the iliopsoas muscle near the anterior edge of the ilium. It creates a fluid- filled compartment which, in turn, spreads the LA cephalad beneath the fascia to reach the nerves of the lumbar plexus-the lateral femoral cutaneous, femoral, and obturator nerves. We hypothesized, that performing a FIB with dilute local anesthetic concentration might provide adequate analgesia, while minimizing the motor block. Thus, patients would have better pain control and allow ambulation in the immediate post-operative period in accordance with ERAS protocol. This retrospective review aims to access the patient's ambulation ability immediately after THA by comparing ambulation in patients who received FICB with those who did not.

MATERIALS AND METHODS

After approval by Institutional Review Board, we reviewed the anesthetic records (CompuRecord®, Philips, MA) and medical records (Prism®, GE Healthcare, United Kingdom) of all undergoing THA with or without FIBs with a single block anesthesiologist from July to December 2016. Patients were evaluated by a member of the physical therapy (PT) team approximately 2 h after admission to the post-anesthesia care unit (PACU). Motor strength was evaluated, and if deemed adequate, the patient was permitted to stand and then ambulate. In addition to patient demographics, we also examined the anesthetic agents administered intra-operatively, looking for differences in anesthetic techniques; spinal *vs* general anesthesia, type of local anesthetic, and adjuvant medications given.

All ultrasound-guided FIBs were performed by residents supervised by a single attending and using a standard technique. The femoral nerve and artery were identified on ultrasound and after moving laterally, a 22 gauge block needle was inserted below the junction of the lateral 1/3 and medial 2/3 of the inguinal ligament as described by a research[4]. Using an in-plane approach, 40 mL of 0.2% ropivicaine was injected beneath the fascia iliaca at the superficial fascial layer as showed in Figure 1

Statistical analysis

Group variable data were analyzed by parametric *t*-test: Based on our sample of 39 patients, it was concluded that the true probability a patient with no block is able to ambulate (89.5%) is higher than the true probability that a patient who underwent FIB is able to ambulate (5%). These results are statistically significant with 95% confidence and the two-tailed p value is less than 0.0001.

RESULTS

Perioperative data was collected on 39 patients who underwent THA. Demographic data appears in Table 1. The majority of patients received a single shot spinal as the primary anesthetic for their THA, with either isobaric bupivacaine (10-15 mg) or hyperbaric bupivacaine (12-15 mg). Twenty patients had FIBs placed at the conclusion of the procedure, while 19 did not receive a block. Of the 20 patients with FIB, only 1 patient was able to ambulate. Eighteen patients did not ambulate secondary to decreased muscle strength and sensation, while 1 patient was unable to walk due to severe nausea. Of the 19 patients without FIB blocks, 17 were able to ambulate. Two patients were not able to ambulate secondary to lethargy, but both were able to stand up with minimal assistance.

DISCUSSION

Although previous publications have promoted the use of FIB to provide excellent analgesia following THA as explained by Mudumbai *et al*[5], we observed that they were associated with delayed ambulation in the immediate postoperative period. While the FIB blocks the lateral femoral cutaneous nerve which is a sensory nerve, local anesthetic spread medially may result in direct block of the femoral nerve, causing quadriceps weakness and an inability to ambulate. Alternatively, there may be some retrograde spread of the local anesthetic into the lumbar plexus, which causes both weakness of quadriceps in addition to hip adductor weakness from obturator nerve involvement.

The concentration of local anesthetic used in FIB (0.2% ropivicaine) should not be enough to cause significant femoral motor blockade; however, the volume of 40cc may be a contributing factor.

Isobaric bupivacaine may be another contribution to prolonged muscle weakness and the prevention of immediate ambulation in the PACU. Our data indicate that this is not the case, since the ambulating and non- ambulating groups had similar spinal doses.

While FIB appears to delay ambulation, we also sought to determine if pain scores were improved in the block group. However, due to the retrospective nature of the study and lack of guidelines for documentation of pain scores, medications administered, and PACU length of stay; it was difficult to find consistent and reliable information. Further studies need to be done to address this issue in a standardized fashion.

