Contamination in Adult Midstream Clean-Catch Urine Cultures in the Emergency Department: A Randomized Controlled Trial

Authors: Mary E. Lough, PhD, RN, CCNS, FCCM, Edward Shradar, MS, RN, CEN, Chuyun Hsieh, MS, MHA, and Haley Hedlin, PhD, Stanford, CA

CE Earn Up to 5.5 Hours. See page 595.

Contribution to Emergency Nursing Practice

- The current literature on midstream clean-catch urine cultures indicates that the national median (50th percentile) contamination rate is almost 15% in emergency departments. This is noteworthy because 3 million ED visits annually list urinary tract infection as a primary diagnosis.
- This article contributes main findings of a randomized controlled trial comparing 2 different urine collection methods and 2 different antimicrobial wipes; there was no difference in midstream clean-catch urine culture contamination among the 4 groups.
- Key implications for emergency nursing practice found in this article are that providing a urine sample was more difficult when using a novel collection system and for patients who were dehydrated with low urine output.

Abstract

Introduction: A midstream clean-catch urine sample is recommended to obtain a urine culture in symptomatic adults with suspected urinary tract infection. The aim of this randomized controlled trial was to determine whether a novel funnel urine-collection system combined with a silver-colloidal cleaning wipe would decrease mixed flora contamination in midstream clean-catch urine cultures from ambulatory adults in the emergency department.

Methods: In a 2x2 factorial trial, adult participants were randomized to 4 groups: (A) sterile screw-top urine collection container/cup paired with a castile-soap wipe (control group); (B) sterile screw-top urine collection container/cup paired with a colloidal silver-impregnated wipe; (C) sterile urine-collection funnel paired with a castile-soap wipe; (D) sterile urine-collection funnel paired with a colloidal silver-impregnated wipe.

Results: The trial was stopped after interim analysis, as the contamination rate in the control group (30%) was markedly lower than the historical ED contamination rate (40%) at the study site. From 1,112 urinalysis results, 223 urine culture results were analyzed (190 female patients and 33 male patients). Urine contamination rates were as follows: Group A, n = 67 (29.9% contaminated); Group B, n = 69 (34.8% contaminated); Group C, n = 51 (23.5% contaminated); Group D, n = 36 (22.2% contaminated). The differences in contamination rates were not statistically different among any of the groups.

Discussion: The use of a funnel urine-collection system and silver-impregnated wipe did not reduce urine-culture

Mary E. Lough is a research scientist in the Office of Research at Stanford Health Care and a Clinical Assistant Professor in the Division of Population Health and Primary Care, School of Medicine, Stanford University, Stanford, CA.

Edward Shradar is a staff nurse in the Emergency Department at Stanford Health Care, Stanford, CA.

Chuyun Hsieh is a Senior Financial Specialist in the Office of Research at Stanford Health Care, Stanford, CA.

Haley Hedlin is a Senior Biostatistician and Associate Director, Clinical Trials Program in the Quantitative Sciences Unit, Stanford University, Stanford, CA.

Editor's Note: The pages immediately following this study contain reprints of 4 of the clean-catch urine sample collection instructions to participants (control group handouts). There are separate instructions for male and female participants, in English and Spanish versions (Supplementary Figures 1-4).

For correspondence, write: Mary E. Lough, PhD, RN, CCNS, FCCM; E-mail: mlough@stanfordhealthcare.org.

J Emerg Nurs 2019;45:488-501.
0099-1767

https://doi.org/10.1016/j.jen.2019.06.001

contamination in adult midstream clean-catch urine cultures in the emergency department.

Key words: Urine culture; Urine contamination; Midstream clean-catch urine culture; Urine specimen collection; Urinary tract infection; Emergency department

Introduction

Urine-culture contamination is a significant problem in the emergency department because more than 3 million visits annually list urinary tract infection (UTI) as the primary diagnosis.[1] A midstream clean catch urine sample is the recommended method to obtain a urine culture to confirm a diagnosis of UTI in symptomatic adults.[2] The challenge of the midstream clean-catch procedure is to obtain a patient-collected sample in a private bathroom, without contamination by vaginal, epidermal, or perianal flora.[2]

