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The impact of the coronavirus disease 2019 pandemic on changes in antimicrobial prophylaxis and development of genito-urinary tract infections after urodynamic study: A retrospective comparative study of a single rehabilitation hospital in Japan

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Abstract

Aims: To investigate the changes in the proportion of antimicrobial prophylaxis (AP) during the urodynamic study (UDS) and the frequency of posttest genito-urinary tract infections (GUTI) before and after coronavirus disease 2019 (COVID-19) pandemic, and evaluate this associations.

Patients and Methods: Patients who underwent UDS between 2015 and 2021 were targeted, and they were allocated to pre-2020 as before the appearance of COVID-19 and post-2020 as after that, and propensity score matching was performed. The impact on AP was assessed by the administration rate, and that on the development of febrile GUTI after UDS was assessed for an equivalence by the GUTI-free rate at 7 days after testing.

Results: After matching, 384 cases of 192 cases each were included. The frequency of AP was 58.3% in pre-2020 and 77.1% in post-2020, an increase of about 19%, and the rate increased significantly in post-2020 ($p < 0.001$). However, the incidence of GUTI after UDS was 4.2% and 4.7%, respectively, with no significant difference. The ratio of GUTI-free rates was within the equivalence margin, confirming an equivalence before and after the appearance of COVID-19.

Conclusions: Under the influence of COVID-19 pandemic, even though AP rate during UDS was increased by 19% from that brought by following the guideline-based administration methods, the frequency of GUTI after UDS was similar, so it is thought to be important to use AP during UDS appropriately for high-risk cases as recommended in the guidelines.

KEYWORDS

antimicrobial prophylaxis, coronavirus disease 2019 pandemic, urinary tract infection, urodynamic study

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1 | INTRODUCTION

Antimicrobial administration is broadly divided into therapeutic and prophylactic administration, in which prophylactic administration is intended to reduce complications of infection that occur after surgeries or various procedures. It is routinely administered in most cases of highly invasive surgeries such as laparotomy or thoracotomy, but in cases of relatively low invasiveness such as examinations, administration is considered according to the individual risks.[1]

There are various reports on the efficacy of antimicrobial prophylaxis (AP) during urodynamic studies (UDS) performed to evaluate lower urinary tract dysfunction (LUTD)[2–4] and a recent meta-analysis showed a significant preventive effect.[5] In the guidelines, AP during UDS is recommended not routinely but for cases with high-risks due to patient backgrounds.[6–8] But, there is a guideline that do not recommend AP in principle.[9] In the case of administration according to such risks, it is difficult to perform that uniformly because the judgment is left to the practitioner, and an excessive prescription could be done in consideration of psychological aspects.

On the other hand, in recent years, there have been widespread efforts to reduce the use of antimicrobials with the aim of curbing the spread of drug-resistant bacteria worldwide, and various results have been reported through the activities such as suggesting appropriate drug selection and treatment duration, and reducing unnecessary administration, including excessive AP.[10–12] However, while those efforts are underway, the current coronavirus disease 2019 (COVID-19) pandemic is expected to increase the use of antimicrobials, and in fact, World Health Organization has warned that these impacts could lead to an increase in the use of antimicrobials and the spread of drug-resistant bacteria.

However, there is little information on what happened to the amount of antibiotics used that are not related to the treatment of COVID-19, and there are no reports of changes in AP during UDS. It is also unknown how the frequency of genito-urinary tract infections (GUTI)s changed before and after the COVID-19 pandemic with the increase or decrease in AP. In this study, therefore we retrospectively compared AP during UDS and changes in the frequency of UTIs after that in a single rehabilitation center in the period before and after the appearance of COVID-19, and it would be meaningful to investigate those changes to evaluate the effect of AP at the same time.

