



# Emergency upper urinary tract decompression: double-J stent or nephrostomy? A European YAU/ESUT/EULIS/BSIR survey among urologists and radiologists

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Received: 3 April 2021 / Accepted: 1 September 2021 / Published online: 14 March 2022  
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## Abstract

**Purpose** To evaluate the decompression of the pelvicalyceal system between urologists and radiologists.

**Methods** A survey was distributed to urologists and to radiologists comparing double-J stent (DJS), percutaneous nephrostomy (PN) and primary ureteroscopy (URS) for three clinical scenarios (1-febrile hydronephrosis; 2-obstruction and persistent pain; 3-obstruction and anuria) before and after reading literature. The survey included perception on radiation dose, cost and quality of life (QoL).

**Results** Response rate was 40% (366/915). 93% of radiologists believe that DJS offers a better QOL compared to 70.6% of urologists ( $p=0.006$ ). 28.4% of urologists consider PN to be more expensive compared to 8.9% of radiologists ( $p=0.006$ ). 75% of radiologists believe that radiation exposure is higher with DJS as opposed to 33.9% of urologists. There was not a difference in the decompression preference in the first scenario. After reading the literature, 28.6% of radiologists changed their opinion compared to 5.2% of urologists ( $p<0.001$ ). The change favored DJS. In the second scenario, responders preferred equally DJS and they did not change their opinion. In the third scenario, 41% of radiologists chose PN as opposed to 12.6% of urologists ( $p<0.001$ ). After reading the literature, 17.9% of radiologists changed their opinion compared to 17.9% of urologists ( $p<0.001$ ), in favor of DJS. Although the majority of urologists (63.4%) consistently perform primary URS, only 3, 37 and 21% preferred it for the first, second and third scenarios, respectively.

**Conclusion** The decision on the type of drainage of a stone-obstructing hydronephrosis should be individualized.

**Keywords** Pelvicalyceal obstruction · Decompression · Double-J stent · Percutaneous nephrostomy · Urologist · Radiologist

## Introduction

Upper urinary tract obstruction is caused by a variety of diseases. Definitive intervention is necessary in the majority of cases to correct the anatomical anomaly, release an acquired obstruction and prevent kidney function [1]. Urolithiasis is a common health problem that affects patients' quality of life, while septic episodes secondary to an infected obstructed system or to stone manipulation constitute the

major life-threatening complication related to urinary stones and/or their treatment [2].

Infection of a hydronephrosis caused by a ureteral stone can lead to systemic inflammatory disease, sepsis, septic shock and death [3]. As urosepsis is an independent risk factor for septic shock and mortality in patients with urinary tract obstruction [4], urgent decompression of the pelvicalyceal system (PCS) and prompt initiation of antibiotic therapy are mandatory life-saving initial steps [5].

Complete obstruction of the renal drainage system can lead to loss of function if left untreated.

Rarely, complete obstruction of the urinary tract when it involves a solitary kidney or bilateral obstruction endangers the overall renal function. Removing the blockage in these cases also prevents the loss of kidney units [6]. Furthermore,

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intractable pain in renal colic occasionally requires urgent decompression to heal [5].

Emergency decompression of the PCS is performed either by placement of a ureteral catheter (double-J stent; DJS) or by percutaneous nephrostomy (PN). There is great disagreement as to which of the two methods is best for the patient [7–10].

The European Association of Urology (EAU) guidelines for lithiasis recommend definitive treatment of the stone after infection or sepsis have been resolved [5]. However, there is an emerging role for the use of primary ureteroscopy (URS) in the management of non-infective ureteric stones [11].

As part of the specialty, the urologist is trained and performs DJS, PN and URS [5, 12]. Specialized radiologists can also place PN selectively or on an emergency basis. The literature suggests that both the urologist and the radiologist can safely place nephrostomies as long as they are properly trained [13].

