



# The impact of single-use digital flexible cystoscope for double J removal on hospital costs and work organization: A multicentric evaluation

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## Abstract

**Background:** Isiris- $\alpha$ <sup>®</sup> is a single-use digital flexible cystoscope with an integrated grasper designed for double J (DJ) stent removal. Aim of this study was to conduct a multicentric evaluation of the costs and criticalities of stent removals performed with Isiris- $\alpha$  in different hospitals and health systems, as compared to other DJ removal procedures.

**Methods:** After gathering 10 institutions worldwide with experience on Isiris- $\alpha$ <sup>®</sup>, we performed an analysis of the reported costs of DJ removal with Isiris- $\alpha$ <sup>®</sup>, as compared to the traditional reusable equipment used in each institution. The cost evaluation included instrument purchase, Endoscopic Room (EnR)/ Operatory Room (OR) occupancy, medical staff, instrument disposal, maintenance, repairs, decontamination or sterilization of reusable devices.

**Results:** The main factor affecting the costs of the procedure was OR/EnR occupancy. Decontamination and sterilization accounted for a less important part of total costs. Isiris- $\alpha$ <sup>®</sup> was more profitable in institutions where DJ removal is usually performed in the EnR/OR, allowing to transfer the procedure to outpatient clinic, with a significant cost saving and EnR/OR time saving to be allocated to other activities. In the only institution where DJ removal was already performed in outpatient clinics, there is a slight cost difference in favor of reusable instruments in high-volume institutions, given a sufficient number to guarantee the turnover.

**Conclusion:** Isiris- $\alpha$ <sup>®</sup> leads to significant cost benefit in the institutions where DJ removal is routinely performed in EnR/OR, and brings significant improvement in organization, cost impact and turnover.

## Keywords

Flexible cystoscope, Isiris, cost, organization, single-use

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## Introduction

Isiris- $\alpha$ <sup>®</sup> is the first single-use device dedicated to double J (DJ) removal, designed to give an easy access to flexible cystoscopy and to streamline the process of stent removal. It has been well demonstrated that the device is effective and functional, allowing to perform the procedure without the aid of an assistant.<sup>1,2</sup> The device gives the possibility of DJ removal outside of a dedicated endoscopy room (EnR)/operating room (OR), which reduces patient stress and brings a significant amount of EnR/OR time saved, while avoiding unpleasant overbooking.<sup>3</sup> Isiris- $\alpha$ <sup>®</sup> is a versatile tool and the procedures can be easily scheduled, possibly leading to a decreased stent indwelling time, which often depends more on the availability of the EnR/OR than on clinical reasons. The main issues concerning Isiris- $\alpha$ <sup>®</sup>, however, are not related to its functionality but to its costs: since this endoscope is single-use and does not require a dedicated place for stent removal, cleaning and storage, the only direct costs with this technology are of Isiris- $\alpha$ <sup>®</sup> itself. Given the different settings of DJ removals in each institution, it is a real challenge to give an accurate and generalized estimation of the costs of the procedure. Indeed, DJ removal may be routinely performed in the EnR/OR or in outpatient clinic. Reprocessing of reusable cystoscopes may be done through high-level disinfection (HLD) process or low temperature sterilization, which can be performed inside the hospital or outsourced. Furthermore, several other options can be considered for DJ removal, including the use of DJ with retrieval strings,<sup>4</sup> or disposable sheaths to avoid the sterilization of reusable flexible cystoscopes.<sup>5</sup> All these elements limit the generalization of a cost analysis drawn from a single center.

Aim of this study was to conduct a multicentric report about cost impact evaluation of DJ removal procedure performed with Isiris- $\alpha$ <sup>®</sup> in different hospitals and health systems, as compared to other options routinely adopted.

## Methods

After gathering 10 institutions worldwide with experience on Isiris- $\alpha$ <sup>®</sup>, as shown by previous publications,<sup>3,6-10</sup> we performed an analysis of the costs related to DJ removal with Isiris- $\alpha$ <sup>®</sup>, according to different hospital settings and health systems. Both consultants and residents performed DJ removals. Among the items considered, we included: cost of the device (different per country/site); cost of the monitor (in some cases in free loan); cost of the procedure setting (EnR/OR, outpatient); cost of medical staff; cost of reusable instrument; cost of maintenance and repairs; cost of disposal; cost of instrument decontamination and sterilization. In some cases, we reported the impact of Isiris- $\alpha$ <sup>®</sup> on parameters related to the hospital work organization, such as EnR/OR time saved, DJ indwell time, urinary tract infection (UTI) rates, and hospital readmissions. This

research was conducted in accordance with the Helsinki Declaration.

