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TRAUMA AND RECONSTRUCTIVE UROLOGY

A multidisciplinary approach to urinary system iatrogenic injuries

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Introduction Urinary system iatrogenic injuries appear because of urological, obstetric-gynecological, and surgical manipulations in the retroperitoneal space, pelvis, or perineum. The purpose of this research was to analyze and obtain knowledge about the issue of iatrogenic injuries, to apply injury prevention algorithms, and to assess multidisciplinary perspectives in modern surgery.

Material and methods The research was interdisciplinary and consisted of several modules: a prospective, single-centre study of urinary system iatrogenic injuries (476 patients) along with four interregional and international procedural types of research.

Results The analysis results indicate an extremely high significance of urinary system injuries evoking numerous negative consequences that are hard to eliminate. A comparative assessment of interdisciplinary interaction demonstrates the more effective interpretation of examination results, more comprehensive and credible clinical diagnosis, more qualitative evaluation of a patient's condition, more effective choice of initial treatment policy, and more satisfactory treatment in patients' opinion. The research allowed for the identification of a typical procedural mistake in the urethral catheter setting causing a high risk of urethra injuries followed by urethra strictures or consecutive infections of the urinary tract.

Conclusions More complicated treatment procedures cause a higher probability of urinary system iatrogenic injuries. The absence of unified algorithms and typical procedural mistakes cause such incidents. A partial solution to this issue could be found in a more profound interdisciplinary interaction in all treatment phases as well as in identifying and eliminating procedural mistakes.

Key Words: kidney iatrogenic injury ‹› ureter iatrogenic injury ‹› urethra iatrogenic injury ‹› urinary bladder iatrogenic injury ‹› urinary system iatrogenic injury

INTRODUCTION

Urinary system iatrogenic injuries include ureter, urinary bladder, urinary tract, and kidneys injuries. It is widely thought that the main reasons for such injuries are urological, obstetric-gynecologic, and surgical manipulations involving the retroperitoneal space, pelvis, or perineum [1, 2].

Analysis of literature data on urinary system iatrogenic injuries allows for the making of some conclusions. Firstly, the issue is properly studied and analyzed [2, 3]. A classic multidisciplinary approach implies a broad discussion of medical cases or joint treatment, including surgical manipulations. It is not new for urologists to interact with oncologists, radiologists, gynecologists, proctologists, and other specialists [4, 5]. In some cases, multidisciplinarity reflects a lack of general knowledge when interacting specialties in isolation do not study the stated issue (urogynecology, pelvic surgery) [6].

In the era of rapid progress, approaches to multidisciplinary medical help are changing [7]. A modern clinician is hardly able to make a complicated mathematical and statistical analysis of research results

on his or her own – it is more efficient to use the service of statisticians, special software, and/or artificial intelligence [7, 8].

One of the outstanding branches of interdisciplinary science is tissue-engineered surgery [9], when a team of interacting biologists, urologists, chemists, morphologists, biotechnologists work for a collective goal.

Modern multi-layer spiral computed tomography (MSCT) equipment allows doctors to get highly detailed 3D models of internal organs and pathological processes. Nowadays it is hard to imagine planning a kidney resection concerning the malignant tumor without a 3D model showing vessels, the kidney collecting system, and surrounding organs [10, 11]. Making a high-quality model requires concerted efforts from a urologist, radiologist, IT specialist, and the use of special software. A model can be printed with a 3D printing station and used for rehearsing operation steps and team interaction [11, 12]. A more extensive, though the not less important, application of 3D printing is caused by making consumables (stents, catheters, etc.) considering an individual patient's anatomic features [13, 14].

The basis of multidisciplinary interaction is an educational program which should consist of modules delivered by different departments helping a student during one semester get mutually supportive information letting to make an overall pattern of a normal or pathological process, a disease function, and progress, and to develop true critical thinking [6, 8, 15].

The current review of urinary tract iatrogenic injuries and multidisciplinary interaction issues has resulted in setting the following goal: to analyze and gain knowledge about the current condition of the issue of iatrogenic injuries, to apply preventive measures algorithms and to assess multidisciplinarity perspectives in modern surgery.

MATERIAL AND METHODS

The research was comprehensive and consists of several modules.

A prospective, single-centre study of urinary system iatrogenic injuries (partially presented) was performed in the urological hospital Irkutsk city clinical hospital №1. The clinical part of the research includes an analysis of the examination and treatment results of patients who underwent therapeutic measures for urinary system injuries and their complications from September 2016 to November 2019.

The research includes male and female patients, over 18 years old, with an established diagnosis of urinary system iatrogenic injuries. The selection of patients for the study who fit the inclusion criteria was carried out prospectively by the continuous sampling method.

During the research, 615 patients had iatrogenic injuries of the urinary system. The research inclusion criteria fit 476 patients. All included patients received conservative or surgical treatment.

Out of 476 patients initially included in the research, 247 were subsequently excluded: 211 patients dropped out due to deviations from the study protocol, and 36 due to personal reasons.

The inclusion criteria were:

- Confirmed acute iatrogenic injury of one of these organs (kidney, ureter, bladder, urethra);
- The patient had complications after the previous injury to one of these organs (kidney, ureter, bladder, urethra);
- The patient is over 18 years old;
- The patient signed a voluntary informed agreement to participate in the study.