Based on the above, the decision to choose between a DJS or PN to decompress the renal collecting system depends on several factors including the given clinical scenario and the physician's abilities and expertise. We designed a survey to see which upper urinary tract (UUT) drainage is preferred by either urologists or radiologists based on specific clinical scenarios before and after their reading of the current literature. At the same time, we present an overview of the literature that has been published on the subject.

## Materials and methods

A survey was designed by board members of the Young Academic Urologists (YAU), the European Society of Uro-Technology (ESUT) and the European Society for Urolithiasis (EULIS), all members of the European Urological Society (EAU), and was distributed through a free access google platform and twitter to all the members of the aforementioned societies and to members of British Society of Interventional Radiologists (BSIR).

All respondents were invited to answer six general questions about their profession and to express their views on patients' quality of life (QOL), cost and radiation exposure compared to the use of a DJS or PN to decompress the PCS. Then, all respondents were asked to answer how they prefer to drain the kidney, with a DJS, PN or URS, in three different clinical scenarios. The three clinical scenarios all involve ureteral stones that cause one of the following three conditions: febrile urinary tract infection, intractable pain or anuria. The responders were asked to answer the three questions before and after reading the suggested literature [10, 14, 15]. These three papers were selected as they are studies that compare the role of nephrostomy and ureteric

stent insertion for upper urinary tract drainage. They also provide and compare the outcomes regarding procedural and fluoroscopy time, resolution of infection or renal dysfunction, success and complication rates of the two techniques (Appendix 1). In addition, they were asked if the choice of the type of drainage was changed based on the 12-h work shift.

Urologists were asked to answer four additional questions about whether they perform PN themselves, whether they perform it with ultrasound guidance, whether they prefer the primary application of URS to treat ureteral stones and whether they perform URS under local anesthesia. The workplaces of the responders were divided into small (<250 beds), medium (250–500 beds), university (> 500 beds), or private hospitals (non-public hospital).

Finally, all responders were asked whether Covid-19 pandemic would change the choice of drainage. Appendix 1 shows the questionnaire used in the present study. Statistical analysis was performed, using Chi squared and Fisher's exact test presenting p values and 95% confidence intervals. A p value < 0.05 was considered statistically significant. A critical review of the current literature was conducted, the results of which are compared with the results of our study and contributed to the design of the final conclusion by the authors. Two ESUT members, SA and SB, acted as joint senior authors for this project.

## Results

Overall response rate was 40% (366/915). There were 366 questionnaire replies 310 (84.7%) from urologists and 56 (15.3%) from radiologists. Respondents answered all questions at a rate of over 93.7. There were 58 (15.9%), 101 (26.6%), 89 (24.3%), 44 (12.0%), and 74 (20.4%) respondents with less than 2 years, 3–5 years, 6–10 years, 11–15 years and more than 15 years of internship, respectively. Of the 335 respondents to the relative question, 12 (3.6%), 57 (17%), 242 (72.2%), and 24 (7.2%) work in small, medium, university or private hospitals, respectively.

There was not an agreement as to which drainage method most affects patients' QOL. Of the 310 respondent urologists, only 219 (70.6%) believe that the DJS offered a better QOL. On the contrary, of the 56 responding radiologists, 52 (93%) stated the same. This was a statistically significant difference ( $p=0.006$ ). Agreement was also not reached on which method is considered more expensive. Of the 310 responding urologists, 164 (53%) consider DJS placement more expensive, while 32 of the 56 (57.1%) responding radiologists also considered the DJS insertion to be more expensive. However, 88 out of 310 (28.4%) urologists believe that PN is more expensive compared to only 5 out of 56 (8.9%) radiologists who believe the same. In addition, only 58 out

of 310 (18.7%) urologists consider that the two methods cost the same as opposed to 19 out of 56 (34%) radiologists who consider the same. The overall difference between the views of urologists and radiologists is statistically significant ( $p=0.006$ ).