2 | MATERIALS AND METHODS

2.1 | Study design and data collection

This study is a single-center retrospective comparative study based on electronic medical record reviews. We evaluated the difference in GUTI rate after UDS as the primary outcome, and AP rate and UDS parameters as other secondary outcomes. Regarding the impact on AP during the target period, the administration ratios were compared. For the impact on the development of febrile GUTI after UDS, we evaluated the GUTI-free rate at 7 days after the test using an equivalence study. Data were collected from the electronic medical records, including age, gender, original diseases, a presence of spinal cord disorder and immune-compromised state, a history of hospitalization, GUTI and urological surgery up to 90 days before the examination, a presence of recurrent GUTI, GUTI within 7 days after UDS, bacteriuria, and AP, methods of urination, and UDS parameters. Ethical issues in this study were approved by the Ethics Committee of Hyogo Prefectural Rehabilitation Central Hospital (Approval No. 2112). In this study, written informed consent was obtained from all patients through a comprehensive agreement method, with the opportunity to opt-out.

2.2 | Patients and allocation criteria

As the definition of the appearance of COVID-19, before January 2020 is defined as before the appearance (pre-2020), and after that is defined as after the appearance (post-2020). Patients who underwent UDS for to evaluate LUTD in the Department of Urology of our hospital during the observation period from April 2015 to August 2021 were included in the study. The target patients included the cases with not only non-neurogenic but also neurogenic LUTD (NLUTD) caused by neurological diseases such as spinal cord disorders, strokes, and neurological intractable diseases. Exclusion criteria were outpatient UDS, unknown status up to 180 days before the test, and cases with no follow-up for 10 days after the test. Cases with GUTI before the test were included if the tests were performed after a sufficient period of time since the completion of treatment. For the sample size, our previous data[13] showed that the GUTI-free rate within 7 days after UDS was about 96%, and if we assume that this rate does not change before and after the appearance of COVID-19, the sample size that satisfies a 80% detection power with an alpha error of 5% would be about 168 cases in each group with 1:1 allocation, for a total of 336 cases, and we designed the patient population to meet this requirement. The equivalence margin was set at

6%, which is corresponding to a half of the lower limit of the confidence interval, based on the results of the meta-analysis.[5]

2.3 | Criteria for AP

As for AP, they are administered for a short period of time after UDS and are intended for patients with a high risk of developing GUTI, such as those with a history of recurrent GUTI, those who have recently developed GUTI, those with a long-term use of indwelling urinary catheters, and those who have been diagnosed with NLUTD before testing. In addition, in the cases with an especially high risk, AP is started the day before or the morning of UDS. The selection and administration of the drugs are determined in consideration with the risks of each patient with reference to various guidelines[7–9] but the final decision is left to the physician in charge of the examination.

2.4 | Diagnostic criteria for GUTI and recurrent GUTI

Cases of GUTI in a nosocomial onset were those in which the urologist diagnosed or strongly suspected febrile GUTI with bacteriuria (equivalent to more than 10^5 colony-forming units/ml by quantitative culture) or pyuria, while cases with bacteremia or those associated with other infections were excluded, and cases in an onset at the referral source were judged by the descriptions in the information sheets. GUTI after UDS was provided for the development of GUTI within 7 days of the test and follows the GUTI diagnostic criteria described above. Recurrent GUTI was defined as GUTI that had developed 2 or more times within 6 months from the date of UDS.

2.5 | About UDS

UDS was performed under the same conditions as our previous study.[13] UDS was performed according to the procedures recommended by the International Continence Society.[14] Briefly, UDS consisted of filling cystometry, sphincter electromyography, pressure-flow study and measurements of post-void residual volume. Examinations were performed in a sitting position. A 7.4 French triple-lumen catheter (COOK®) was used for measuring intra-vesical pressure by instillation of physiological saline solution warmed to body temperature at a rate of 40 ml/min. A 9.0 French rectal balloon catheter (RPC-9®; Laborie®) inflated with water was used to measure intra-abdominal pressure. Intravesical and intra-abdominal pressure, electromyogram, and flowmetry were simultaneously recorded and analyzed using the urodynamic computer (Janus Urovision® system; Life-Tech®, Inc.).[15]

2.6 | Statistical analysis

Variations between patients assigned to two groups were adjusted by propensity score matching under the condition of a 0.2-fold caliper setting with regard to age, gender, immune-compromised, methods of urination, a presence of spinal cord disorders, and a history of hospitalization, GUTI, recurrent GUTI, and urological surgery up to 90 days before the examination. We performed Fisher's exact test and the Mann–Whitney *U* test for an univariate analysis of the backgrounds, also McNemar's test and Wilcoxon signed rank test after propensity score matching, and then performed a logistic regression analysis of the presence or absence of AP and the development of GUTI within 7 days after UDS in before and after the appearance of COVID-19. EZR version 1.54 (Saitama Medical Center, Jichi Medical University, Saitama, Japan) was used for these analyses,[16] and the statistical differences among means were considered significant when $p < 0.05$. In the equivalence test for the GUTI-free rate, it was judged to be equivalent if the confidence interval in the ratio of the rate was within a range of 6% of the preset equivalence margin.