The exclusion criteria were:

- Absence of convincing data for the iatrogenic nature of the injury;
- The patient did not sign a voluntary informed agreement to participate in the study;
- The patient refused to participate at any stage of the research;
- Due to any reason, the patient did not complete the planned examination and treatment.

The research has the following endpoints:

- The primary 'solid' endpoint is the examination not earlier than three months after treatment and detected relapse at any stage of the postoperative observation.
- The secondary 'soft' endpoints are signs of a complication as a result of iatrogenic injury and complication relapse after treatment.

The research incorporated anamnestic, clinical, biochemical, radiological, ultrasound, magnetic resonance, and endoscopic methods. An anamnestic method allows for establishing the possible cause and duration of the disease.

Laboratory tests included clinical analysis of blood and urine, determination of total protein, blood sugar, creatinine, urea, bilirubin, amylase and transaminase activity, and water-electrolyte balance in the blood. All patients underwent bacteriological urine test, electrocardiography, and ultrasound of the urinary tract with an assessment of the residual urine volume. Patients estimated the quality of life (QoL) by using the self-test standard questionnaires. Patients recorded complaints, satisfaction with the state of health, and prescribed treatment.

To clarify the nature and degree of pathological changes, examination included uroflowmetry, urethrocystography, urethrocystoscopy, ureterorenos-

copy, MSCT, or magnetic resonance imaging (MRI) of the urinary system with or without contrast (due to any contraindications) with 3D image reconstruction for the final verification of the diagnosis.

Three months after the treatment all patients were recommended follow-up examinations at one-year intervals according to the established research protocol: consultation with a urologist, clinical blood and urine tests, MSCT, or MRI of the urinary system. Also, patients used the QoL scale to assess the subjective quality of life status.

Treatment was prescribed according to clinical guidelines. In the case of acute urethral injury, urethrocystoscopy was performed with a urethral catheter (recanalization) and prolonged drainage (for a period of 2 weeks to 3 months). In case of complications (pelvic and perineal urohematoma, paraurethral abscess, or phlegmon), patients underwent cystostomy, revision of the lesion area, and recanalization. In cases of the urethral stricture, there were two treatment methods: for short strictures up to 10 mm – internal optical urethrotomy (DIVU), for strictures of greater length – anastomotic, magnifying, or replacement urethroplasty.

In the case of acute bladder injury, depending on its nature and size, treatment included extended urethral drainage (less than 5 mm) or revision and suturing of the defect (more than 5 mm). To eliminate urinary fistulas, reconstructive operations were performed.

In the case of acute ureter injury (urohematoma, complete separation of the ureter, partial or complete damage of external intersection, ligation, or ureter necrosis), depending on the nature, length and size of the injured area, the treatment included ureteral stenting, revision, and reconstructive surgery. In the case of complications, one of the methods of reconstructive surgery was performed. No cases required intestinal plastic surgery of the ureter.

In the case of acute kidney injury, depending on its nature, the treatment included ureteral stenting, nephrostomy, vascular embolization or kidney revision, hemostasis, ligation or restoration of vessel integrity, resection, or nephrectomy. In case of damage to the pyelocaliceal system with the development of infectious complications, paranephritis, and urinary leakage, inspection, and reconstruction of the kidney or nephrectomy were performed.

The study also included four interregional and international procedural types of research: from September 2016 to November 2019, the medical staff of several medical institutions in Irkutsk participated in the examination study on the rules for placing and maintenance of a urethral catheter. From September 2019 to November 2019, surgeons of various specialties from different regions of the Russian Federation participated in the examination study on knowledge of the urinary system's topographic anatomy and signs of injuries. From October to November 2019, doctors of various specialties took part in distant survey-testing (in the Russian Federation, Germany, Israel, United Arab Emirates, France) to identify typical procedural mistakes in bladder catheterization. From September 2016 to November 2019, (if it needed, so – 3 team, 20 nurses, 20 doc's) analyzed the effectiveness of profound interdisciplinary interaction in the process of conservative and surgical treatment and patients' and doctors' satisfaction with that.

The employees of various surgical, therapeutic, neurological, and intensive care units voluntarily and anonymously participated in an examination study on the survey and control of the equipment setting and maintenance of a urethral catheter. The exam consisted of an 'I know / I don't know' assessment.

A confidential survey concerning the topographic anatomy and signs of damage of the urinary system was distributed among doctors of different specialties involved in surgeries of the retroperitoneal space and pelvis (general and vascular surgery, purulent surgery (its special surgical department), gynecology, urology, coloproctology, oncology). The survey assessed the knowledge of topographic anatomy nuances and understanding of the anatomical orientation principles of the urinary system. By using the 'I know / I don't know' assessment, surgeons described the anatomical landmarks and topography of the kidneys (1st question), ureters in the middle and upper thirds (2nd question), ureters in the lower third (3rd question), and the topography of the bladder (4th question). An incomplete or inaccurate answer to any of the four questions referred to a general level of 'I don't know'.

Also, an online virtual survey (using the Google application) concerning the identification of typical procedural mistakes in catheterization of the urinary bladder was voluntarily and anonymously completed by doctors of various specialties (from the Russian Federation, Germany, Israel, United Arab Emirates, France). The survey consisted of 20 questions, with a single or multiple-choice answer, hidden control questions, distracting questions, and without specifying the primary purpose of the survey to increase the reliability of the results.