Furthermore, there was no agreement between urologists and radiologists as to which method would expose the patient to more radiation. The urologists appeared divided. Of the 310 urologists, 105 (33.9%) believe that DJS placement is associated with more radiation exposure, 119 (38.4%) believe that PN placement is associated with higher radiation exposure, and 86 (27.7%) believe that both expose the patient the same. In contrast, of the 56 radiologists who participated in the study, 42 (75%) believe that radiation exposure is greater when a DJS is placed. Only 6 (10.7%) radiologists answered that PN exposes the patient to higher doses of radiation while 8 (14.3%) consider that radiation exposure is the same as the placement of a DJS or PN. The aforementioned difference between the urologist and nephrologist perception was statistically significant ( $p < 0.001$ ) (Table 1).

In the clinical scenario of the first case, a 40-year-old woman with a 9 mm stone in the upper third of the ureter that blocked the PCS as shown by the computed tomography presents to the hospital with a fever of 38 °C and increased inflammation markers. Of the 310 urologists who responded, 167 (53.9%) preferred DJS placement and 81 (26.1%) PN as opposed to 56 radiologists, of whom 42 (75%) prefer to have a PN while only 11 (11.6%) support the use of a DJS. This difference was not statistically significant ( $p=0.08$ ). The preference of urologists did not change significantly after reading the proposed literature ( $p=0.37$ ). Similarly, the preference of radiologists did not change significantly after reading the proposed literature ( $p=0.21$ ). However, there was a statistically significant difference between the change of views of urologists and radiologists after reading the proposed studies. Only 16 of the 310 (5.2%) urologists changed their minds by reading the literature compared to 16 of the 56 (28.6%) radiologists ( $p < 0.001$ ). This difference is due to the change in the opinion of radiologists in favor of DJS placement (Table 2).

In the clinical scenario of the second case, a 27-year-old man with a body mass index of 45 and a stone 10 mm in the middle of the ureter with concomitant hydronephrosis

shows pain that persists and does not respond to conservative treatment. Of the 310 urologists who responded, 185 (59.6%) preferred DJS placement and 7 (2.2%) PN, while among 56 radiologists 33 (59%) also chose DJS placement and 9 (16.6%) chose PN. This difference was statistically significant ( $p=0.003$ ). In this clinical scenario, primary URS was preferred by 111 (36%) urologists and 11 (20%) radiologists. This difference was statistically significant ( $p=0.02$ ). The preference of both urologists ( $p=0.14$ ) and radiologists ( $p=0.64$ ) did not change after reading the proposed literature. In addition, the rate of change of opinion after reading the studies did not differ among urologists and radiologists ( $p=0.11$ ) (Table 2).

In the clinical scenario of the third case, a 60-year-old man with a solitary kidney is admitted to the hospital with renal colic, anuria and impaired renal function due to a 6 mm obstructive stone in the middle of the ureter. Out of 310 urologists who answered for this case 63 (20.4%) chose the URS, 178 (57.4%) the DJS and 39 (12.6%) the PN. Of the 56 radiologists who answered for this case, 2 (4%) chose URS, 26 (46%) the DJS and 23 (41%) the PN. The overall difference was statistically significant ( $p < 0.001$ ).

The preference of both urologists ( $p=0.83$ ) and radiologists ( $p=0.55$ ) did not change after reading the proposed literature. However, the rate of change of opinion after reading the studies differed significantly between urologists (8/310; 2.6%) and radiologists (10/56; 17.9%) ( $p < 0.001$ ). This difference is due to the change in the opinion of radiologists in favor of DJS placement (Table 2).