3 | RESULTS

3.1 | Patient background

A flowchart of patient selection, the overall patient background, and that before and after propensity score matching are shown in Figure 1, Tables 1, 2, and 3, respectively. The objects were 706 of 2436 cases during the observation period, and they were adjusted to 192 cases in each group and 384 cases in total after the matching, where the background factors between the two groups were adjusted to have no significant differences. AP during UDS was performed in 62.9% of all cases, with cefaclor being the most common in 87.8%, followed by levofloxacin in 7.6% among the AP cases. No adverse events due to AP were observed in either group.

3.2 | Breakdown of GUTI after UDS and causative bacteria

Among the 706 cases, 32 cases (4.5%) developed GUTI, where 30 cases had acute pyelonephritis, and 2 had acute

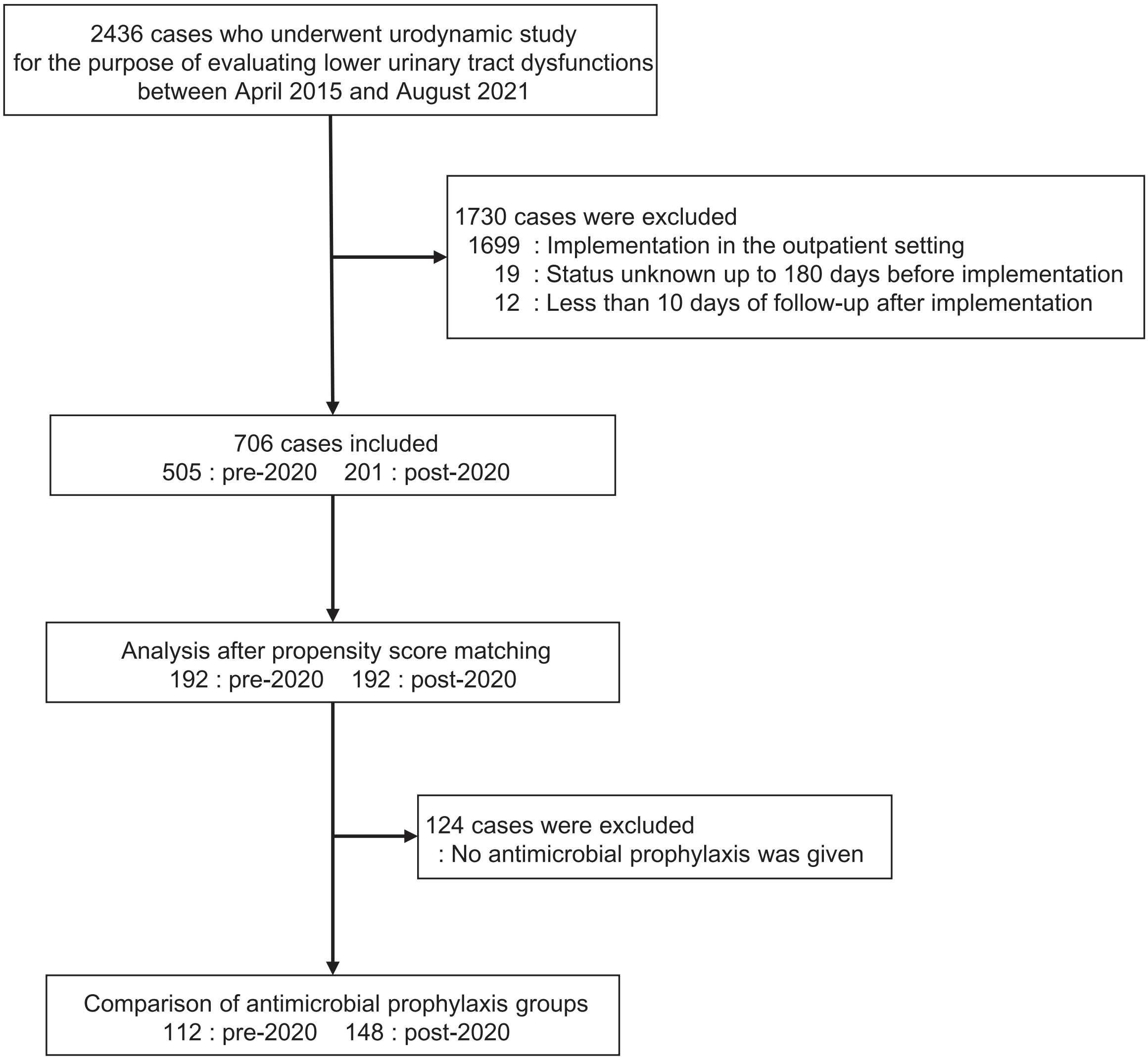

FIGURE 1 Flowchart of patient selection. A single-center retrospective comparative study in japan. After retrospectively extracting patients, we selected them according to the exclusion criteria and a propensity score matching that aligns the background factors between the pre-2020 and post-2020 groups

epididymitis. *Escherichia coli* was the most common causative bacteria in 9 cases, followed by *Pseudomonas aeruginosa* in 5 cases, *Enterococcus faecalis* in 4 cases, *Klebsiella pneumoniae* in 3 cases, and *Serratia marcescens* and *Proteus vulgaris* with 2 cases each.

3.3 | Primary outcome of GUTI development before and after 2020 after matching

As for the primary outcome, the incidence of GUTI within 7 days after UDS was 4.2% in pre-2020 and 4.7% in post-2020, and by the logistic regression analysis, showed an odds ratio of 1.13 (95% confidence interval [CI]: 0.43–3.00 $p = 0.8$) with no statistically significant difference between the two periods (Table 4).

3.4 | Other secondary outcomes

3.4.1 | AP frequency before and after 2020 after matching