This article presents the most significant parts of the studies to highlight the problem of interdisciplinary interaction for urinary system iatrogenic injuries.

The initial data and the results were analyzed using the STATISTIKA software for Windows 10.0 (Statsoft, Inc, USA), SPSS Statistics 23.0 (IBM, USA), and Stata 14.2 (StataCorp, USA).

RESULTS

A prospective, single-center study of the urinary system iatrogenic injuries problem continued from September 2016 to November 2019. There were 615 patients with confirmed urinary system iatrogenic injuries. The research inclusion criteria applied to 476 patients. All included patients received conservative or surgical treatment.

From the group of 476 patients initially included in the study (intention-to-treat group, ITT), 247 patients dropped out: 211 due to deviations from the study protocol, and 36 due to personal reasons. According to the protocol (per-protocol group, PP), 229 patients completed the study. Table 1 presents the general characteristics of patients in these groups.

Presented data analysis showed that the ITT and PP groups are statistically equal in terms of age, gender, and the duration of the disease. Patients included in the study (ITT) and completed the study (PP) demonstrate statistical equality of the ratio for a group of kidney and urinary bladder injuries. There was a discrepancy between the number of patients enrolled in the study (ITT) and completed the study (PP) for the ureter injuries group (greater adherence) and urethra injuries group (less adherence).

A significant discrepancy appeared between the number of patients included into the study and

Table 1. *The initial parameters in ITT and PP groups of patients*

Parameter	ITT (n = 476)	PP (n = 229)	P
Average age, years	59.93 ±15.5	58.01 ±15.9	0.900
Gender, male / female ratio, %	74/26	65/35	0.557
The acute injury duration, days	2 (1; 3)	2 (1; 4)	0.694
The 'overlooked' iatrogenic injury duration, days	224 (53; 365)	365 (38; 365)	0.826
QoL, points	4.76 ±0.9	4.84 ±0.8	0.785
The acute/overlooked injury ratio, %	78/22	54/46	0.104
Cases of acute injury, N	371	124	0.005
Cases of overlooked injury, N	105	105	< 0.0001
Kidney injury, N	54	34	0.247
Ureter injury, N	68	60	0.001
Bladder injury, N	40	23	0.514
Urethral injury, N	314	112	0.027

ITT – intention-to-treat; PP – per-protocol; QoL – quality of life; N – number

Table 2. *The initial parameters of ITT and PP groups for iatrogenic kidney injuries*

Parameter	ITT (n = 54)	PP (n = 34)	P
Average age, years	55.5 ±17.1	59.7 ±17.3	0.304
Gender, male / female ratio, %	62/38	58/42	0.772
The acute injury duration, days	1.5 (1; 4)	1.5 (1; 4)	0.907
The 'overlooked' iatrogenic injury duration, days	62.5 (30; 124)	34 (17; 147)	0.862
QoL, points	4.9 ±0.9	5.1 ± 0.7	0.630
Acute kidney parenchyma injury, N	21	15	0.754
Acute renal artery/vein injury, N	3	3	0.581
Acute pyelocaliceal system injury, N	9	4	0.584
Arteriovenous fistulas, pseudo-aneurysms, N	5	3	0.949
Acute pyelonephritis, paranephritis, urinary leakage, N	16	9	0.810

ITT – intention-to-treat; PP – per-protocol; QoL – quality of life; N –number

Table 3. *Initial parameters of ITT and PP groups for ureters iatrogenic injury*

Parameter	ITT (n = 68)	PP (n = 60)	P
Average age, years	52.4 ±17.5	54.4 ±17.3	0.590
Gender, male/female ratio, %	15/85	13/87	0.723
The acute injury duration, days	3.0 (1; 5)	3.0 (1; 4)	0.671
The 'overlooked' iatrogenic injury duration, days	365 (39; 365)	365 (34.5; 365)	0.668
QoL, points	4.7 ±1.0	4.7 ±1.0	0.923
Internal ureter injury without urohematoma, N	12	7	0.412
Internal ureter injury with urohematoma, periarteritis, N	6	4	0.674
External ureter injury, N	5	5	0.848
Ureteric strictures, N	45	44	0.973

ITT – intention-to-treat; PP – per-protocol; QoL – quality of life; N – number

Table 4. *The initial parameters of ITT and PP groups for iatrogenic bladder injuries*

Parameter	ITT (n = 40)	PP (n = 23)	P
Average age, years	64 (54; 72)	50 (34; 77)	0.080
Gender, male/female ratio, %	87/13	76/24	0.522
The acute injury duration, days	1 (1; 4)	1 (1; 1)	0.135
The 'overlooked' iatrogenic injury duration, days	55 (32; 98)	55 (32; 98)	1.0
QoL, points	4.6 ± 0.9	4.5 ± 1.1	0.826
Internal bladder injury, N	7	2	0.399
External bladder injury, N	23	12	0.825
Urinary fistulas, N	10	9	0.395

ITT – intention-to-treat; PP – per-protocol; QoL – quality of life; N – number

patients who completed the study in the group of acute injury (a large percentage of exclusion from the study occurredmdue to various reasons, mainly due to failure to attend the follow-up appointment within the prescribed period) and full compliance with participation in the study for patients with overlooked injuries.