## Double J removal with Isiris- $\alpha$ <sup>®</sup>

Isiris- $\alpha$ <sup>®</sup> (Porgès-Coloplast) is a single-use digital flexible cystoscope with an integrated grasper designed for DJ stent removal (Figure 1). It is equipped with a metal oxide semiconductor sensor located at the tip of the endoscope and provides 0° direct view with 85° field of vision. The scope is connected via a cable to a reusable dedicated 8.5-inches LCD portable monitor.<sup>1,2</sup> Stent removals can be performed in outpatient clinic by healthcare professionals (surgeon or nurse according to country), with xylocaine gel anesthesia, removing the stent with the integrated grasper by activating the button on the handle of the device.

## Results







Table 1 shows the cost estimates per DJ removal in settings, including OR, EnR, and outpatient clinic. We highlight the extreme variability of costs across different institutions and countries. In general, the main factor affecting the costs of the procedure is OR/EnR occupancy (ranging from 250€ to 1.125€ for 30'). Decontamination and sterilization account for a small portion of total costs (from 17.5€ to 60.5€ per procedure). Isiris- $\alpha$ <sup>®</sup> appears more beneficial in institutions where a transfer of stents removals to outpatient office is feasible, and when the cost resulting from the EnR/OR immobilization have been considered in the calculation. In most cases, a significant saving (from 41€ to 745€) per procedure is reported. In the only institution (Columbus, Ohio) where DJ removal with Isiris is performed in the same setting than the traditional procedure, there is a slight cost benefit in favor of reusable material.

The impact of Isiris- $\alpha$ <sup>®</sup> on work organization of participating centers is summarized in Table 2, together with an estimation of the potential economic benefit derived from the use of a single-use instrument. According to reported experiences, the single-use device allows to free a significant amount of EnR/OR time that can be dedicated to other surgeries, and provides that a sufficient number of cystoscopes is always available to guarantee an effective turnover, leading to shorter DJ indwelling times. These factors result in potential additional income.

## Discussion






In many hospitals the removal of DJ stents is performed in a dedicated EnR or in alternative in the OR, with a great amount of time spent at the possible expense of other surgeries. In both the EnR and the OR, the entire length of the procedure is estimated at around 30 min,