With THA becoming a shorter stay, and in some cases an ambulatory procedure, it

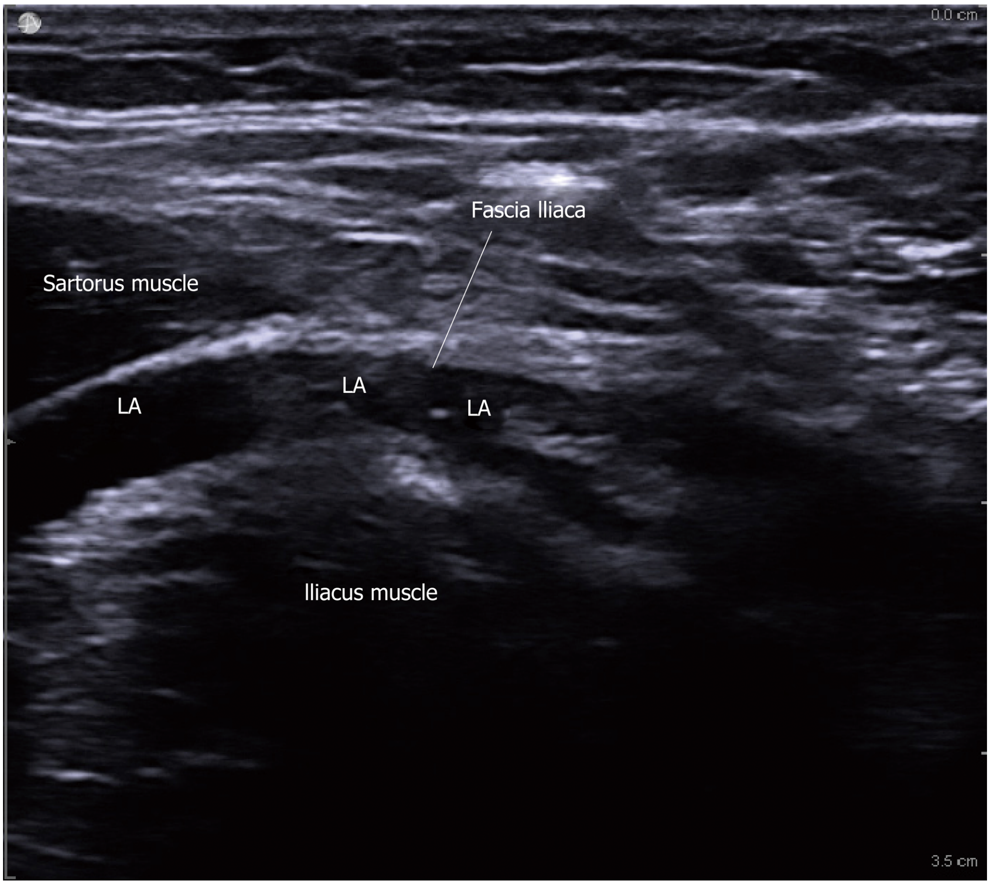

Figure 1 Ultrasound image of fascia iliaca plane block. Image is permitted and modified from Dr. Ali Shariat. LA: Local anesthetic injected beneath the fascia iliaca ligament.

is important to develop ERAS protocols, which will provide excellent pain control, while still allowing prompt post-operative ambulation. Though FIB may provide post-operative analgesia, it appears to be preventing ambulation and should not be included in an ambulatory THA pathway until further studies examine this relationship.

Table 1 Demographic data, anesthetic data, and ambulatory outcomes

Demographics	FIB	No block
Gender (F:M)	12:08	7:12
Average age (yr)	67.1	64.6
Average BMI	28.36	30.08
Anesthesia technique		
Spinal (isobaric:hyperbaric)	11:03	14:01
Combined spinal-epidural	1	4
Epidural	1	0
General anesthesia	4	0
Outcomes		
Ability to ambulate	1 (5%)	17 (89.5%)

FIB: Fascia iliaca compartment block; BMI: Body mass index.

ARTICLE HIGHLIGHTS

Research background
Peripheral nerve block has provided excellent analgesia for total joint replacement procedures. However, its associated motor weakness is undesirable in enhanced recovery after surgery (ERAS) protocol. While Fascia iliaca compartment blocks (FIBs) have been shown to be satisfactory in pain control and minimize quadriceps weakness after total hip arthroplasty (THA), their value is still debatable. Prior studies have demonstrated the superiority of FIBs and femoral nerve blocks for pain control and ambulation following THA as compared to standard therapy of parenteral analgesics on postoperative day (POD) 2-3. However, there are few studies that investigate how this block affects the ambulation in POD 0 after THA, the time of ambulation that is recommended and considered beneficial under the new ERAS guidelines.