All cases of urinary system iatrogenic injuries had a significant impact on the quality of life.

Tables 2 to 5 present the characteristics of the patients in these subgroups (kidney, ureter, bladder, urethra injuries) (Table 2).

The cases of acute kidney parenchyma injury or renal vessel injury appeared as a result of percutaneous nephrostomy (PCN) or percutaneous nephrolithotripsy (PCNL). Acute kidney collective system injury in 3 of 9 (33%) cases were caused by PCN or PCNL, and in 6 cases (67%) – by kidney stenting (Table 3).

All cases of internal ureter injury were a result of ureteroscopy and intraoperative detection allowed for the timely insertion of a drainage stent in order to avoid the development of urogematom (Table 4).

Three cases (42.8%) of internal bladder injury were the result of impaired placement of a urethral catheter and 4 cases (57.2%) developed due to transurethral resection of bladder tumors (Table 5).

The development of urethrorrhagia was caused by incorrect urethral catheter implantation technique in all cases.

Table 5. *The initial parameters of ITT and PP groups for urethra iatrogenic injuries*

Parameter	ITT (n = 314)	PP (n = 112)	P
Average age, years	60.8 ±14.3	61.1 ±14.7	0.907
Gender, male/female ratio, %	99/1	99/1	1.0
The acute injury duration, days	1.0 (1; 1)	1.0 (1; 1)	1.0
The 'overlooked' iatrogenic injury duration, days	2 (1; 9)	2 (1; 8)	0.657
QoL, points	4.6 ±0.9	4.5 ±0.8	0.494
IPSS before injury, points	28.2 ±4.5	28.8 ±4.3	0.391
IIEF5 before injury, points	12 (5; 14)	11.5 (5; 14)	0.736
Traumatic catheterization, urethrorrhagia, N	168	12	<0.0001
Injury after transurethral operations, N	18	3	0.219
External urethral injury during pelvic organs operations, N	14	12	0.027
Urethral fistula, N	7	7	0.049
Urethral strictures, N	107	78	0.786

ITT – intention-to-treat; PP – per-protocol; P – p-value ; n/N – number
QoL – quality of life

Table 6. *The treatment effectiveness of patients with iatrogenic kidney injuries*

Type of injury / complications	Treatment method	PP, n	Recovery, n (%)	Complication / relapse, n (%)
Hematuria	Conservative therapy	15	12 (80%)	3 (20%)
Subcapsular / perinephral hematoma	Conservative therapy	6	2 (33%)	4 (67%)
	Vessel embolization	1	1 (100%)	0
	Revision, hemostasis	3	3 (100%)	0
Pyelonephritis / paranephritis	Conservative therapy	5	2 (40%)	3 (60%)
	Kidney revision	2	2 (100%)	0
	Nephrectomy	1	1 (100%)	0
Urinary flow	Stenting	4	2 (50%)	2 (50%)
	Revision, suturing of a defect	2	2 (100%)	0
Arteriovenous fistulas, pseudoaneurysms	Conservative therapy	3	0	3 (100%)
	Embolization	3	1 (33%)	1 (33%)
	Kidney resection	1	1 (100%)	0
	Nephrectomy	1	1 (100%)	0

PP – per-protocol; n – number; y – years

Table 7. *The treatment effectiveness of patients with iatrogenic ureters injuries*

Type of injury / complications	Treatment method	PP, n	Recovery, n (%)	Complication / relapse, n (%)
Hematuria	Conservative therapy + stenting	7	7 (100%)	0
Pyelonephritis \ ureteritis	Conservative therapy + stenting	6	6 (100%)	0
Urohematoma	Stenting	4	2 (50%)	2 (50%)
	Revision, suturing of a defect	2	2 (100%)	0
External ureter injury	Defect stenting and suturing	5	5 (100%)	0
Upper ureter stricture	Direct anastomosis	2	2 (100%)	0
	Renal pelvis grafting	2	2 (100%)	0
	Ureterocalycostomy	4	4 (100%)	0
	Nephrectomy	2	2 (100%)	0
	Nephrostomy	2	2 (100%)	0
Ureteral stricture of the middle and lower third	Direct anastomosis	2	1 (50%)	1 (50%)
	Reimplantation	12	10 (83%)	2 (17%)
	Boari operation	14	12 (85.7%)	2 (14.3%)
	Nephrostomy	4	2 (50%)	2 (50%)

PP – per-protocol; n – number

All of the per-protocol patients were included in the examination and treatment results analysis. The study contains an indicative analysis of treatment effectiveness depending on the method of primary treatment with an indication of the frequency of any significant complications occurrence of disease relapses. Tables 6 to 9 present the results (Table 6).

The results of the analysis indicate significance of the complications of iatrogenic kidney injury, which resulted in a large number of cases requiring surgical treatment with possible loss of an organ (Table 7).

The results of the analysis indicate the high efficiency of conservative treatment tactics and reconstructive operations of the ureters, which allow for the achievement of recovery in most cases (Table 8).

The results of the analysis indicate the high efficiency of the treatment tactics recommended for bladder perforations, however, the issue of bladder fistula is still not completely resolved (Table 9).

The results of the analysis indicate the extremely high impact of urethral injuries, leading to many negative consequences, the elimination of which seems to be a difficult task.