The most widely accepted definition of urine contamination is from the College of American Pathologists.[3,4] The definition has 2 parts: The clinical laboratory denotes a threshold for multiple isolates, measured in colony-forming units per mL (CFU/mL), and the clinical laboratory describes the sample as contaminated with descriptors such as mixed flora, skin flora, vaginal flora, or multiple isolates. Most microbiology laboratories use a urine contamination threshold of equal to or greater than (≥)10,000 CFU/mL, with ≥ 2 isolates.[4]

To evaluate contamination rates of urine cultures obtained in outpatient settings, the College of American Pathologists has conducted 3 surveys of hospital clinical laboratories, examining consecutively obtained urine culture results.[3,4] In both surveys, data specific to the emergency department were reported.[3,4] In the 1998 survey, 39,811 urine cultures from 524 emergency departments had a median (50th percentile) contamination rate of 15.7%.[3] In 2008, a survey of 4,413 urine cultures from 114 emergency departments had a median contamination rate of 14.8%.[4] In the 10 years between surveys, the median urine-culture contamination decreased by only 1%, indicating that urine-culture contamination remains a significant problem for patients presenting with UTI symptoms.

Because it takes 48 to 72 hours to receive detailed culture results, antibiotics for UTI are prescribed on an empiric basis. A contaminated urine culture represents an expensive waste of resources because the result can neither be used to confirm a UTI diagnosis nor to verify that the correct antibiotic was prescribed. If a follow-up urine sample is requested, this involves additional cost and inconvenience for both the patient and health care system. Consequently, many emergency departments have introduced interventions to reduce contamination: predominantly, wipes for genital cleaning[2,5,6] and patient education about how to provide the midstream clean-catch urine sample.[4,7-10] An additional challenge is how to be certain that patients are able to follow the instructions.[11]

One innovation in midstream clean-catch urine collection is the funnel-shaped collection system, specifically designed to reduce urine contamination. Two published studies of funnel-collection systems have demonstrated a reduction in urine-culture "mixed growth" contamination.[12,13] Jackson et al conducted a randomized controlled trial (RCT) in women aged 20 to 35 years, recruited from antenatal and general practice outpatient clinics. The funnel group (n = 902), had a urine-culture mixed growth of 9.5%, compared with 14% in the control group (n = 927).[12] Collier et al compared prospective use of a funnel-collection system in female recipients of kidney transplants in an outpatient clinic (n = 420) with historical controls (chart review) who used the conventional urine-collection method.[13] The funnel group had a mixed-growth urine-culture contamination rate of 5.6%, compared with 9.5% contamination in the historical controls (n = 424).[13] The results of these 2 studies suggest that a funnel-collection system might reduce urinate contamination below 20% in an ambulatory population in the emergency department.[12,13]

Wipes saturated with antimicrobial solutions represent another area of innovation to decrease contamination, although not all antimicrobial wipes are approved for cleaning the genital area. Colloidal silver-impregnated wipes are safe for use on genital mucosa and are used to prevent catheter associated UTIs (CAUTIs) in some hospitals.[14]

In this study, we compared the effectiveness of 2 genital cleaning methods and 2 urine-collection methods in a 2x2 factorial trial with randomization to the 4 groups. The primary aim was to compare urine-culture contamination in midstream clean-catch urine cultures in ambulatory adults across cleaning and collection methods in the emergency department. A secondary aim was to characterize patient satisfaction with the different methods.

Methods

STUDY DESIGN

This is a randomized controlled trial (RCT) with 4 groups. Participants were randomized equally among the 4 groups: (A) sterile screw-top urine collection container/cup with handle, paired with a castile-soap wipe (control group; represents usual practice in this setting); (B) sterile screw-top urine collection container/cup with handle, paired with a colloidal silver-impregnated wipe; (C) sterile urine-collection funnel paired with a castile-soap wipe; (D) sterile urine-collection funnel paired with a colloidal silver-impregnated wipe. The study was approved by the facility Institutional Review Board (IRB) and registered on ClinicalTrials.gov (NCT03131609). The IRB approved use of participant verbal consent because obtaining a urine sample is a noninvasive procedure for which written consent is not normally required. Research coordinators followed an IRB-approved script during the enrollment process.

SETTING

The study setting is an emergency department in an academic medical center in the United States, with 70,000 patient visits annually and 17,000 urinalyses annually, of which 5,000 are midstream clean-catch urine samples. Historically, despite several quality-improvement initiatives, urine cultures obtained in this emergency department had a 40% rate of contamination.