Research motivation
The use and popularity of ERAS protocols has led to the need for a common post-operative anesthetic plan following THA. We sought to examine the relationship between FIB and delayed ambulation after THA.

Research objectives
We collected perioperative data on 39 patients following THA, some with and without FIBs, and evaluated their ability to ambulate in the immediate post-operative period on POD 0 with a physical therapy team.

Research methods
In this retrospective cohort study, the medical record and anesthetic records of patients undergoing THA with or without FIBs by a single physician throughout 2016 were reviewed. Patients that were evaluated by physical therapists promptly, within two hours, after arrival at the post-anesthesia care unit were identified. These patients were all evaluated for motor strength and if appropriate, were allowed to stand and ambulate. We additionally reviewed patient demographics as well as anesthetic agents administered intra-operatively in order to look for differences in anesthetic technique (*i.e.*, spinal *vs* general anesthesia, adjuvant medications given, and type of local anesthetic.) that may affect the early ambulation.

Research results
We found that all but one patient in the FIB group were unable to ambulate within 2 h post-operative, mainly due to weakness, significantly lower than the patients without FIB. While pain control appeared to be adequate, the lack of ambulatory ability poised a problem with early ambulation as part of the ERAS protocol.

Research conclusions
Out data indicated that there is significant correlation associated between the FIB and the delayed ambulation on POD 0 after THA. Despite the fact that the ERAS pathway of THA emphasized early ambulation during the immediate post-operative period and shorter stay in hospital, FIB appears to be interfering with this goal. Therefore, this post-operative pain control block should be excluded from the ERAS pathway of THA until further study.

Research perspectives
This study is based on the retrospective reviewing of the data and some crucial information, such as degree of the motor weakness and Oxford Hip Score in both pre and post-operatively, are not available. Therefore, to objectively determine the efficacy of FIB for post-operative pain management and its role in the ERAS protocol, a prospective control study should be

consideration. Going forward, the ideal pain management means for THA needs to be further examined in a way that can provide a common pathway for both pain control and early ambulation that satisfies the patients' comfort as well as ERAS protocols.

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OPINION REVIEW

Healthcare delivery cost and anesthesiologists: Time to have a greater role and responsibility

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Abstract

With the advancement of technology and health sciences, health care delivery costs are steadily increasing. This affects both households and governments. Unfortunately, the present truth is that health has become an essential but unaffordable commodity. This is very concerning. Quality, up-to-date, cost-effective health care delivery is one of the prime objectives, and focuses on administration and health care authority. As the per capita spent on health from public/government funds is very poor in developing countries, the responsibility of cost-effective health care delivery falls primarily on the shoulder of the treating physicians. Anesthesiologists are becoming an indispensable part of health care delivery, having a diverse role in the emergency, critical care, pain, and perioperative care of patients. As the population ages, the need for surgical care is also increasing. Therefore, the anesthesiologist can also play a more significant role in delivering cost-effective health care, and minimize the cost without affecting the quality. This brief narrative review analyzes the current practice of anesthesiologists in two prime areas in the context of cost-savings: Preoperative investigation and low/minimal flow anesthesia.

Key words: Health expenditures; Cost control; Anesthesiologists; Anesthesia

Core tip: Health care costs are escalating worldwide, affecting both governments and households. The need for surgery and interventional procedures are also steadily increasing. This has led to the increased requirement of clinical services from anesthesiologists. Therefore, anesthesiologists can also play an important role in cost containment. Two of the significant areas where cost reduction is possible are preoperative tests and the use of low and minimal flow anesthesia. However, a few factors may act as a hindrance to clinical practice. This opinion review paper discusses these issues and the possible remedial steps for providing cost-effective, quality healthcare, especially in developing countries.

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INTRODUCTION

Rising health care cost is becoming a more significant obstacle in both advanced and developed countries like the United States[1,2]. It affects both households and governments. Cost-effective health care delivery is not only the responsibility of the government, but also hospital administrations and health care providers. The responsibility of hospital administrations and health care providers takes a special position in developing and third world countries where the public sector expenditure to health is very minimal[3,4]. The active role of anesthesiologists in health care delivery is increasing, and encroachment of more extensive areas is happening day by day. Perioperative care is one of the most important areas of such a duty. A total of 28%-32% of the global disease burden comes from surgical diseases[5]. With an aging population, the requirement of surgical procedures has been predicted to increase by 14%-47%[6]. These data clearly show the current increased need of anesthesia and surgery services, with ample opportunity to fulfill the responsibility.