**Table 1.** Cost estimates per procedure in different institutions and settings.






Authors	City, hospital	Costs/procedure, Single-use cystoscope	Costs/procedure, reusable cystoscope	Cost benefits	
Oderda 	Molinette Hospital, Torino (ITA)	Setting: outpatient clinic Device: Isiris™ # procedures: NR Purchase of instrument: 317 € VAT-incl LCD monitor purchase: free loan Urologist/nurse work: 39.2€ TOTAL, per-use: 356.2 €	Setting: EnR Device: Storz™ flexible cystoscope # procedures: NR Purchase of instrument and grasper: 44.1 € Repairs fee: 14.1 € Urologist/nurse work: 39.2 € Decontamination and sterilization: 17.5 € EnR cost (for 30'): 386.5 € TOTAL, per-use: 501.4 €	+145.1 €	
Pietro Paolo, Somani 	Southampton Hospital, Southampton (UK)	Setting: outpatient clinic Device: Isiris™ # procedures: 35 Purchase of instrument: 250 £ VAT-incl LCD monitor purchase: free loan Consumables : 2.1 £ VAT-incl TOTAL, per-use: 252.2 £	Setting: EnR Device: Pentax digital flexible cystoscope # procedures: 37 Purchase of instrument and grasper: 49.4 £ Reprocessing consumables: 67.6 £ Reprocessing wages: 21.9 £ Purchase of instrument and grasper: 49.4 £ Room immobilization: 109.3 £ Maintenance repair: 15.3 £ Cost of complications (3 URS removal of encrusted stent): 98.2 £ TOTAL, per-use (without complications): 267.2 £ TOTAL, per-use (with complications): 365.4 £	+112.8 £ (+127.55 €)	
Falcone 	Clinica Sedes Sapientiae, Torino (ITA)	Setting: outpatient clinic Device: Isiris™ # procedures: 17 Purchase of instrument: 250 € VAT-incl LCD monitor purchase: free loan Urologist/nurse work : 17.5 € TOTAL, per-use: 257.7 €	Setting: EnR Device: Storz™ flexible cystoscope # procedures: NR Purchase of instrument and grasper: 50 € Repairs fee: 20 € Urologist/nurse work: 17.5 € Decontamination and sterilization: 17.5 € EnR cost (for 30'): 350 € TOTAL, per-use: 455 €	+197.5 €	
Knudsen 	Columbus, OH (USA)	Setting: outpatient clinic Device: Isiris™ # procedures: NR Purchase of instrument. TOTAL, per-use: 200 \$	Setting: outpatient clinic Device: Olympus™ flexible cystoscope # procedures: 871 Purchase of instrument, repair fee (based on 1-yr contract), sterilization equipment, reprocessing, labor and accessory costs. TOTAL, per-use: 161.85 \$ (break-even point estimated at 705 DJ removals)	-38.15 \$ (-34.61 €)	
Oderda 	San Lazzaro Hospital, Alba (ITA)	Setting: outpatient clinic Device: Isiris™ # procedures: 127 Purchase of instrument: 317 € VAT-incl LCD monitor purchase: 26.5 € Urologist/nurse work: 17.5€ TOTAL, per-use: 361 €	Setting: OR Device: Storz™ flexible cystoscope # procedures: 170 Purchase of instrument and grasper: 44.1 € Repairs fee: 14.1 € Urologist/nurse work: 25.6 € Decontamination and sterilization: 17.5 € OR cost (for 30'): 1.025.5 € TOTAL, per-use: 1.126.8 €	+765.8 €	
Doizi 	Tenon Hospital, Paris (FRA)	Setting: outpatient clinic Device: Isiris™ # procedures: NR  Purchase of instrument: 250 € Instrument elimination: 0.6 € Office cost (for 30'): 34.8 € TOTAL, per-use: 285.4 €	Setting: EnR Device: flexible cystoscope # procedures: 603 Purchase of instrument, grasper and maintenance 9.2 € Decontamination: 30.5 € Sterilization: 30 € EnR cost (for 30'): 260 € TOTAL, per-use: 329.7 €	Setting: OR Device: flexible cystoscope # procedures: 6 Purchase of instrument, grasper and maintenance 14.6 € Decontamination: 30.5 € Sterilization: 30 € OR cost (for 30'): 350 € TOTAL, per-use: 425,1 €	+44.3 € +139.7 €

(Continued)

**Table 1.** (Continued)






Authors	City, hospital	Costs/procedure, Single-use cystoscope	Costs/procedure, reusable cystoscope	Cost benefits
Phan 	Hereford County Hospital, Hereford (UK) <sup>10</sup>	Setting: EnR Device: Isiris™ # procedures: 10 Purchase of instrument: 250 £ Cost and breakdown: 7.63 £ Other costs: NR TOTAL, per-use: 260.65 £	Setting: EnR Device: Olympus™ flexible cystoscope # procedures: 10 Purchase of instrument, grasper and maintenance, EnR cost: NR Reprocessing cycle: 10.94 £ Cost and breakdown: 28.35 £ TOTAL, per-use: 123.41 £	-137.24 £ (-149.02 €)
Estrade 	Centre Hospitalier d'Angouleme, Angouleme (FR)	Setting: outpatient clinic Device: Isiris™ # procedures: 23 Purchase of instrument: 250 € Office cost (for 30'): 34.8 € TOTAL, per-use: 284.8 €	Setting: EnR Device: flexible cystoscope # procedures: 7 Purchase of instrument, maintenance, reprocessing: 126 € EnR occupancy (for 30'): 250 € TOTAL, per-use: 326 €	+41.2 €
Grey 	Manchester University Hospital, NHS Foundation Trust, Manchester (UK)	Setting: outpatient clinic Device: Isiris™ # procedures: 27 Use of Isiris™ in kidney transplant patients provides an annual saving of approximately 30,000 £ based on the annual volume of approximately 300 kidney transplants.	Setting: EnR/OR Device: flexible cystoscope # procedures: NR	+100 £ (+116.46 €)
Grey 	Manchester Hospital Foundation Trust, Manchester (UK)	Setting: ER Device: Isiris™ # procedures: NR Equipment cost: 258 £ ED attendance: 132 £ 24 h on a ward: - 1 h emergency theater: - TOTAL, per-use: 390 £	Setting: OR Device: flexible cystoscope # procedures: NR Equipment cost: 95 £ ED attendance: 132 £ 24 h on a ward: 303 £ Cost of emergency theater (for 30'): 500 £ TOTAL, per-use: 1030 £	+640 £ (+745.32 €)
Alhamri 	King Abdulaziz Medical City, Riyadh, Saudi Arabia	Setting: OR Device: Isiris™ # procedures: 70 Equipment cost/procedure: 533 \$ OR attendance: 140 \$ TOTAL, per-use: 673 \$	Setting: OR Device: Olympus™ flexible cystoscope # procedures: 70 Equipment cost: 258 \$ OR attendance: 192 \$ Sterilization: 85 \$ Cystoscope repair (one breakage): not evaluated TOTAL, per-use: 686 \$	+13 \$ (+10.64 €)