To evaluate the effectiveness of multidisciplinary interaction, some patients participated in a procedural experiment (double-blind, randomized participation) of interdisciplinary interaction. The treatment results are presented by comparing two groups – the standard treatment group (ST) and the interdisciplinary interaction group (MD). Table 10 presents these comparative results. Evaluation of satisfaction with the treatment was performed by the method of subjective assessment (1 point – poor, 5 points – excellent) (Table 10).

The comparative assessment of interdisciplinary interaction demonstrated a significantly more effective interpretation of the examination results, a more complete and accurate clinical diagnosis, a better assessment of the patient's condition, a more effective selection of primary treatment tactics, and greater satisfaction with the treatment by the patients.

The survey of knowledge of the urinary system topographic anatomy and signs of damage using 'I know / I don't know' format was passed by 49 doctors of various specialties. An incomplete aswer to any of the four questions was interpreted as 'I don't know'. Figure 1 reflects the results.

This study demonstrated a high level of understanding of the topographic anatomy nuances among doctors of all specialties, which means that iatrogenic injuries are not the consequences of lack of knowledge, but come from procedural irregularities in clinical situations.

The online-survey testing on common procedural mistakes during bladder catheterization taken by physicians of various specialties (from the Russian

Table 8. *The treatment effectiveness of patients with iatrogenic bladder injuries*

Type of damage / complications	Treatment method	PP, n	Recovery, n (%)	Complication / relapse, n (%)
Perforation less than 5 mm	Prolonged urethral drainage	2	2 (100%)	0
Perforation more than 5 mm	Revision, suturing of a defect	12	12 (100%)	0
Bladder fistula	Reconstructive surgery	9	6 (67%)	3 (33%)

PP – per-protocol; n – number

Table 9. *The treatment effectiveness of patients with iatrogenic urethra injuries*

Type of damage / complications	Treatment method	PP, n	Recovery, n (%)	Complication / relapse, n (%)
Urethral internal trauma	Prolonged urethral drainage	15	4 (27%)	11 (73%)
External urethra trauma	Revision, suturing of a defect	12	4 (33%)	8 (67%)
Urethral fistula	Reconstructive surgery	7	4 (57%)	3 (43%)
Urethral strictures, less than 5 mm in length	DIVU	32	14 (43.7%)	18 (56.3%)
Urethral strictures, more than 5 mm in length	Urethroplasty	46	40 (86.9%)	6 (13.1%)

PP – per-protocol; DIVU – direct vision internal urethrotomy; n – number

Table 10. *Examination and treatment results of ST and MD groups*

Parameter	ST (n = 190)	MD (n = 39)	P
Erroneous, incomplete or inaccurate diagnosis, %	32 (16.8%)	1 (2.5%)	0.036
Incorrect assessment of the disease severity, %	45 (23.6%)	2 (5%)	0.024
Incorrect or incomplete interpretation of the survey results, %	76 (40%)	3 (7.6%)	0.003
Successful primary treatment tactics, %	72 (37.8%)	2 (5%)	0.001
Satisfaction with treatment, patient, score	3.2± 1.0	4.5 ±0.5	0.021
Satisfaction with treatment, doctor, score	3.9 ±0.7	4.5 ±0.5	0.087

ST – standard treatment group; MD – interdisciplinary interaction group; n – number; P – value

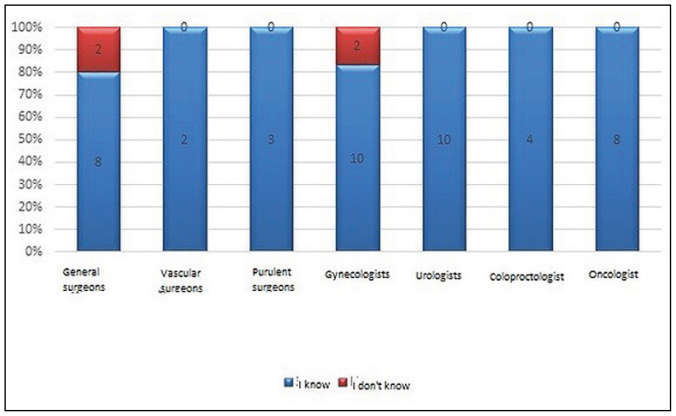

Figure 1. *The urinary system topographic anatomy knowledge examination.*

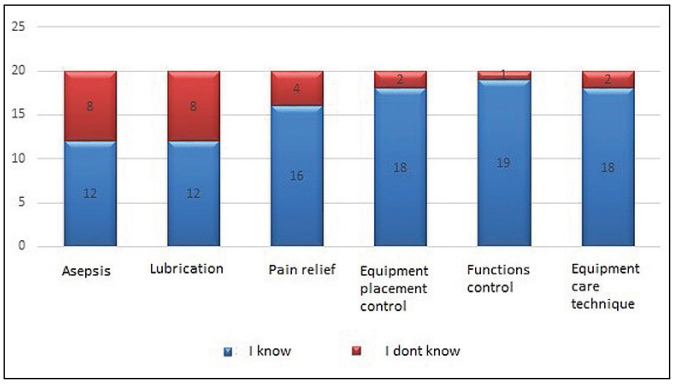

Figure 3. *The bladder catheterization algorithms and urethral catheter maintenance study among doctors.*