One of the components of surgical care expenditures is investigations.Inappropriate or unnecessary tests and procedures recommended by physicians, as well as frequent requests from patients, leads to wasteful health care spending[7]. Preoperative investigation, mainly routine preoperative investigation, is one such entity. The expenditure incurred by the government/administration or patient varies widely depending on the type of surgery and perioperative care. A study conducted in India has shown that the average expenditure by a patient for routine preoperative investigations, even in a subsidized, public sector hospital, is 1029 Indian rupees[8]. Spending on preoperative testing for even cataract surgery in Canada is $40 per surgery[9]. As the lion's share of health care delivery is from the private sector where the charges are not subsidized, the prices are expected to be very high in these situations. Studies have shown that routine preoperative investigation has very little to no effect on patient outcome[10,11], and there is a negative perception of routine investigations[12,13].

Anesthesiologists actively decide the intraoperative management of anesthesia maintenance. Nevertheless, many of the cases can be, and are being safely performed under regional anesthesia; a good number of patients still require general anesthesia (GA) for conducting surgery or interventions. Balanced, inhalational anesthetic-based GA is the most commonly practiced GA technique, and in cases other than total intravenous anesthesia, the maintenance phase of GA is usually managed with volatile anesthetics[14]. The consumption of volatile anesthetics directly depends on the fresh gas flow (FGF) used. It has been found that using low/minimal flow anesthesia reduces the cost of anesthesia[15]. Therefore, the anesthesiologists' decision and practice affects the cost of care. Although anesthesiologists are involved in multiple aspects of the clinical practice, this brief narrative review analyzes the current practices of anesthesiologists in the context of preoperative investigation and low/minimal flow anesthesia.

CURRENT PRACTICE OF PREOPERATIVE TESTING AND EVIDENCE

The American Society of Anesthesiologists and the National Institute of Health and Clinical Excellence (NICE) recommends against the routine use of preoperative investigations[12,13]. However, despite the current negative recommendations, the routine preoperative investigation practices are still very prevalent[16,17]. A study analyzing the impact of abnormal test results from routine preoperative investigations found that the implications of abnormal test results in changing anesthetic management is very minimal[8]. A similar study conducted in patients over 60 years old also found an insignificant impact in most of the cases[18]. Another study evaluating the effect of preoperative routine blood investigations in elderly patients who underwent oncosurgical procedures found that it did not predict the postoperative complication rate and did not influence anesthetic management[19].

Another study analyzing the usefulness of routine preoperative testing in developing countries found that abnormal tests were very much prevalent, but only 0-8.3% of the test results led to management changes[20]. Analysis of routine preoperative tests from the National Surgical Quality databases found that the postoperative outcomes were not associated with either testing or abnormal results in patients undergoing low-risk ambulatory surgeries[21]. A systematic review evaluating the effectiveness of non-cardiac preoperative testing in non-cardiac elective surgery did not find convincing evidence that preoperative testing was beneficial in healthy adults undergoing non-cardiac surgery[22]. However, abnormal test results in co-morbid patients were significantly and more frequently changing the anesthetic management compared to non-co-morbid patients in some disease-specific tests[23]. The systematic review also indicated that testing should be based on the specific pathology (co-morbidity / disease-specific).

CURRENT PRACTICE OF LOW AND MINIMAL FLOW ANESTHESIA AND EVIDENCE

The use of low and minimal flow anesthesia has many advantages, including reduced volatile anesthetic agent consumption[15]. With the advancement of anesthesia workstations and monitoring modalities, the precise management of carrier gases and volatile anesthetics has become a reality. The relatively new volatile anesthetic agents are costlier, yet their use becomes economically acceptable when used with lower FGF[24]. A study has shown that desflurane-based anesthesia is costlier[25]. However, a study has shown that the use of minimal flow anesthesia can even reduce the cost of desflurane-based anesthesia to a great extent, and can also be economically *via* for a long surgery duration[26]. A recent study has shown that the cost incurred for minimal flow anesthesia (FGF 500 mL/min) using sevoflurane was lower than low flow anesthesia (FGF 1L/min) for 1 MAChour of anesthesia[27]. The study also found that using sevoflurane for both induction and maintenance was more cost-effective[27]. Another study found that automated control of end-tidal sevoflurane with 500 mL/min FGF was very cost-effective when compared with conventional flow technique[28].