SAMPLE

Inclusion criteria were ambulatory adults older than 18 years of age, with urine-culture orders from physicians in emergency departments. Participants provided verbal consent and independently provided midstream clean-catch urine samples in private bathrooms. Exclusion criteria were the presence of a urinary catheter and patients who were nonambulatory, not mentally competent to consent, or spoke a language for which no interpreters were available.

Sample-Size Calculation

A sample-size calculation was conducted under the following assumptions: that 30% of urinalysis samples would progress to urine culture (based on ED microbiology laboratory data), that the historical contamination rate was 40%, and that the 2 novel interventions would reduce contamination to less than 20% in at least 1 of the 3 experimental groups.[12,13] The sample calculation used a 2-sample z-test at a 2-sided significance level of 1.67%. A Bonferroni correction for conducting 3 tests ($\alpha = 1.67\%$) provided power of 92%. Enrollment of 2,000 participants randomized at 500 per arm would produce 150 urine cultures (30% of 500) per arm, with 60 contaminated urine cultures (40% of 150) in the control group (Group A). Because the contamination rate in this emergency department (40%) was higher than the median contamination rate in national surveys (15%),[3,4] and it was unknown whether the contamination rate would increase or decrease in the experimental groups, an interim data analysis was planned and described in the protocol.

STUDY PROCEDURES

Participant Education Instructions

An external health communications company developed a color 1-page, educational handout with simple anatomical drawings to illustrate the correct technique for providing a midstream clean-catch urine sample for each group.[15] Individual handouts were urine-collection method-specific, male-/female-specific, English-/Spanish-specific, and included instructions on genital precleaning before urine collection. The handouts were pretested in focus groups before use in the study.[15]

Recruitment

In the emergency department, after a physician ordered a urine culture, a research coordinator would approach a patient to explain the study using a standardized script. Eligible participants who provided verbal consent were randomly assigned to 1 of the 4 groups using a secure iPad at point-of-care.

Randomization

A statistician programmed a randomization sequence of repeating randomly chosen block sizes of 4 and 8. This sequence was inserted into a secure research database: Research Electronic Data Capture (REDCap, Vanderbilt University, Nashville, TN).[16] Men and women were randomized in separate strata to randomly allocate equal numbers of men and women across the 4 groups. The randomization sequence programmed into REDCap and the secure iPad ensured that the research coordinators had no influence on group allocation. The research coordinators did not have access to the participant's electronic health record at any time.

Procedures

Immediately following enrollment, the research coordinators provided participants with a group-specific printed instruction sheet, a urine-collection kit specific to their group, and verbal instructions about the urine-culture method. The participant provided the urine sample in a private bathroom. Following standard procedures in the hospital clinical laboratory, the urine sample was analyzed for presence of leukocyte esterase, nitrates, and white blood cells

(WBCs). If the results were negative, the testing process ended. If the results were positive, the urine was cultured for 48 to 72 hours.

Fidelity to the Research Protocol

Additional verification steps were added to monitor fidelity to the research protocol. After the participant left the bathroom, the research coordinator checked that all supplies were used: specifically, if the wipes packet was opened, and the urine collection equipment was used. Each participant was also asked to rate "ease of use" for the urine-collection system, the wipes, and the instructions, using a 3-point scale ("difficult to use," "neutral," "easy to use"). The questions were available on an iPad in both English and Spanish.

In addition, because the urine collection containers are preservative free, the time of enrollment and dispatch to the clinical laboratory was verified. This is because uropathogenic *Esherichia coli* numbers can double every 22 minutes when outside the gastrointestinal tract,[17] potentially creating a false positive urine-culture result.[2]

DATA-ANALYSIS PROCEDURES

Statistical Analysis

Statistical analysis was performed for all participants, comparing urine-culture contamination ≥10,000 CFU/mL vs no contamination. A Cochran-Mantel-Haenszel test was used to test whether the proportion of participants differed by group when accounting for the randomization stratification by sex (male/female). The Cochran-Mantel-Haenszel test was used to compare the conventional collection cup vs funnel, and the castile-soap wipes vs silver wipes. Odds ratios comparing the 3 intervention arms with the control group and 95% confidence intervals estimated from logistic regression models adjusted for gender (male/female) are presented. A separate logistic regression was fit for each of the 3 outcomes: (1) the urinalysis results available from all randomized participants; (2) the urine culture results available for participants with urinalysis results; and (3) the contaminated urine cultures from participants with urine-culture results.