From the questions that were addressed only to the urologists, it was shown that half of them perform PN themselves (158/310; 51.3%) and insert it under ultrasound guidance quite often (158/308; 51.3%). Of the 309 urologists who answered the question about the primary URS, 196 (63.4%) and 85 (27.5%) answered that they performed it regularly or occasionally, respectively (Table 3). This decision did not depend on the type of hospital where they practiced urology ( $p=0.96$ ). The majority of urologists (251/308; 81.5%) avoid performing URS only under local anesthesia (Table 3). The choice of the type of drainage for both urologists and radiologists is not affected by the 24-h shift. The Covid-19 pandemic did not affect the opinion of urologists, as 62.1% (190/306) would not change their opinion on how to drain an obstructive system.

**Table 1** Differences in opinion between cost, QoL and radiation dose associated with double-J stent (DJS) or percutaneous nephrostomy (PN)

	Urologist (n = 310)			Radiologist (n = 56)			p (Chi-square)
	DJS	PN	Either PN or DJS	DJS	PN	Either PN or DJS	
Which offers better quality of life?	219 (70.6%)	33 (10.7%)	58 (18.7%)	52 (93%)	2 (3.5%)	2 (3.5%)	0.006
Which is more expensive?	164 (53%)	88 (28.3%)	58 (18.7%)	32 (57.1%)	5 (8.9%)	19 (34%)	0.006
Which involves more radiation?	105 (33.9%)	119 (38.4%)	86 (27.7%)	42 (75%)	6 (10.7%)	8 (14.3%)	<0.001

**Table 2** Choice of urinary drainage for the three scenarios between urologists and radiologists, before and after reading the evidence provided to them (double-J stent (DJS) or percutaneous nephrostomy (PN))

	Urologist (n = 310)						Radiologist (n = 56)						p (Chi-square)		
	PN			DJS			Primary URS			Either PN or DJS				p (Chi-square)	
Scenario 1	Pre	81 (26.1%)	167 (53.9%)	9 (2.9%)	53 (17.1%)	42 (75%)	11 (19.6%)	1 (1.8%)	2 (3.6%)	0.37	42 (75%)	11 (19.6%)	1 (1.8%)	2 (3.6%)	0.21
	Post	88 (28.4%)	159 (51.3%)	10 (3.2%)	53 (17.1%)	35 (62.5%)	16 (28.5%)	0	5 (9%)		35 (62.5%)	16 (28.5%)	0	5 (9%)	
	Total change	16/310 (5.2%)				16/56 (28.6%)					16/56 (28.6%)				<0.001
Scenario 2	Pre	7 (2.2%)	185 (59.6%)	111 (36%)	7 (2.2%)	9 (16%)	33 (59%)	11 (20%)	3 (5%)	0.14	9 (16%)	33 (59%)	11 (20%)	3 (5%)	0.64
	Post	13 (4.2%)	173 (55.8%)	117 (37.8%)	7 (2.2%)	11 (20%)	32 (57%)	8 (14%)	5 (9%)		11 (20%)	32 (57%)	8 (14%)	5 (9%)	
	Total change	24/310 (7.7%)				8/56 (14.3%)					8/56 (14.3%)				0.11
Scenario 3	Pre	39 (12.6%)	178 (57.4%)	63 (20.4)	30 (9.6%)	23 (41%)	26 (46%)	2 (4%)	5 (9%)	0.83	23 (41%)	26 (46%)	2 (4%)	5 (9%)	0.55
	Post	39 (12.6%)	174 (56.1%)	67 (21.7%)	30 (9.6%)	22 (39.3%)	22 (39.3%)	3 (5.4%)	9 (16%)		22 (39.3%)	22 (39.3%)	3 (5.4%)	9 (16%)	
	Total change	8/310 (2.6%)				10/56 (17.9%)					10/56 (17.9%)				<0.001

## Discussion

Urinary stones are a common condition that affects a patient's QOL in a variety of ways.

Upper urinary tract (UUT) stones often cause acute obstruction of the PCS which causes severe pain which is sometimes resistant to medication, while it can lead to loss of the corresponding renal unit or even endanger the life of the patient especially if hydronephrosis is complicated by infection. The decompression of the pelvicalyceal system in these cases can be done either temporarily by placing a DJS or a PN or permanently by ureteroscopic removal of the stone that causes the obstruction.