Regarding one of the other outcomes, the frequency of AP was 58.3% in pre-2020 and 77.1% in post-2020, it showing a significant increase in post-2020 ($p < 0.001$) (Table 5).

3.4.2 | UDS parameters and incidence of bacteriuria before and after 2020 after matching

The results of UDS parameters and an incidence of bacteriuria before and after the appearance of COVID-19 after matching are shown in Table 5. In post-2020, the

TABLE 1 Patients' background

	n
Overall	706
Median age [range]	65.59 [14.30–97.12]
Gender (%)	
Female	217 (30.7)
Male	489 (69.3)
Immune-compromised (%)	
Diabetes mellitus	117 (16.6)
Taking steroids	10 (1.4)
No	579 (82.0)
Original disease (%)	
Spinal cord injury	155 (22.0)
Cerebral infarction	109 (15.5)
Cerebral hemorrhage	103 (14.6)
Parkinson disease	49 (6.9)
Lumbar spinal stenosis	32 (4.5)
Spinal cord infarction	30 (4.2)
No	7 (1.0)
Other	221 (31.3)
Spinal cord disorder (%)	
No	373 (52.8)
Yes	333 (47.2)
Methods of urination (%)	
Clean intermittent catheterization	120 (17.0)
Spontaneous voiding	432 (61.2)
Indwelling catheterization	154 (21.8)
Recurrent GUTI (%)	
No	692 (98.0)
Yes	14 (2.0)
GUTI up to 90 days before the examination (%)	
No	564 (79.9)
Yes	142 (20.1)
Hospitalization up to 90 days before the examination (%)	
No	150 (21.2)
Yes	556 (78.8)
Urological surgery up to 90 days before the examination (%)	
No	699 (99.0)
Yes	7 (1.0)
Urine culture (%)	
Implemented	275 (39.0)
Culture result positive	206 (74.9)
Culture result negative	69 (25.1)
Not implemented	431 (61.0)
Bacteria isolated in urine culture (%)	274
E. coli	98 (35.8)
K. pneumoniae	32 (11.7)
E. faecalis	26 (9.5)
ESBL-producing *E. coli*	21 (7.7)
P. aeruginosa	17 (6.2)
S. marcescens	10 (3.6)
E. cloacae	7 (2.6)
ESBL-producing *K. pneumoniae*	7 (2.6)
M. morganii	6 (2.2)
K. oxytoca	5 (1.8)
Methicillin-Resistant *S. aureus*	5 (1.8)
Others	40 (14.6)
AP (%)	
Cefaclor	390 (55.2)
Levofloxacin	34 (4.8)
Sulfamethoxazole/Trimethoprim	10 (1.4)
Cefotiam	5 (0.7)
Cefdinir	2 (0.3)
Ampicillin	2 (0.3)
Fosfomycin	1 (0.1)
No AP	262 (37.1)