A χ^2 test was used to test whether the "ease of use" responses differed between the conventional cup vs funnel and between the castile-soap wipes vs silver wipes. A Fisher's exact test was used to determine whether the ease of use of the instructions differed between the arms. The tests were performed including "no response" as a category. A sensitivity analysis was performed, removing nonrespondents from the analysis.

A CONSORT flow diagram was developed to display the number of participants assessed for study eligibility, number enrolled and randomized, follow-up from urinalysis to urine culture, and analysis of urine contamination from the urine-culture results (Figure 1). Demographic characteristics are summarized using N (%) for categorical variables and median (interquartile range [IQR]) for continuous variables. We compared the distribution of risk predictors in the 4 groups using the standardized difference, a measure of difference among groups expressed in standard deviation units.[18] All tests were conducted at the 0.05 significance level. All analyses were performed using R version 3.5.0.[19]

DATA COLLECTION

Data collection occurred over 10 months between December 2015, and September 2016. Trained research coordinators—RNs who were not part of the ED staff—performed all participant enrollment and data collection. The research team was blinded to the urine-culture results during the period of data collection. All laboratory urinalysis and urine-culture data were extracted from participants' electronic health records in a single batch, using an independent research database service.[20]

Results

Over the 10-month study period, 1,848 participants were assessed for study eligibility with 1,371 adults enrolled and randomized to 1 of the 4 groups in the emergency department. The number of participants in each group was equivalent at time of randomization (Figure 1, Table 1); groups were similar in age, sex, race, and ethnicity (Table 2). When there was a time delay of greater than 1 hour between enrollment and the urine sample being sent to the clinical laboratory, the electronic health record and the REDCap data record were retrospectively assessed to identify the reason for the delay. When the urine sample was not obtained as part of the study protocol, the urinalysis sample was excluded, as noted in Figure 1. The reasons for exclusion of a urinalysis sample after randomization include insufficient urine (n = 153); difficulty with collection equipment (n = 47); no wipes used (n = 9); order cancelled after sample collected (n = 14); participant was unstable walking (n = 9); pregnancy test (n = 6); participant was unable to follow instructions (n = 6); toxicology screen (n = 5); diarrhea or blood in urine sample (n = 4); participant declined after randomization (n = 4); and urinary catheter *in situ* (n = 2). This resulted in the exclusion of 259 urine samples, as shown in Figure 1. Most of the