Of the cases mentioned above, the most urgent is obstructive pyelonephritis as surgical decompression of the kidney has been shown to be associated with a reduction in mortality in patients with sepsis and ureteral stone. In a retrospective study, among 1712 patients who presented with stone obstruction and sepsis, a percentage of 78% underwent surgical decompression mainly by placement of a ureteral catheter ( $n = 933$ ), or nephrostomy ( $n = 390$ ). The study showed that patients who did not undergo decompression were 2.6 times more likely to die during their hospitalization ( $p < 0.001$ ) [16].

The ideal drainage method should be easily applicable, have complete success, be inconsistent with complications and not affect the QOL of patients. Three reviews, the last systematic, which took place a decade apart, agreed that there is no ideal way to drain [9, 17, 18].

There are many reasons why there is no consensus on whether a DJS or a PN is the best way to drain a hydronephrosis. The literature is full of comparative studies [7, 10, 14, 15, 19–28] but only six are randomized controlled trials (RCTs) [10, 14, 15, 25–27]. The successful application of early URS after decompression of a febrile hydronephrosis due to a stone [29–31] led to the application of ureteroscopy as a primary method of drainage of the UUT [32]. As a result, comparative studies [22, 33] and RCTs [34] between URS, DJS, or PN have been published as methods of immediate renal decompression.

Unfortunately, the RCTs are not well designed, and they are non-multicenter studies and involved a small number of patients, which by definition reduces their power. The lack of high-quality clinical trials is mainly due to the heterogeneity of clinical scenarios after which lithiasis patients appear. Consequently, the results of a well-designed study with a specific end purpose will not be easy to apply widely.

In addition, RCTs can show a difference only for the primary goal they set, e.g., successful or unsuccessful removal of the obstruction, the impact of complications, the QOL of patients or the cost to the medical system.

**Table 3** Questions addressed only to urologists (GA general anesthesia, LA local anesthesia, IR interventional radiology)

	Urology			
Do you perform nephrostomy insertion yourself or ask interventional radiologist?	Urology 159 (51.5%)		Interventional radiology 150 (48.5%)	
Do you perform primary ureteroscopy for ureteric stones?	Occasionally 85 (27.5%)	Yes 196 (63.4%)	No 28 (9.1%)	
Do you perform local anesthetic ureteroscopy?	Occasionally 35 (11.4%)	Yes 22 (7.1%)	No 251 (81.5%)	
During nephrostomy placement, do you perform ultrasound scan yourself?	Occasionally 6 (2%)	Yes 158 (51.3%)	IR 130 (42.2%)	No 14 (4.5%)
Would Covid-19 pandemic change your preferred choice of drainage?	GA 17 (5.5%)	Nephrostomy 56 (18.4%)	LA 43 (14%)	No 190 (62.1%)

If we want to design a study to demonstrate a statistically significant predetermined difference for more than one parameter then the number of patients to participate increases significantly, which is difficult in clinical practice and may be immoral to perform in urgent and dangerous to life situations.

An additional problem for the correct choice of drainage method is the fact that its decision often involves different medical specialties such as physicians, urologists, oncologists and radiologists.

We conducted a study using a questionnaire sent to both urologists and radiologists. We consulted on three different clinical scenarios before and after reading the international literature as listed in a table of data from three RCTs.

The majority of both urologists and radiologists believe that a DJS is associated with a better QOL. In fact, a larger percentage of radiologists preferred the DJS. None of the RCTs of the literature was designed with the primary endpoint in the difference in QOL. In one RCT, a questionnaire was used which was completed by 40 patients immediately after drainage and 2–4 weeks after decompression of the PCS from a stone that caused hydronephrosis with or without fever. Although QOL was initially better and gradually improved more in patients who had PN, the difference was not statistically significant and the overall impact on QOL was generally low with both methods [15].