Similarly, real-time decision support that notified of excessive FGF was also found to be effective in delivering more cost-effective anesthesia[29]. This indicates that the scope for economical use and practice of the newer volatile anesthetic agents are there. Unfortunately, the practice of low and minimal flow anesthesia is still not universal. Two recent surveys showed that the acceptance of low flow anesthesia is still sparse, and that minimal flow anesthesia or even an FGF < 600 mL/min is far less[30,31]. Surveys also showed the lack of relatively advanced monitoring required for practicing low and minimal flow anesthesia[30,32]. Low flow anesthesia until now has remained an under-utilized yet effective and sustainable anesthesia practice modality[33].

LIMITATIONS FOR CLINICAL PRACTICES AND POSSIBLE REMEDIES

While anesthesia maintenance is in the hands of the anesthesiologist, preoperative investigations are not. Moreover, practicing minimal and low flow anesthesia usually requires advanced anesthesia workstations, agent monitoring, inspired and expired gas concentrations, *etc.*, The Association of Anaesthesiologists of Great Britain and Ireland recommends for the routine use of anesthesia gas monitoring when using volatile anesthetic-based anesthesia as a standard[34]. However, the availability of such advanced and costly modalities are not universal, especially in developing and third world countries. A recent survey conducted in India has shown that a good number of practicing anesthesiologists are using Boyle's machine. Not having the minimum alveolar concentration monitoring facilities results in them mostly practicing conventional or high flow anesthesia[30]. Similarly, guidelines and recommendations could not take out the apprehensions of medico-legal aspects, and harassment from the mind of practicing anesthesiologists. A survey has shown that even after acknowledging the negative recommendations and agreeing to abandon the routine preoperative testing, this was not possible, as many institutes have a protocol that is in favor of a battery of tests or so-called "routine testing"[16].

Prospective studies have also shown that most patients attend the pre-anesthetic assessment clinic with all of the possible tests performed by the surgical team[17]. Thus, it is imperative to have an interchange of thoughts between surgeons and anesthesiologists regarding the indications of different preoperative tests, especially the need for patient and surgery-specific tests. This is important not only to optimize the utilization of preoperative tests by surgeons, but also to increase team efficiency towards the cost-effective health care delivery by reducing unnecessary preoperative laboratory tests. Therefore, communication with surgeons must be a priority for anesthesiologists as a means of reducing these expenditures.

Similarly, anesthesiologists should also take into account the cost of volatile anesthetic agent use. Although desflurane can be cost-effective for long-duration surgery, it may not be the right choice for short procedures, even with low or minimal flow anesthesia[26]. This is because even low and minimal flow anesthesia needs high FGF in the initial phase of anesthesia. In such a situation, cheaper agents like Isoflurane are likely to be the right choice for cost reduction.

WHAT IS THEIR ROLE BEYOND CLINICAL PRACTICE?

By now, it is clear to us that the anesthesiologist does have a more significant role and responsibility to play in reducing the surgical care cost. However, their hands are bound to some extent by certain limitations like the administrative decision, equipment availability, and interdepartmental categories, especially anesthesia and surgical team co-cooperativeness. Therefore, only concentrating on the clinical practice aspect cannot provide most of the results in terms of cost-reduction. Anesthesiologists and anesthesia societies need to take a step towards formulating practice guidelines and protocols at the local hospital, regional, and national levels. They should approach the administration, convince them with concrete evidence, and discuss the pros and cons of having a better evidence-based protocol. An article welcoming the updated 2016 NICE preoperative test guideline suggested three-tier roles at the institute/hospital level, at the professional bodies/organization/societies level, and at the national health authority level, for maximum utilization of the recommendations[35]. With the advancement of electronic health record management and information technology, anesthesiologists and surgeons can work jointly to increase the coordination, which is likely to reduce the prescription of unnecessary preoperative testing[36]. However, an ongoing study will give us a better idea of this aspect in the future[37].

CONCLUSION

The anesthesiologist can play a vital role in reducing the cost of health care delivery, especially in surgical care. This requires better and greater implementation of low and minimal flow anesthesia, while discarding routine preoperative testing and adopting patient and surgery-specific preoperative investigations. However, limitations in clinical practice and applications exist, so this involvement in protocol formation and administration are therefore very essential. Governments/administrations should also take on anesthesiologists and/or anesthesia societies, while formulating plans and protocols for the greater interests of the patient and national economy.

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