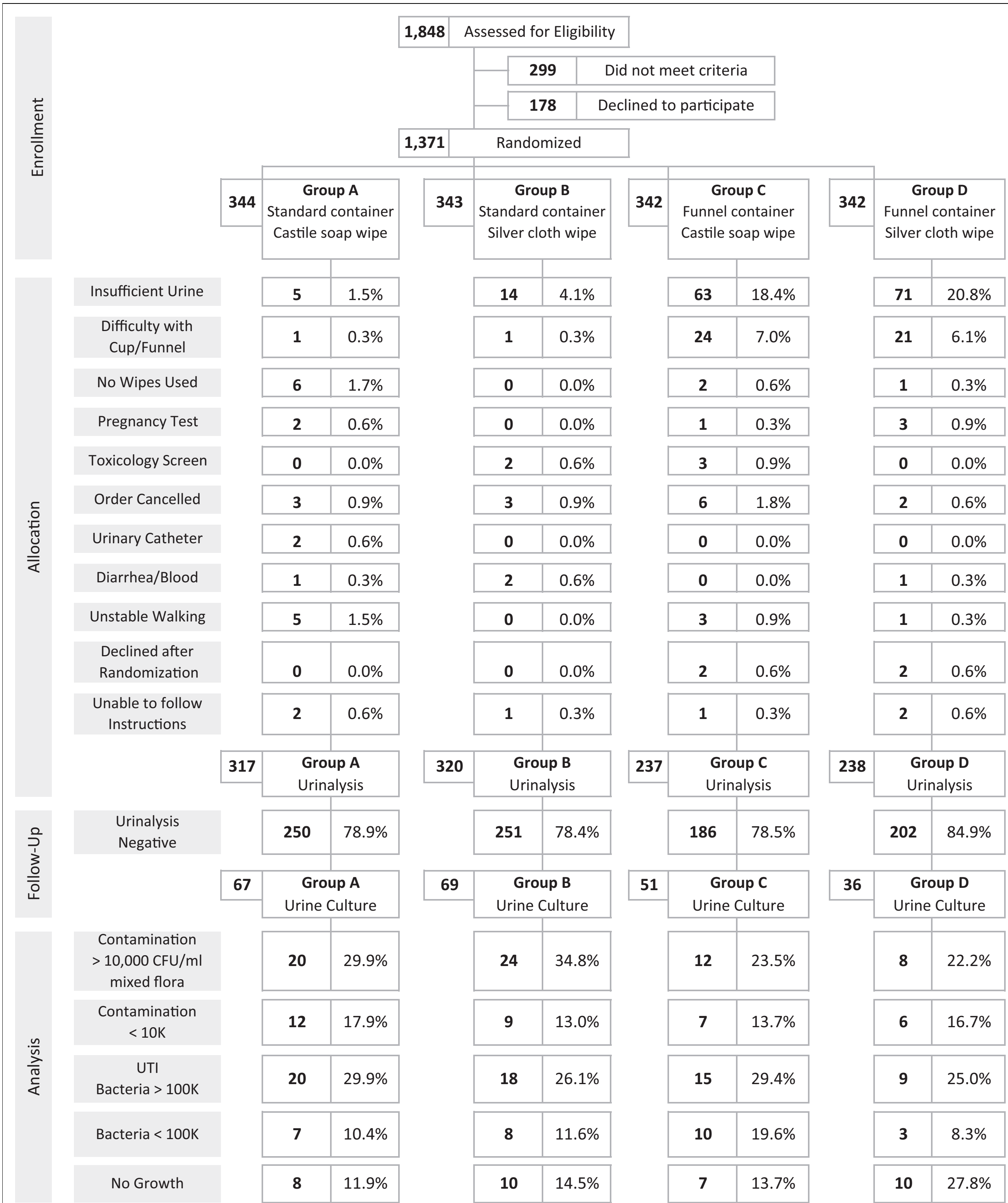


FIGURE 1

A CONSORT flow diagram for “Contamination in adult midstream clean catch urine cultures in the emergency department: A randomized controlled trial,” showing participant flow through the study and progression of urinalysis samples to urine culture. The urine culture results are listed by contamination, urinary tract infection (UTI), and no growth.

TABLE 1

Participant characteristics by randomization group

	Cup + castile wipe (control) A	Cup + silver wipe B	Funnel + castile wipe C	Funnel + silver wipe D	Standardized difference
N	344	343	342	342	
Age (median [IQR])	46.74 [32.01, 63.15]	39.82 [30.22, 57.69]	42.44 [29.57, 61.19]	46.08 [31.34, 62.83]	0.12
Male n (%)	93 (27%)	95 (28%)	92 (27%)	96 (28%)	0.02
Race n (%)					0.15
American Indian or Alaska Native	0 (0.0)	2 (0.6)	1 (0.3)	0 (0.0)	
Asian	39 (11.3)	47 (13.7)	40 (11.7)	52 (15.2)	
Black or African American	19 (5.5)	20 (5.8)	21 (6.1)	18 (5.3)	
Native Hawaiian or Other Pacific Islander	7 (2.0)	8 (2.3)	7 (2.0)	7 (2.0)	
White	133 (38.7)	146 (42.6)	139 (40.6)	131 (38.3)	
More than 1 race	3 (0.9)	6 (1.7)	4 (1.2)	4 (1.2)	
Unknown/not reported	143 (41.6)	114 (33.2)	130 (38.0)	130 (38.0)	
Ethnicity n (%)					0.06
Hispanic or Latino	117 (34.0)	101 (29.4)	114 (33.3)	111 (32.5)	
Not Hispanic or Latino	146 (42.4)	153 (44.6)	147 (43.0)	154 (45.0)	
Unknown/not reported	81 (23.5)	89 (25.9)	81 (23.7)	77 (22.5)	

All cells contain N (%) unless otherwise noted.
IQR, interquartile range; the 25th to 75th percentile of the distribution for continuous variables is listed in square brackets.
Standardized difference is a measure of the difference among groups expressed in units of standard deviations (Cohen's d). Values of 0.2 and smaller indicate the difference among groups is small.
Race: Percentages are calculated using the denominator for each group.
Ethnicity: Percentages are calculated using the denominator for each group.

excluded urinalyses were in the groups randomized to use the funnel urine-collection system (C, D) with 28% (n = 134) of participants in these 2 groups excluded because of insufficient urine (Figure 1). Of the total 1,112 urinalysis samples, 80% (n = 889) screened negative for leukocyte esterase, nitrates, and WBCs and did not progress to urine culture (Figure 1).