**Table 2.** Impact of Isiris on hospital work organization in different institutions.

Authors	Hospital, city	Setting	Hospital work organization	Potential economic benefit
Oderda 	Molinette Hospital, Torino (ITA)	EnR vs office	Less anxiety for the patients that do not enter in the OR, easier planning with no delays for DJ removals.	Easier management of DJ in kidney transplant patients. EnR time saved for other procedures.
Pietropaolo, Somani 	Southampton General Hospital, Southampton (UK)	EnR vs office	Dwell time: no procedures delayed for organizational reasons with single-use device. More endoscopy slots created for urgent cancer diagnostic patients. Encrustation rates: none of the patients developed stent encrustations.	Avoidance of complications linked to stent encrustations. Cost saving from reduced or no fines related to cancer diagnostic delays.
Amato 	Civico Hospital, Palermo (ITA)	OR vs office	Dwell time: no procedures delayed for organizational reasons with single-use device. UTI rates: no patient readmitted for UTI	Avoidance of complications linked to DJ encrustation in kidney transplant patients
Oderda 	San Lazzaro Hospital, Alba (ITA)	OR vs office	OR time: 64 hours of OR saved with single-use device in outpatient clinic	In-office JJ removal could save 765 € per procedure
Doizi 	Tenon Hospital, Paris (FRA)	EnR/OR vs office	EnR/OR time: 301.5 h of EnR and 3 h of OR saved with single-use device in outpatient clinic Dwell time: reduced DJ dwell time due to immediate availability of single-use cystoscope	In-office DJ removal could save around 45 € compared to the cost in the EnR and 140 € in the OR

(Continued)

Table 2. (Continued)

Authors	Hospital, city	Setting	Hospital work organization	Potential economic benefit
Rukin 	Redcliffe Hospital, Redcliffe, Queensland (AUS)	EnR vs office	EnR time: 65 elective cystoscopy appointments freed by using in-office single-use device. Repairs: in 12-mo, 58.660 \$ saved in repairs/replacements of reusable cystoscopes.	In 6 months, surplus of 80.625 \$ (1.075 \$ per case) by using single-use devices; the overall surplus was 104.434 \$.
Olsburgh 	Guy's Hospital, London (UK)	EnR vs office	Organization of DJ removal in kidney transplant patients easier with single-use device (in-office, at patient's bed)	Estimated saving of 5.120 £ with single-use device, considering 17 procedures performed and Isiris™ cost of 180 £ per unit
Delarosette 	AMC University Hospital, Amsterdam (NET)	EnR vs office	Single-use device may allow a shift on staff needs, a shift on removal place need, and a shift on infrastructure needs. It avoids reprocessing of reusable instruments	EnR time saved by using in-office single-use device
Estrade 	Centre Hospitalier d'Angouleme, Angouleme (FR)	EnR vs office	Dwell time: shorter DJ indwell times (2–5 days) by using single-use device	Single-use device allowed the surgeon to triple DJ removal activity
Grey 	Manchester Hospital, NHS, Manchester (UK)	EnR vs office	Dwell time: DJ dwell time reduction with single-use device (1vs 8 days) ER attendances: reduction with single-use device (14%vs 22%) Readmissions: reduction with single-use device (11%vs 14%) UTI rates: reduction with single-use device (13.5%vs 10.3%)	49 diagnostic endoscopy appointments released, equated to 38.600£ per 100 stents potential additional income

from patient entrance to next patient entrance, including patient positioning, and room cleaning.<sup>3</sup> Given the high number of DJ removals scheduled each year in every unit, it is easy to estimate the number of hours that could be saved by moving the procedure out of the EnR/OR and the consequent economic benefit. Suffice to say that, according to an estimate based on Medicare database, around 275.000 DJ removals are performed each year in the USA (*Coloplast, internal data*). The single-use flexible cystoscope Isiris- $\alpha$ <sup>®</sup> has been developed to overcome this issue, aiming to give an easy access to flexible cystoscopy and to streamline the process of stent removal.<sup>1,2</sup>