In a prospective study, 75 patients who underwent decompression to treat a febrile hydronephrosis, acute renal failure, or drug-resistant pain were asked to answer two QOL questionnaires at two points; on discharge and when re-admitted to deal with the problem permanently [28]. The patients' answers to the first ("Tube symptoms") questionnaire upon discharge from the hospital showed that patients with DJS had a higher rate (80.1 vs 31%;  $p < 0.001$ ) of lower urinary tract symptoms while patients with PN had worse mobility (86.2 vs 42.9%;  $p = 0.002$ ) and personal hygiene (60.7 vs 33.3%;  $p = 0.014$ ). Upon admission to the hospital for definitive treatment, the only statistically significant difference that remained was in

the symptoms of the lower urinary tract which was again more in the group of patients with DJS (80.6 vs 45.5%;  $p = 0.034$ ). The answers to the second questionnaire (Euro-QoL EQ-5D) showed that at the time of discharge from the hospital the usual activities (19 vs 57.70%;  $p = 0.005$ ) and the possibility for personal care of the patient (7.10 vs 37.90%;  $p = 0.004$ ) were better in those who they had a DJS. At the time of definitive treatment, patients who underwent PN had a lower rate of anxiety or depression (0 vs 19.40%;  $p = 0.012$ ) and higher rates of good health (83.2 vs 68.6%;  $p = 0.016$ ) [28]. These findings were confirmed in another prospective non-randomized study which also used two QOL questionnaires which further showed that patients who had a DJS had a higher incidence of hematuria (68.7 vs 16.7%;  $p < 0.001$ ) and greater need for analgesics ( $p = 0.018$ ) [7]. Despite advances in materials technology, patients' views have not changed as shown by the first QOL comparative survey published 20 years ago [35].

Our study showed that both urologists and radiologists believe that a DJS is more expensive than a PN. Of all the experts who believe that PN is more expensive, the majority were urologists, while of those who answered the questionnaire saying that the two methods cost the same, the majority were radiologists.

Cost was not a primary endpoint in any of the RCTs. Pearle et al. considered cost as a secondary endpoint and showed that DJS placement (\$2,401.33) was more than twice as expensive as PN placement (\$1,137.01). The surgery equipment and the operating time, the compensation of the anesthesiology team and the use of the recovery room were responsible for the higher cost of the DJS placement.

According to our study, radiologists believe that the placement of a PN exposes the patient to less radiation. The urologists appeared divided in their opinion. In the literature, radiation exposure has not been studied comparatively during emergency decompression of the PCS. A systematic review of the literature showed that fluoroscopy was most commonly used for either DJS placement or PN [17].

Although fluoroscopy time is not a direct indicator of radiation exposure, two RCTs showed shorter surgery and irradiation times during DJS placement [10, 14].

Although it is not the subject of the present study to review the radiation exposure of patients undergoing DJS or PN, our experience shows that PN placement under ultrasound guidance alone is effective, safe and does not expose the patient to radiation [12].

We used three clinical scenarios for which we asked participants to answer prior to and after reading the proposed literature. The main reason was that comparative studies to date have been performed in a wide clinical range of patients, for example in patients with infection or sepsis and obstruction without a clear separation of specific clinical cases. As already mentioned, this fact is responsible for some conflicting results that make it difficult for the expert to take a clear position in favor of one or the other method. For example, a systematic review of the literature showed that treating physicians preferred and performed PN more often when the stone causing the obstruction was large in size, the patient was seriously ill, or they themselves worked in a large urban training center [17]. Although this systematic review showed that higher rates of sepsis, longer hospital stays, and higher costs were associated with PN placement, this result could well be due to patient's choice [17].