URINE-CULTURE CONTAMINATION RATES

A total of 223 urine-culture results were available for an interim analysis (Figure 1, Table 2). The total urine cultures sample comprised 190 female patients and 33 male patients. Notably, the contamination rate in the control group (29.9%) was markedly lower than the historical ED contamination rate (40%). The urine culture contamination rates across the 4 groups were as follows: Group A, n = 67 (29.9% contaminated); Group B, n = 69 (34.8% contaminated); Group C, n = 51 (23.5% contaminated); Group D, n = 36 (22.2% contaminated) (Figure 1, Table 2). Although some groups have lower percentage values, there was no statistical difference in the contamination rates among any of the groups ($P = 0.37$). In addition, the groups with the lowest contamination rates (C, D) also had the greatest loss of participants (Figure 1).

There was no statistical difference in contamination rates (≥10,000 CFU/mL mixed flora) between the conventional screw-top container/cup and the funnel urine-collection system and no statistical difference in contamination rates between the castile-soap and silver-colloid wipes. There was no statistical difference in UTI (≥100,000 CFU/mL single bacterial isolate) across the 4 groups (Figure 1).

Data collection was stopped after this interim analysis because of the absence of any statistical difference for the primary aim. In this study, contamination decreased in all 4 groups, including the control group, compared with the historic contamination rate in this setting.

TABLE 2
Urinalysis, urine culture and contaminated urine culture by randomization group

All participants	Cup + castile wipe (control) A	Cup + silver wipe B	Funnel + castile wipe C	Funnel + silver wipe D	*P* value*
Randomized (n)	344	343	342	342	
Validated UA result (n)	317	320	237	238	
Validated UA result (%)	92%	93%	69%	70%	<0.001
OR (95% CI)†	Ref	1.18 (0.66,2.11)	0.19 (0.12,0.30)	0.19 (0.12,0.31)	
Urinalysis Result (n)	317	320	237	238	
UC result from UA (n)	67	69	51	36	
UC result from UA (%)	21%	22%	22%	15%	0.26
OR (95% CI)†	Ref	1.05 (0.72,1.53)	0.72 (0.48,1.08)	0.49 (0.31,0.75)	
Urine Culture (n)	67	69	51	36	
UC contaminated (n)	20	24	12	8	
UC contaminated (%)	30%	35%	24%	22%	0.37
OR (95% CI)†	Ref	1.46 (0.70,3.07)	0.76 (0.33,1.77)	0.76 (0.29,1.99)	

CI, confidence interval; OR, odds ratio; UA, urinalysis; UC, urine culture.
Urine-culture contamination defined as ≥10,000 CFU/mL.
Ref, Reference is the control group
* *P* value calculated from a Cochran-Mantel-Haenszel test stratified by sex (male/female).
† The odds ratios were estimated from a logistic regression adjusted for sex (male/female).

EXPERIENCE WITH URINE COLLECTION EQUIPMENT

The urine-collection systems were described as "easy to use" by most participants (cup 86%; funnel 61%), with a higher percentage of participants finding the cup easier to use (Table 3). When participants described a urine-collection method as "difficult to use," the reason given for the cup was that the screw-on handle was difficult to remove. The funnel was generally described as difficult when a urine sample was not collected.

EXPERIENCE WITH WIPES

The wipes were described as "easy to use" (castile-soap 81%; silver-colloidal 87%), with more participants rating the silver-colloidal wipes as easy to use (Table 4). When participants rated the wipes as "difficult to use," the most frequent reason was that the packet was difficult to open for both types of wipes. Product-specific reported reasons were that the castile wipe was too small and difficult to unfold, and the silver-colloidal wipes were very moist and difficult to separate.