DJ removal with Isiris- $\alpha$ <sup>®</sup> can be performed in office without the aid of any assistant, even if a nurse is present anyway in most centers to speed up the process, or simply due to institutional policy. Moving the procedure of DJ removal in office may reduce patient anxiety related to an additional access to the operating room.<sup>3</sup> More importantly, it can lead to shorter DJ indwell duration, which often depends more on the availability of the endoscopic room than on clinical reasons. This is an important aspect, if we consider that ureteral stents often cause bothersome symptoms that sometimes affect patient ability to work. It has been shown that prolonged stent indwell time post-ureteroscopy increases the risk of postprocedural events including urinary tract infections (UTIs) and hospital readmissions.<sup>7</sup> This is particularly important for vulnerable immunosuppressed kidney transplant patients, where the infection risk might be related to longer DJ dwell duration. Isiris- $\alpha$ <sup>®</sup> can be also easily used in the Emergency Department (ED) if needed, thanks to the small, portable

LCD monitor, avoiding unnecessary hospitalization and anesthesia and reducing waiting times for patients.

Since Isiris- $\alpha$ <sup>®</sup> is disposable and does not require a dedicated place for stent removal, cleaning and storage, the only direct costs are the ones of the endoscope itself. It is very difficult to perform an accurate cost analysis, involving different institutions and countries. Given the difference in procedures and equipment between hospitals, we find different instrument purchasing and maintenance costs, various EnR/OR costs and differences in DJ removal locations and process. In this light, the current study gives an insight into the various costs of DJ removal in different institutions worldwide and cannot give definitive conclusions on average cost saving. According to our evaluation, the results found by most institutions are quite consensual on a cost-benefit of Isiris- $\alpha$ <sup>®</sup>, especially when considering the cost related to EnR/OR use. A micro-costing analysis has shown that Isiris- $\alpha$ <sup>®</sup> leads to significant cost reduction and encrustation-related complications associated with delayed stent.<sup>10</sup>

As for other costs, decontamination and sterilization of reusable scopes represent a less important part of total costs but might impact on the longevity of reusable instruments.<sup>11</sup> According to a recent study comparing different sterilization processes for flexible ureteroscopes, HLD with peroxyacetic acid might cause more damage than glutaraldehyde, both on the shaft of the instrument and on the fibers.<sup>12</sup> When speaking of instrument longevity, however, the lifetime of a reusable flexible cystoscope can be only estimated, and the duration of warranty varies according to the institution and country. Recurrent use of graspers for



**Table 3.** Other in-office solutions for JJ removal.

Authors, year	Hospital, city [Ref]	Device	Cost	Potential benefits
O'Kelly, 2019	James Connolly Memorial Hospital, Blanchardstown, Dublin (IRE) <sup>27</sup>	Magnetic stent, Black-Star, Urotech	90€ per stent	Mean cost saving of 203€ per procedure as compared to standard JJ (255€ vs 458€)
Le, 2019	University of California San Diego, Rady Children's Hospital San Diego, CA (USA) <sup>4</sup>	Stent with retrieval strings (not specified)	400.5 US\$ per procedure	Mean cost saving of 1890.4 US\$ per procedure (pediatric sample)
Liu, 2018	University Hospital of Zhejiang, Zhejiang (CHI) <sup>25</sup>	Stent with retrieval strings, Cook Medical	8.9 CNY per stent removal on average	Overall cost of the procedure significantly less than traditional stents: 86.7vs 507.9 CNY
Amer, 2014	RIMS, Imphal (IND), <sup>24</sup>	US guided stent removal with straight forceps	Not specified	The procedure under US guidance is much cheaper than with cystoscopy (only females)
Coste, 2013	Centre hopitalier Lyon Sud, Lyon (FRA) <sup>21</sup>	Disposable sheath, Endosheath System, Vision-Sciences	31.1€ per sheath	Mean cost of cystoscopy with sheath 48.3€ vs 55.8€ for standard cystoscopy
Kimuli, 2007	St James University Hospital, Leeds (UK) <sup>22</sup>	Disposable sheath, Dantec Dynamics Ltd	18£ + VAT sheath	JJ removals transferred in an out-patient settings, avoiding day-ward or theater attendance.
Krebs, 2007	University of California, Irvine Medical Center, Orange, CA (USA) <sup>23</sup>	Disposable sheath, Endosheath System, Vision-Sciences	25 US\$ per sheath Estimated cost per procedure (in-office): 37 US\$	It can save 4–31 min of processing time while avoiding exposure to irritants.
Lawrentschuk, 2005	University of Melbourne, Austin Hospital, Heidelberg, Victoria (AUS) <sup>5</sup>	Disposable sheath, Endosheath System, Vision-Sciences	40 US\$ per sheath	Procedure comparable to standard cystoscopy in costs, reducing exposure to sterilizing agents and potentially time saving