Abbreviations: AP, antimicrobial prophylaxis; ESBL, extended spectrum beta lactamase; GUTI, genito-urinary tract infection.

median maximum cystometric capacity (MCC) ($p < 0.001$) and the frequency of MCC >200 ($p < 0.001$) were significantly lower, but there were no significant differences in the other results including the incidence of bacteriuria.

3.5 | UDS parameters and other factors among the AP cases before and after 2020 after matching

The UDS parameters and other factors among the AP cases before and after 2020 after matching are shown in Table 6. The median value of bladder compliance was significantly lower (40.6 vs 28.0 ml/cmH_2O) ($p = 0.027$) and the

TABLE 2 Patients' background before propensity score matching

Factor	Group	pre-2020	post-2020	p value	SMD
n		505	201		
Median age [range]		65.04 [14.30–97.12]	67.00 [18.00–92.00]	0.441	0.076
Gender (%)	Female	158 (31.3)	59 (29.4)	0.652	0.042
	Male	347 (68.7)	142 (70.6)		
Immune-compromised (%)	No	428 (84.8)	151 (75.1)	0.003	0.242
	Yes	77 (15.2)	50 (24.9)		
Spinal cord disorder (%)	No	251 (49.7)	122 (60.7)	0.01	0.222
	Yes	254 (50.3)	79 (39.3)		
Methods of urination (%)	Clean intermittent catheterization	94 (18.6)	26 (12.9)	0.01	0.255
	Spontaneous voiding	315 (62.4)	117 (58.2)		
	Indwelling catheterization	96 (19.0)	58 (28.9)		
Hospitalization up to 90 days before the examination (%)	No	117 (23.2)	33 (16.4)	0.053	0.17
	Yes	388 (76.8)	168 (83.6)		
Urological surgery up to 90 days before the examination (%)	No	500 (99.0)	199 (99.0)	1	<0.001
	Yes	5 (1.0)	2 (1.0)		
Recurrent GUTI (%)	No	501 (99.2)	191 (95.0)	0.001	0.252
	Yes	4 (0.8)	10 (5.0)		
GUTI up to 90 days before the examination (%)	No	412 (81.6)	152 (75.6)	0.078	0.146
	Yes	93 (18.4)	49 (24.4)		

Abbreviations: GUTI, genito-urinary tract infection; SMD, standardized mean difference.

frequency of bladder compliance <10 was significantly higher in post-2020 (6.2 vs. 14.2%) ($p = 0.045$). MCC was also significantly lower in the median (267.0 vs. 200.5 ml) ($p < 0.001$) and higher in the frequency of MCC < 200 (33.0 vs. 48.6%) ($p = 0.016$) in post-2020, but no significant differences were found in the other factors.

3.6 | Equivalence study of GUTI-free rate at 7 days after UDS

The ratio of the GUTI-free rate between pre- and post-2020 after matching was 1.005 (95% CI: 0.963–1.050), and that in AP cases was 0.996 (95% CI: 0.945–1.049). In both cases, the equivalence was confirmed as the CIs were within the predefined equivalence margin of 6%.

4 | DISCUSSION

In our study, the frequency of AP during UDS was 58.3% in pre-2020 before the COVID-19 pandemic and 77.1% in post-2020 after that, and increased significantly by about 19%. Meanwhile, the incidence of GUTI after UDS was 4.2% and 4.7%, respectively, and the GUTI-free rate within 7 days after UDS was found the equivalence. A meta-analysis[5] of the efficacy of AP on GUTI (or UTI) after UDS showed that there was a significant difference between with and without AP. On the other hand, there are several studies[2,3,17] that show no significant differences of the frequency of subsequent UTI development between with and without AP, but the equivalence of incidence has not been verified. Therefore, as far as we know, this is the first study to show retrospectively that the incidence of GUTI after UDS is similar even though the prophylactic dose rate increases.