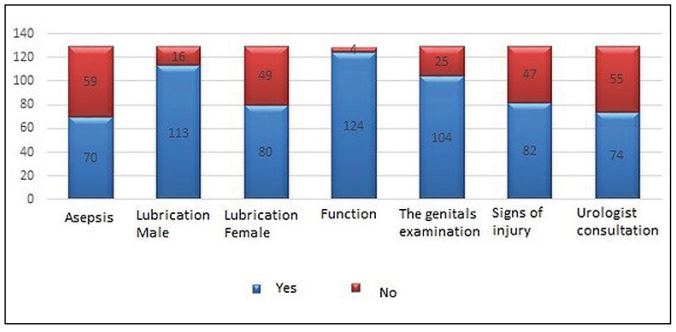

Figure 2. *The study results on typical procedural mistakes of bladder catheterization.*

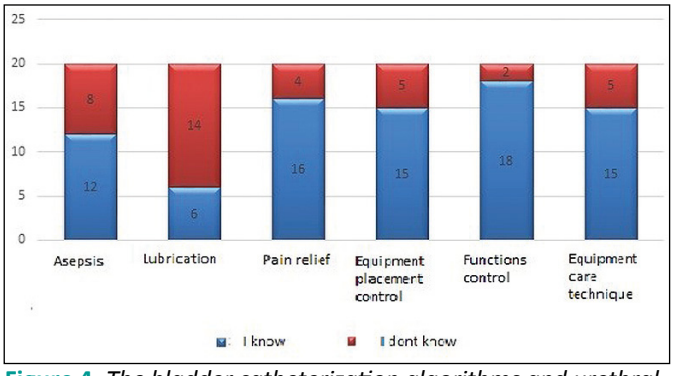

Figure 4. *The bladder catheterization algorithms and urethral catheter maintenance study among nurses.*

Federation, Germany, Israel, UAE, and Korea) demonstrated a contradictory result (Figure 2).

The survey study among medical staff concerning the technique of catheter placement and maintenance also showed conflicting results. Figures 3 and 4 present the results of knowledge and adherence to the algorithm's assessment from 20 nurses and 20 doctors.

Thus, the above results (Figures 2 to 4) identified the typical procedural mistake in the urethral catheter placement algorithm, which leads to a high risk of urethra injuries with the subsequent development of urethral strictures or urinary tract secondary infection.

DISCUSSION

The purpose of this research was to analyze obtain knowledge about the problem of urinary system iatrogenic injuries, to apply injury prevention algorithms and to evaluate the prospects of interdisciplinarity in modern surgical practice.

Damage to the urinary system can be direct or indirect, which leads to a complete or partial loss of function (due to denervation, devascularization, formation of scar contractures or pathological bends, etc.) [16, 17]. Indirect damage, for example, can lead to interventions and incidents in the vascular system (stenting, prosthetics, occlusion, and embolism) and the central and peripheral nervous systems (spinal surgery, installation of neurostimulators, etc.). Urinary tract infection associated with medical care plays an important role [18].

The increasing number of iatrogenic injuries has brought special attention to their prevention and subsequent treatment [19]. Preventive procedures include identifying errors in the execution of typical procedures, explicit and hidden, which can cause iatrogenic injuries [16, 17]. For example, excessive performing of transurethral surgery, lack of periodic lubrication, and exceeding the recommended duration of a procedure contributes to damage due to leakage and mechanical friction of the instrument in the urethra [20].

Specialists should train to focus not only on the treatment but also on the diagnosis of complications in the treatment of non-urological diseases. Obstetricians, gynecologists, proctologists, surgeons, radiologists, and other specialists should learn the nuances of anatomy, the peculiarities of the unintentional trauma mechanisms, and diagnostic techniques for

screening them. Such training will reduce the number of 'overlooked' iatrogenic injuries [21]. All related specialties should know measures and techniques to reduce the risk of injury [19]. For example, the use of light indication (luminous catheters and stents [22]), tissue-organ mock-ups for working out the course of the operation, or complex assistance of artificial intelligence, augmented reality [23].

Assessment of iatrogenic injuries is consistent with global trends – traumatic medical procedures lead to the patient's decline in quality of life, there is a risk of incomplete recovery of the urinary system functioning even with the correct treatment tactics, as well as the risk of irreversible organ loss or the development of chronic disease [1]. The increasing complexity of medical procedures does not reduce the risk of iatrogenic injuries [24]. The more medical knowledge is accumulated and the academic interaction develops, the clearer becomes the importance of even minor incidents. An incorrect interpretation of simple bladder catheterization complications can lead to serious consequences for the patient's health [25]. In terms of long-term effects, the most significant injuries concern the urethra, and to a lesser extent, kidneys, and bladder. Ureter injuries mostly can be successfully treated [2, 26].

This study has shown several important results. First, adherence to treat patients with iatrogenic injuries of the kidney, ureter, and bladder ($P > 0.05$) was significantly higher than adherence in patients with urethral injuries. Probably, this ratio is due to more significant and early manifesting consequences of iatrogenic injury of the kidney, ureters, and bladder than with damage to the urethra. For example, the formation of a urethral stricture is possible weeks or months after the patient left the hospital, and urinary leaks and hematomas are a significant consequence, detected during the period of hospitalization. Also, a possible reason is a typical diagnostic collision, when it is not always possible to timely identify a urethral stricture at the outpatient stage (obstructive symptoms are misinterpreted by specialists, leading to suspicions of BPH), in contrast to ureteral strictures (since hydronephrosis is an obvious problem that is easily detected by ultrasound). At the same time, patients with neglected injuries were more adherent to treatment, probably due to their greater importance for the patient's health.