In the first clinical scenario, febrile hydronephrosis, most urologists preferred DJS placement. Nevertheless, radiologists changed their minds more often in favor of the DJS after reading the literature. Although we did not ask for a justification for the change and as both methods were equally effective and without serious complications, we believe that the radiologists were affected by the shorter surgical and radiological time when a DJS was placed, as shown in the RCTs [10, 14, 15]. In the second clinical scenario, obstruction with intractable pain, more radiologists than urologists preferred PN and did not change their mind after reading the studies. Only in one of the RCTs were patients with intractable pain included [15]. Unfortunately, the study was not designed exclusively for these patients, and the authors did not present their results in detail based on the criteria for inclusion in the study. In the third clinical scenario, anuria and impaired renal function in a single kidney, the majority of both urologists and radiologists chose the DJS. However, more radiologists initially preferred PN, although they frequently changed their view in favor of the DJS after reading the literature. Two RCTs, one for children [27] and one for adults [26], were designed with the primary endpoint in correcting anuria and renal impairment. The first study recommended DJS placement as complications were greater after PN placement. The second study recommended the placement of a PN by the urologist himself as its placement was faster and resulted in lower rates of infection after the intervention compared to the placement of a DJS.

Our study showed that although the majority of urologists (63.4%) consistently perform primary URS, only 3% preferred it for the first clinical scenario, 37% for the second scenario and 21% for the third scenario. The response of urologists who did not insert PN was also not too dissimilar. The literature mainly supports the placement of a PN in acute septic patients. However, URS can be performed in selected cases [32]. Wang et al. designed a RCT comparing PN to URS in 107 patients with sepsis due to an impacted stone [34]. The primary endpoint was the return of white blood cells to normal and the fall of the fever, while the secondary endpoints were the use of analgesics, the time of hospitalization and the complications. There was no difference in the primary endpoint and complications, which is why the authors argue that ureteroscopy should not be contraindicated in patients with sepsis due to obstructive stone.

Decision making in patients with obstructed upper urinary tract should ideally be based on patient choice and informed consent, clinical condition and availability of stent or nephrostomy, and protocol based in close collaboration and discussion between the urologists and radiologists [36]. There is no other similar study in the literature which compares the views of radiologists and urologists on includes various clinical scenarios of UUT drainage. Although the response rate was high in general from urologists, there were less radiology responders compared to the urologists, although the ratio of responders was similar. This issue of UUT drainage dilemma is an everyday clinical practice which all urologists have to deal with. Although it is a well-designed study, yet this is only a survey with the inherent limitations of the survey. Although the ratio of urologists and radiologists were good, overall a limited number of radiology responses were obtained, which were around a fifth of urology responses. Similarly, there is a lack of high-quality randomized control trials which were used for the clinical scenarios to support our view, which inevitably impair the clinical decision making of these complex clinical situations. The difference of procedural cost between PN and DJS in countries could have influenced the choice of treatment, but we did not look at the cost of procedures. Future studies should look into the cost of interventions, which could also influence the intervention chosen.

## Conclusion

Based on the results of our study and the literature review, we believe that until there are well-designed RCTs for different clinical questions, the decision on the type of drainage for a stone-obstructing hydronephrosis should be individualized. The design and implementation of an in-hospital protocol, common to urologists and radiologists, reduced time to

decompression, hospital stay, and improved overall clinical outcome are needed in critically ill patients.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s00345-022-03979-4>.

**Author contributions** Protocol/project development: AP, LMS, Amad ASA, and SM. Data collection or management: AP, PK, TT, LT, KS, AG, EE, ES, and AS. Data analysis: RG. Manuscript writing/editing: AP, BPR, ZBMH, EL, JGR, ASk, and BKS.

**Funding** Not applicable.

**Data availability** Available to the journal and editor by the corresponding author.

**Code availability** Not applicable.

## Declarations

**Conflict of interest** None.

**Research involving human participants and/or animals** Not applicable.

**Informed consent** Not applicable.

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