Previous studies have reported UTI (or GUTI) incidences ranging from 3.6% to 20% after UDS and 2.3% to 31.3% without AP[5,18] In our study, it was 4.2% and 4.7% before and after 2020, so it is considered that the incidences were relatively well controlled. However, Lowder et al reported that AP is not beneficial unless the UTI incidence exceeds 10% in patients who do not receive AP at UDS,[19] and in our study, since it was 3.8% and 6.8% in pre- and post-2020 in cases without AP, we

TABLE 3 Patients' background after propensity score matching

Factor	Group	pre-2020	post-2020	*p* value	SMD
n		192	192		
Median age [range]		65.28 [14.30–87.00]	67.00 [18.00–92.00]	0.864	0.036
Gender (%)	Female	57 (29.7)	57 (29.7)	1	<0.001
	Male	135 (70.3)	135 (70.3)		
Immune-compromised (%)	No	144 (75.0)	143 (74.5)	1	0.012
	Yes	48 (25.0)	49 (25.5)		
Spinal cord disorder (%)	No	116 (60.4)	119 (62.0)	0.828	0.032
	Yes	76 (39.6)	73 (38.0)		
Methods of urination (%)	Clean intermittent catheterization	19 (9.9)	24 (12.5)	0.712	0.087
	Spontaneous voiding	116 (60.4)	115 (59.9)		
	Indwelling catheterization	57 (29.7)	53 (27.6)		
Hospitalization up to 90 days before the examination (%)	No	30 (15.6)	33 (17.2)	0.779	0.042
	Yes	162 (84.4)	159 (82.8)		
Urological surgery up to 90 days before the examination (%)	No	192 (100.0)	190 (99.0)	0.475	0.145
	Yes	0 (0.0)	2 (1.0)		
Recurrent GUTI (%)	No	190 (99.0)	189 (98.4)	1	0.046
	Yes	2 (1.0)	3 (1.6)		
GUTI up to 90 days before the examination (%)	No	149 (77.6)	150 (78.1)	1	0.013
	Yes	43 (22.4)	42 (21.9)		

Abbreviations: GUTI, genito-urinary tract infection; SMD, standardized mean difference.

TABLE 4 Proportion and logistic regression analysis of GUTI development before and after 2020 after matching

				Univariate analysis	Logistic regression analysis	
Factor	Group	pre-2020 (%)	post-2020 (%)	*p* value	Odds ratio (95%CI)	*p* value
GUTI after UDS	No	184 (95.8)	183 (95.3)	1	1.13 (0.43–3.00)	0.8
	Yes	8 (4.2)	9 (4.7)			

Abbreviations: CI, confidence interval; GUTI, genito-urinary tract infection; UDS, urodynamic study.

could not rule out the possibility that this was a group of patients in whom the incidence of GUTIs was unable to be improved so much by an increase in the rate of AP. But, looking at it another way, it is possible that the incidence could be kept less than 10% in our institution because we are administering prophylaxis somewhat appropriately to patients who would benefit from it. The guidelines recommend AP after UDS not in all cases but in cases with a high risk, such as a presence of LUTD or bladder outlet obstruction, chronic catheter use, and so forth[7,8] Our hospital uses a risk-based AP with reference to the recommendations, and 58.3% of patients received AP according to the dosing standard, and the infection rate was sufficiently controlled at 4.2% in pre-2020. Given that the incidence of GUTI did not change in post-2020 with an about 19% increase in the rate of AP from that brought by the standard in pre-2020, a further increase in AP is thought to be no benefit, and at the same time, the result could indicate that the guideline recommendations are reasonable.