Many previously described studies [16, 17] named urological percutaneous interventions as the main source of kidney damage in modern clinical practice (nephrostomy, nephrolapaxia (percutaneous nephrolithotomy), or endourological manipulations and operations (stenting, ureteroscopy), open or laparoscopic operations (kidney resection and others). The contribution of operations from related disciplines is minimal. On the opposite side, most of the strictures (96%) and damage to the ureter arose because of bowel surgery, obstetric-gynecological operations, vascular interventions, or external beam radiation therapy [27]. A similar situation was with damage to the bladder and the urethra. However, these pathologies occur due to typical procedural errors (medical: during endourological surgery – the bladder resections, adenoidectomies or prostatectomies; medical surgeries: traumatic catheterization of the bladder), which indicates a defect in the algorithms of work (typical procedural errors) and non-compliance with safety regulations. External injuries in all cases were the results of the work of coloproctologists, gynecologists, and surgeons.

These results highlight the critical importance of multidisciplinary interaction in all operations. Any large surgical center should have a competent urologist who can promptly identify and eliminate iatrogenic lesions, or prevent them in the preoperative period (participating in the diagnosis [28], and performing prophylaxis, for example, catheterizing the kidneys with luminous stents-catheters [22]) or intraoperative period (participating in the operation) [29]. The problem of a multidisciplinary approach becomes especially urgent in terms of treatment, which often requires multiple interventions and long-term rehabilitation. We consider it expedient to introduce the principles of a multidisciplinary approach and principles of teamwork of related specialists at the training stage [30]. Therefore, a multidisciplinary team should perform the training, which correlates with other researchers [31].

The present study also evaluated the effectiveness of multidisciplinary interaction in individual groups (standard treatment, 190 patients; multidisciplinary approach, 39 patients; with P kidney in all aspects of the assessment not more than 0.036), which demonstrated excellent results of such teamwork.

An attempt to identify the causes of iatrogenic injuries using the example of bladder catheterization showed no significant contribution from the medical personnel education; however, the correct execution of procedures demonstrated a great influence, which also correlates with the other researchers' results [30].

The assessment of the understanding of the urinary system organs topographic anatomy features and the risks of their injury, the typical procedural mistakes, as well as the observance of medical intervention algorithms established the main sources of iatrogenic injuries: typical procedural mistakes [32], the violation of injuries prevention algorithms [24] as well as complex clinical situations with problematic anatomical orientation and a risk

of accidental damage to the urinary system organs [33]. The wide geography of the study participants demonstrates the universal nature of the problem. There are no strict standardized clinical algorithms and recommendations for typical procedures. Thus, it is important to study the procedural complications problems, and to develop, and implement common algorithms for typical procedures.

CONCLUSIONS

Interdisciplinary interaction in the prevention and treatment of patients with urinary system iatrogenic injuries showed the highest significance and effectiveness of this approach. The study highlighted such parameters as inaccurate or incorrect diagnosis ($p = 0.036$), incorrect assessment of the disease severity ($p = 0.024$), incomplete or incorrect interpretation of examination results ($p = 0.003$), successful primary treatment tactics in eliminating iatrogenic complications ($p = 0.001$), patient's satisfaction with treatment ($p = 0.021$). We consider it expedient to widely implement this approach in medical care.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