**Figure 1.** Isiris- $\alpha$ <sup>®</sup>.

DJ removal may represent a risk for working channels. In 2019, Donato et al. from Redcliffe Hospital reported that in the 12 months previous to Isiris introduction, 13 reusable flexible cystoscopes had been damaged, costing \$58,660 (37,555 € in repairs and replacements). The introduction of Isiris led to cost savings of approximately \$23,809 (15,242 €), equivalent to 203€ per removal

procedure (75 removal procedure in 6 months period),<sup>9</sup>. In 2013, McGill et al. found a total of five failures occurring in four cystoscopes over a study period of 14 months, underlining that cystoscopes damages occurred earlier in higher percentages of operative procedures such as stent removals, biopsies, and fulgurations.<sup>13</sup> Actually, a significant rate of instrument breakage occurs outside of the OR, during processing and storage, as shown in flexible ureteroscopes.<sup>11</sup>

One criticism of single-use devices involves the environmental impact, given a non-negligible amount of waste that is produced. Interestingly, a recent study focused on flexible ureteroscopes has concluded that single-use and reusable instruments have a comparable total carbon footprint, warning the scientific community that also the typical life cycle of reusable urological instruments is a concerning source of environmental emissions.<sup>14</sup> Similarly, an analysis on bronchoscopes has shown that cleaning and disinfection of reusable devices leads to comparable or higher material and energy consumption as compared to single-use, as well as higher emissions of carbon dioxide equivalents and values of resource consumption.<sup>15</sup> It is likely that the same conclusions apply to flexible cystoscopes. The issue of waste disposal, however, must be carefully addressed when dealing with single-use devices.

Another issue to be considered is the risk of UTIs after flexible cystoscopy: given that there is a contact with patient's mucous membranes, flexible cystoscope is considered as a semi-critical device that must minimally be high-level disinfected.<sup>16</sup> Proper cleaning of the instrument and working channel is essential, to obtain a good disinfection without causing damages. A recent study has shown that disinfection, intended as a reduction in bacterial load of  $>7 \log_{10}$  colony forming units, does not occur unless the channel is actively perfused with HLD.<sup>17,18</sup> It is also demonstrated that HLD does not kill all the bacterial spores, even well properly done.<sup>19</sup> Disposable devices such Isiris- $\alpha$ <sup>®</sup> have the clear advantage of being always sterile and not requiring any sterilization process, possibly translating into a lower risk of UTIs as suggested in this study by Grey and Amato. This is of primary importance especially in kidney transplant patients, where complications and infections must be avoided at any cost. We are currently conducting a comparative study between single-use and reusable cystoscopes to clearly evaluate the rate of postoperative bacteriuria and UTIs.

In our analysis, reusable instruments seemed to be more cost-effective than Isiris- $\alpha$ <sup>®</sup> in institutions where DJ removal is already routinely performed in outpatient clinic, such in the case of Columbus, Ohio. To do so, however, a sufficient number of reusable flexible cystoscopes to guarantee an adequate turnover during a daily session of DJ removals, and an endoscopic column, or at least a telepack, must be available. A recent study showed that only very high-volume centers performing more than 705 in-office DJ removals per year benefit from the purchase of reusable equipment.<sup>6</sup> Two previously published studies had reported a cost benefit in favor of the reusable instruments as compared to Isiris- $\alpha$ <sup>®</sup>, one in the EnR setting and the other in an unspecified setting. In both cases, however, several parameters were not considered, such as the costs of room occupancy, personnel, and reusable instrument purchase and maintenance.<sup>19,20</sup>