As for the relationship between UDS parameters and the incidence of GUTI after UDS, Huang et al reported that post void residual, maximal flow rate, and average flow rate were independent risk factors for UTI after UDS,[20] but we could not find any report indicating an association with low bladder compliance. In addition, no significant association was found between them in our previous study[13] including bladder compliance. On the other hand, although not after UDS, Seki et al.[21] reported that detrusor overactivity and poor bladder compliance

TABLE 5 AP frequency, UDS parameters and incidence of bacteriuria before and after 2020 after matching

Factor	Group	pre-2020	post-2020	*p* value
n		192	192	
AP	No	80 (41.7)	44 (22.9)	<0.001***
	Yes	112 (58.3)	148 (77.1)	
Detrusor overactivity (%)	No	102 (53.1)	106 (55.2)	0.771
	Yes	90 (46.9)	86 (44.8)	
Median MCC [range]		260.50 [22.00, 935.00]	206.50 [17.00, 786.00]	<0.001***
MCC (%)	<200	60 (31.2)	91 (47.4)	<0.001***
	≥200	132 (68.8)	101 (52.6)	
Median bladder compliance [range]		36.25 [1.40, 775.00]	31.30 [0.00, 742.00]	0.157
Bladder compliance (%)	<10	18 (9.4)	26 (13.5)	0.28
	>10	174 (90.6)	166 (86.5)	
Median maximal flow rate [range]		6.30 [0.00, 21.50]	5.60 [0.00, 27.70]	0.742
Median residual urine [range]		112.00 [0.00, 996.00]	120.50 [0.00, 900.00]	0.941
BOO index (%)	≤40	160 (83.3)	166 (86.5)	0.496
	>40	32 (16.7)	26 (13.5)	
Bacteriuria (%)	No	79 (41.1)	85 (44.3)	0.056
	Yes	113 (58.9)	107 (55.7)	

Abbreviations: AP, antimicrobial prophylaxis; BOO, bladder outlet obstruction; MCC, maximum cystometric capacity.
***$p < 0.001$.

were significant risk factors for febrile UTI in pediatric patients. Therefore, the relationship between UTI and low bladder compliance after UDS in adults should be still uncertain. In this study, even though there was no difference in bladder compliance among all patient groups before and after 2020 after matching, in AP group, the proportion of cases with low bladder compliance (<10 ml/cmH_2O) was significantly higher in post-2020, which was 14.2% compared to 6.2% in pre-2020. If a patient develops a febrile condition during this epidemic period, it is treated as a suspected COVID-19 infection, requiring strict management, including isolation and limited rehabilitation until test results are available. As a result, the medical staff, which is not sufficient even on a daily basis, is taken up with infection control measures, and medical resources allocated to normal medical care, such as rehabilitation and treatment of UTIs, are severely limited. In addition, patient's and families' satisfactions may decrease due to restrictions on treatment, behavior, and visits, which may lead to complaints. Thus, the increased burden on the medical staff can exhaust the entire facility and make it difficult to maintain the quality of care, which could have led to a risk-averse mentality among physicians in charge and increased the rate of AP. This is thought to be the background for the impact of the COVID-19 epidemic in AP during UDS. This is probably due to the fact that the physicians in charge administered antimicrobial agents generously so that patients with this condition would not suffer a febrile GUTI which could affect their rehabilitation during hospitalization. And with the fact that more AP to such patients did not reduce the incidence of GUTI after UDS, it is suggested that low bladder compliance alone is not an immediate indication for AP, but as the same time, it cannot be ruled out that AP may be meaningful when there are multiple other risk factors or in a group of patients with different backgrounds.

MCC in the post-2020 period was significantly lower than that in the pre-2020 after the matching and among AP cases, but the percentage of cases with MCC below 200 ml was similar at 47.4% and 48.6%, respectively, indicating that the difference was due to that in the postmatching results and that cases with lower MCC did not receive AP preferentially. Therefore, approximately the same proportion of patients received AP before and after 2020, but there was no change in the incidence of GUTI, suggesting that the association between MCC and GUTI after UDS is negative.