References

1. Esparaz AM, Pearl JA, Herts BR, LeBlanc J, Kapoor D. Iatrogenic urinary tract injuries: aetiology, diagnosis, and management. Semin Intervent Rad. 2015; 2: 195-208.
2. Madec FX, Dariane C, Cornu JN. Evaluation and comparison of basic gestures in ex vivo laparoscopic surgery using a robotic instrument and traditional laparoscopic instruments. Prog Urol. 2020; 30: 58-63.
3. Celsus CA. Celsus: On Medicine. Vol. 1, Books 1-4. Translated by WG Spencer, Cambridge: Harvard, Heinemann, Loeb Classical Library, 1935.
4. Dhaou MB, Zouari M, Ammar S, Zitouni H, Jallouli M, Mhiri R. Hybrid laparoendoscopic single-site (LESS) pyeloplasty: Initial experience in children. Prog Urol. 2017; 27: 87-92.
5. Grimm MO, Bex A, De Santis M, et al. Safe Use of Immune checkpoint inhibitors in the multidisciplinary management of urological cancer: The European Association of urology position in 2019. Eur Urol. 2019; 3: 368-380.
6. Gazimiev MA, Gadzhiev ZK, Krupinov GE. Multidisciplinary approach in urology. Educational aspect. Urologiia. 2019; 4: 36-38.
7. Glybochko PV, Butnaru DV. Multidisciplinary approach in urology. Research aspect. Urologiia. 2019; 4: 2-6.
8. Heidenreich A, Salem J, Paffenholz P, Pflister D. Interdisciplinary education in urology: innovations for better training. Der Urologe. 2019; 8: 870-876.
9. Osman NI, Hillary C, Bullock AJ, MacNell S, Chappie CR. Tissue-engineered buccal mucosa for urethroplasty: progress and future directions. Adv Drug Deliver Rev. 2015; 82: 69-76.
10. Ternovoy SK, Alyaev YG, Amosov AV. Multidisciplinary approach in urology. Current imaging studies in urology. Urologiia. 2019; 4: 25-27.
11. Conté C, Jauffret T, Vieillefosse S, Hermieu JF, Deffieux X. Laser procedure for female urinary stress incontinence: a review of the literature. Prog Urol. 2017; 27: 1076-1083.
12. Wake N, Rude T, Kang SK, Stifelman MD, Borin GF, Sodickson DK. 3D printed renal cancer models derived from MRI data: application in pre-surgical planning. Abdom Radiol. 2017; 5: 1501-1509.
13. del Junco M, Okhunov Z, Yoon R, Khanjpour R, Juncal S, Abedi G. Development and initial porcine and cadaver experience with three-dimensional printing of endoscopic and laparoscopic equipment. J Endourol. 2014; 29: 58-62.
14. Park CJ, Kim HW, Jeong S, et al. Anti-reflux ureteral stent with polymeric flap valve using three-dimensional printing: an in vitro study. J Endourol. 2015; 8: 933-938.
15. Brzoszczyk B, Milecki T, Jarzemski P, Antczak A, Antoniewicz A, Kolodziej A. Urology resident training in laparoscopic surgery – results of the first national survey in Poland. Wideochir Inne Tech Maloinwazyjne. 2019; 3: 433-441.
16. Delacroix SE, Winters JC. Urinary tract injures: recognition and management. Clin Colon Rectal Surg. 2010; 2: 104-112.
17. Esparaz AM, Pearl JA, Herts BR, LeBlanc J, Kapoor B. Iatrogenic urinary tract injuries: etiology, diagnosis, and management. Semin Intervent Radiol. 2015; 2: 195-208.
18. Glynn A. Hospital-acquired infection : surveillance, policies, and practice. London: Public Health Laboratory Service, 1997.
19. Summerton DJ, Kitrey ND, Lumen N, Serafetinidis E, Djakovic N. EAU guidelines on iatrogenic trauma. Eur Urol. 2012; 4: 628-639.
20. Komura K, Inamoto T, Takai T, et al. Incidence of urethral stricture after bipolar transurethral resection of the prostate using TURis: results from a randomized trial. BJU Int. 2015; 4: 644-652.
21. Thomas AZ, Giri SK, Meagher D, Creagh T. Avoidable iatrogenic complications of urethral catheterization and inadequate intern training in a tertiary-care teaching hospital. BJU Int. 2009; 8: 1109-1112.
22. Boyan Jr WP, Lavy D, Dinallo A, et al. Lighted ureteral stents in laparoscopic colorectal surgery; a five-year experience. Ann Transl Med. 2017; 5: 44.
23. Yu F, Song E, Liu H, Li Y, Zhu J, Hung CC. An Augmented Reality Endoscope System for Ureter Position Detection. J Med Syst. 2018; 8: 138.
24. Hosein M, Paskar D, Kodama R, Ditkofsky N. Coming together: A review of the American Association for the surgery of trauma's updated kidney injury scale to facilitate multidisciplinary management. Am J Roentgenol. 2019; 5: 1091-1099.
25. Davis NF, Quinlan MR, Bhatt NR, Browne C, MacCraith E, Manecksha R. Incidence, cost, complications and clinical outcomes

of iatrogenic urethral catheterization injuries: A prospective multi-institutional study. J Urol. 2016; 5: 1473-1477.

26. Delacroix SE, Winters JC. Urinary tract injuries recognition and management. Clin Colon Rect Surg. 2010; 2: 104-112.

27. Gild P, Kluth LA, Vetterlein MW, Engel O, Chun FK, Fisch M. Adult iatrogenic ureteral injury and stricture-incidence and treatment strategies. Asian J Urol. 2018; 2: 101-106.

28. Neroev VV, Saakyan S V, Myakoshina EB, Okhotsimskaya TD, Fadeeva VA. Role of optical coherence tomography angiography in diagnostics of early choroidal melanoma and circumscribed choroidal hemangioma. Vestn Oftalmol. 2018; 134: 4-18.

29. Shamshirsaz AA, Fox KA, Erfani H, Belfort MA. The Role of Centers of Excellence with Multidisciplinary Teams in the Management of Abnormal Invasive Placenta. Clin Obstet Gynecol. 2018; 4: 841-850.

30. Rodziewicz TL, Houseman B, Hipskind JE. Medical Error Prevention Treasure. Island (FL): StatPearls Publishing, 2020.

31. Gazimiev MA, Gadzhiev ZK, Krupinov GE. Multidisciplinary approach in urology. Educational aspect. Urologiia (Moscow, Russia). 2019; 4: 36-38.

32. Heistermann HP, Tobusch A, Palmes D. Prevention of bile duct injuries after laparoscopic cholecystectomy. 'The critical view of safety'. Zentralbl Chir. 2006; 6: 460-465.

33. Cordon BH, Fracchia JA, Armenakas NA. Iatrogenic nonendoscopic bladder injuries over 24 years: 127 cases at a single institution. Urology. 2014; 1: 222-226.