Other solutions have been recently marketed to simplify DJ removal procedure (Table 3): a profitable option for in-office DJ removal could be represented by disposable slide-on sheaths to be applied to the scope, that is sterilized only at the beginning and end of the day list.<sup>5,21–23</sup> However, these sheaths might affect the vision during the procedure, and great care must be paid to the barrier protection against bacterial and viral contamination, particularly related to the working channel. Amer et al. has recently proposed ultrasound-guided stent removal with simple straight forceps,<sup>24</sup> but this approach can be used only on females, is not devoid of discomfort for the patient and can be risky in case of encrusted stents. The use of extraction strings on stents has gained popularity in recent years, due to the perceived benefit of being less invasive and inexpensive to remove.<sup>4,7,25</sup> The main complication of extraction strings is stent dislodgement, especially in

females, that leads to ED admission and, in some case, to a new placement of a DJ stent. For these reasons, the use of extraction strings is not advised in patients whose care would be significantly compromised by the stent being dislodged.<sup>25,26</sup> Moreover, it cannot be used for dwell times longer than 7 days. The newest product on the market is a magnetic DJ stent that can be removed by a special catheter-like retrieval instrument with a magnetic tip.<sup>27</sup> Magnetic DJ stents seem advantageous over stents with extraction strings in terms of risk of dislodgement, but data on large numbers of patients are needed to draw more definitive conclusions concerning their functionality. It has to be kept in mind that the blinded removal of encrusted DJ could cause serious procedure complications for the patient. The comparison between Isiris- $\alpha$ <sup>®</sup> and some of these options was beyond the scopes of this study, but could represent an interesting idea for future studies.

Our study is not devoid of limitations, among which its retrospective design and the fact that cost-analysis was not uniform across participating institutions, considering different factors according to each institutional policy. Furthermore, it was not possible to do a systematic evaluation of procedural outcomes, device damages, or infections. Nevertheless, the current study is the first to gather multicentric data on the single-use cystoscope Isiris- $\alpha$ <sup>®</sup>, providing an interesting insight on the costs and criticalities of DJ removals in different hospitals worldwide.

In conclusion, we have shown that single-use cystoscope Isiris- $\alpha$ <sup>®</sup> leads to significant cost benefit in most institutions where DJ removal is routinely performed in EnR/OR, allowing to transfer the activity to less expensive facilities like outpatient office while sparing EnR/OR time for other procedures. Only very high-volume centers seem to benefit from the purchase of reusable equipment.

#### Authors' contributions

Marco Oderda: project development, data management, data analysis, manuscript writing. Antonio Amato: data collection. Jean de la Rosette: data collection, manuscript editing. Steve Doizi: data collection. Vincent Estrade: data collection. Marco Falcone: data collection, manuscript editing. Ben Grey: data collection, manuscript editing. Bodo Knudsen: data collection, manuscript editing. Jonathon Olsburgh: data collection. Amelia Pietropaolo: data collection, manuscript editing, data analysis. Nick Rukin: data collection. Omidreza Sedigh: data collection, manuscript editing. Alhamri Saeed: data collection. Bhaskar K Somani: data collection, manuscript editing. Paolo Gontero: project development.

#### Declaration of conflicting interest

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: dr Marco Oderda and Dr Steeve Doizi have worked as consultants for Coloplast.

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## Ethics approval

This research was conducted in accordance with the Helsinki Declaration.