There are several limitations in this study. First, it is a retrospective study of a single facility in a rehabilitation

TABLE 6 UDS parameters and other factors among the AP cases before and after 2020 after matching

Factor	Group	pre-2020	post-2020	*p* value
n		112	148	
Median age [range]		63.41 [14.91, 85.54]	66.50 [18.00, 85.00]	0.771
Gender (%)	Female	37 (33.0)	44 (29.7)	0.591
	Male	75 (67.0)	104 (70.3)	
Immune-compromised (%)	No	92 (82.1)	113 (76.4)	0.286
	Yes	20 (17.9)	35 (23.6)	
Spinal cord disorder (%)	No	68 (60.7)	90 (60.8)	1
	Yes	44 (39.3)	58 (39.2)	
Methods of urination (%)	Clean intermittent catheterization	11 (9.8)	19 (12.8)	0.746
	Spontaneous voiding	65 (58.0)	85 (57.4)	
	Indwelling catheterization	36 (32.1)	44 (29.7)	
Hospitalization up to 90 days before the examination (%)	No	19 (17.0)	26 (17.6)	1
	Yes	93 (83.0)	122 (82.4)	
Urological surgery up to 90 days before the examination (%)	No	112 (100.0)	146 (98.6)	0.508
	Yes	0 (0.0)	2 (1.4)	
Bacteriuria (%)	No	41 (36.6)	61 (41.2)	0.522
	Yes	71 (63.4)	87 (58.8)	
GUTI after urodynamic study (%)	No	107 (95.5)	142 (95.9)	1
	Yes	5 (4.5)	6 (4.1)	
Recurrent GUTI (%)	No	111 (99.1)	146 (98.6)	1
	Yes	1 (0.9)	2 (1.4)	
GUTI up to 90 days before the examination (%)	No	81 (72.3)	112 (75.7)	0.569
	Yes	31 (27.7)	36 (24.3)	
Detrusor overactivity (%)	No	57 (50.9)	80 (54.1)	0.619
	Yes	55 (49.1)	68 (45.9)	
Median MCC (range)		267.00 [22.00, 906.00]	200.50 [17.00, 786.00]	<0.001***
MCC (%)	<200	37 (33.0)	72 (48.6)	0.016*
	≥200	75 (67.0)	76 (51.4)	
Median bladder compliance [range]		40.55 [1.40, 309.00]	28.00 [0.00, 742.00]	0.027*
Bladder compliance (%)	<10	7 (6.2)	21 (14.2)	0.045*
	>10	105 (93.8)	127 (85.8)	
Median maximal flow rate [range]		5.35 [0.00, 21.50]	4.95 [0.00, 24.90]	0.925
Median residual urine [range]		138.50 [0.00, 927.00]	134.00 [0.00, 900.00]	0.485
BOO index (%)	≤40	92 (82.1)	128 (86.5)	0.387
	>40	20 (17.9)	20 (13.5)	

Abbreviations: BOO, bladder outlet obstruction; GUTI, genito-urinary tract infection; MCC, maximum cystometric capacity.

*$p < 0.05$; ***$p < 0.001$.

hospital, and since it is an analysis in a population including various original diseases due to the scale in this study, it is not examined for each disease. Second, since this is a retrospective study, we selected our subjects by propensity score matching with the aim of examining the two groups with as much alignment of pre-UDS conditions as possible between the two groups. However, this method cannot adjust for unknown bias due to items for which no data were obtained, caution must be exercised in interpreting the results. It should be noted that the propensity score matching method is not a universal method that can be easily analyzed. Third, the urine culture test was not performed for all patients before UDS, so the bacterial carriage status was not fully understood, and the choice of antimicrobials may have been empiric in many cases. Fourth, it should be noted that the evaluation criteria of GUTI are not completely consistent because the diagnosis of GUTI is made by each physician, and because of the retrospective chart review, there remains the possibility that undocumented GUTI will not be detected and the actual urinary tract infection rate will be underestimated.

5 | CONCLUSIONS

In conclusion, after the appearance of COVID-19 in a single rehabilitation hospital in Japan, although the proportion of patients receiving AP during UDS increased by 19% compared to that brought by following the guideline-based administration methods, the frequency of GUTI after UDS did not change. Therefore, it is thought to be important to use AP during UDS appropriately for high-risk cases as recommended in the guidelines.

AUTHOR CONTRIBUTIONS

Shigeto Mukai: study design, data collection, drafting manuscript, analysis and implementation of data. **Masashi Nomi**: study design, drafting manuscript and management of patients. **Sae Kozawa**: data collection and analysis. **Akihiro Yanagiuchi**: management of patients. **Katsumi Shigemura**: study design. **Atsushi Sengoku**: study design, management of patients and drafting manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is not available.

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