## Consent for publications

Not applicable

## ORCID iD

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## References

- Doizi S, Kamphuis G, Giusti G, et al. First clinical evaluation of a new single-use flexible cystoscope dedicated to double-J stent removal (Isiris®): a European prospective multicenter study. *World J Urol* 2017; 35: 1269–1275.
- Talso M, Emiliani E, Baghdadi M, et al. The new grasper-integrated single use flexible cystoscope for double J stent removal: evaluation of image quality, flow and flexibility. *World J Urol* 2017; 35: 1277–1283.
- Oderda M, Antolini J, Falcone M, et al. Cost-effectiveness analysis of a single-use digital flexible cystoscope for double J removal. *Urologia* 2020; 87: 29–34.
- Le HK, Gleber R, Bush RA, et al. Cost analysis of removing pediatric ureteral stents with and without a retrieval string. *J Pediatr Urol* 2019; 15: 624.e1–e6.
- Lawrentschuk N and Chamberlain M. Sterile disposable sheath system for flexible cystoscopes. *Urology* 2005; 66: 1310–1313.
- Beebe SC, Jenkins LC, Posid T, et al. Single-use grasper integrated flexible cystoscope for stent removal: a micro-costing analysis-based comparison. *J Endourol* 2020; 34: 816–820.
- Smith PM, Harbias A, Robinson R, et al. Isiris: a novel method of removing foreign bodies from the lower urinary tract to avoid unnecessary hospitalization and anesthesia. *J Endourol Case Rep* 2016; 2: 144–147.
- Baston EL, Wellum S, Bredow Z, et al. Office-based ureteric stent removal is achievable, improves clinical flexibility and quality of care, whilst also keeping surgeons close to their patients. *Cent Eur J Urol* 2018; 17: 196–201.
- Donato P, Honore M, Zana T, et al. Prospective trial of single-use, flexible cystoscope for ureteric double-J stent removal: cost and utility analysis. *J Clin Urol* 2020; 13: 160–163.
- Pietropaolo A, Hughes T, Tear L, et al. Comparison of ureteric stent removal procedures using reusable and single-use flexible cystoscopes following ureteroscopy and lasertripsy: a micro cost analysis. *Cent Eur J Urol* 2020; 73: 342–348.
- Marchini GS, Torricelli FC, Batagello CA, et al. A comprehensive literature-based equation to compare cost-effectiveness of a flexible ureteroscopy program with single-use versus reusable devices. *Int Braz J Urol* 2019; 45: 658–670.
- Joshi HB, Stainthorpe A, MacDonagh RP, et al. Indwelling ureteral stents: evaluation of symptoms, quality of life and utility. *J Urol* 2003; 169: 1065–1069.
- McGill JJ, Schaeffer AJ and Gonzalez CM. Durability of flexible cystoscopes in the outpatient setting. *Urology* 2013; 81: 1287–1291.
- Davis NF, McGrath S, Quinlan M, et al. Carbon footprint in flexible ureteroscopy: a comparative study on the environmental impact of reusable and single-use ureteroscopes. *J Endourol* 2018; 32: 214–217.
- Sorensen BL and Gruttner H. Comparative study on environmental impacts of reusable and single-use bronchoscopes. *Am J Environ Prot* 2018; 7: 55–62.
- Herr HW. The risk of urinary tract infection after flexible cystoscopy in patients with bladder tumor who did not receive prophylactic antibiotics. *J Urol* 2015; 193: 548–551.
- Rutala WA and Weber DJ. Reprocessing semicritical items: current issues and new technologies. *Am J Infect Control* 2016; 44: e53–e62.
- Rutala WA, Gergen MF, Bringham J, et al. Effective high-level disinfection of cystoscopes. Is perfusion of channels required? *Infect Control Hosp Epidemiol* 2016; 37: 228–231.
- Almeras C, Loison G, TOLLON C, et al. Évaluation du coût en structure privée d'une ablation de sonde double J en externe à l'aide d'un fibroscope re-stérilisable. *Prog Urol* 2017; 27: 1031–1035.
- Phan YC, Cobley J and Mahmalji W. Cost analysis and service delivery on using Isiris α™ to remove ureteric stents. *J Endolum Endourol* 2018; 1: e3–e16.
- Coste AC, Ruffion A, Lechevallier E, et al. Cystoscope flexible à gaine sterile à usage unique: impact organisationnel et économique et sécurité bactériologique. *Progrès en Urologie* 2013; 23: 356–363.
- Kimuli M and Lloyd SN. Out-patient flexible cystoscopy using a disposable slide-on endosheath system. *Ann R Coll Surg Engl* 2007; 89: 426–430.
- Krebs A, Borin JF, Kim IY, et al. Evaluation of practice efficiency with a novel sheathed flexible cystoscope: a randomized controlled trial. *Urology* 2007; 70: 883–887.
- Amer B, Gupta S, Kanwar VS, et al. JJ stent removal under ultrasound guidance in women: it is simple and Safe. *J Clin Diagn Res* 2014; 8: NC04–NC06.
- Liu H, Pan W and Zhang N. Ureteral stent removal using an extraction string after uncomplicated ureteroscopy: a cost-benefit analysis. *Urol J* 2018; 15: 329–332.
- Oliver R, Wells H, Traxer O, et al.; YAU group. Ureteric stents on extraction strings: a systematic review of literature. *Urolithiasis* 2018; 46: 129–136.
- O'Kelly JA, Haroon UM, Rauf AJ, et al. Ureteric stenting with magnetic retrieval: an alternative to traditional methods. *Ir J Med Sci* 2020; 189: 289–293.