TABLE 3
Usability of the urine-collection systems (N = 1,371)

	Cup[1]	Funnel[2]	χ^2 (df = 3)	*P* value*
Easy to use	593 (86%)	416 (61%)	123.75	<0.001
Neutral	58 (8%)	117 (17%)		
Difficult to use	22 (3%)	115 (17%)		
No response	14 (2%)	36 (5%)		

Responses in answer to the question, "How easy was the urine collection system to use?" in all randomized participants.
[1] Participants in groups A and B evaluated the urine container/cup.
[2] Participants in groups C and D evaluated the urine-collection funnel.
* *P* value calculated from a χ^2 test. df, degrees of freedom. The results were similar when excluding nonrespondents ($P < 0.001$).

TABLE 4
Usability of the wipes (N = 1,371)

	Castile[1]	Silver[2]	χ^2 (df = 3)	*P* value*
Easy to use	558 (81%)	595 (87%)	8.19	0.04
Neutral	78 (11%)	57 (8%)		
Difficult to use	21 (3%)	12 (2%)		
No response	29 (4%)	21 (3%)		

Responses in answer to the question "How easy were the wipes to use?" in all randomized participants.
[1] Participants in groups A and B evaluated the castile wipes.
[2] Participants in groups B and D evaluated the silver-colloidal wipes.
* *P* value calculated from a χ^2 test. df, degrees of freedom. The results were similar when excluding nonrespondents ($P = 0.03$).

EXPERIENCE WITH EDUCATION INSTRUCTIONS

The printed education instructions were available in English or Spanish, with male and female versions, for each randomization group. Thus, each participant received an instruction sheet that was specific to his or her randomization group, gender, and preferred language. The instructions for all 4 groups used a similar style, with simple drawings and minimal text. Most participants rated the instructions as "easy to use." The instructions for the cup groups (A, B) were rated higher than the funnel groups (C, D): Group A (92%), Group B (94%), Group C (85%), and Group D (86%). These rating differences were significant across the 4 groups (Table 5). There were no "difficult to use" comments about the education instructions.

Discussion

This is the first RCT to study methods to reduce urine contamination in adults providing a midstream clean-catch urine sample in an emergency department. To our knowledge, it is also the first study of urine contamination to incorporate systematic checks to monitor fidelity to the research protocol, including having dedicated research coordinators collect data on whether each urine-collection method was used as expected and when the urine sample was dispatched to microbiology. Although these measures provided data on adherence to the protocol, they also contributed to a loss of urine samples, and, unfortunately, the reduction was not uniform, with the largest reduction in the groups using the funnel-collection system.

INADEQUATE URINE OUTPUT

The main reason for loss of participants was an inability to provide an adequate volume of urine for the sample (n = 153, all groups). This predominantly affected the groups using the funnel-collection system (Groups C, D). We posit that some participants randomized to use the cup (Groups A, B) could only void a small quantity of urine for the sample, but the emergency nurse considered the quantity clinically adequate for urinalysis.

The funnel system is designed to capture a midstream clean-catch urine sample without having to start and stop the urine flow. However, it is apparent that the system requires a robust flow of urine to divert the midstream sample into the collection container. Participants described how if they had a weak urine flow, "a trickle," or could void only a small amount, the urine did not enter the funnel in adequate volume to fill the collection container, and a sample was not collected. In a different outpatient setting, in which patients have adequate urine volumes, such as antenatal clinics[12] or post-kidney transplant,[13] this limitation would not apply.

URINE-COLLECTION EQUIPMENT

Some participants (n = 47, all groups) reported difficulty with urine-collection equipment (Figure 1). Equipment issues in which no urine sample was collected predominantly occurred with the funnel-collection system, including difficulty in assembling the funnel-collection system; difficulty unscrewing the container from the funnel; or participants' reporting that they had voided urine, but the container was empty (n = 45 in Groups C, D). If difficulty with collection equipment resulted in the loss of a urine sample, the participant's contamination results could not be determined. Any urine samples that were obtained 1 to 3 hours later, using a conventional container, were considered outside of the study protocol. In other outpatient settings in which patients have multiple repeat visits, the unfamiliar equipment might not be a limitation.[12,13]

TABLE 5

Usability of the education instructions (N = 1,371)

	Cup + castile wipe (control)	Cup + silver wipe	Funnel + castile wipe	Funnel + silver wipe	*P* value*
Easy to use	318 (92%)	323 (94%)	290 (85%)	293 (86%)	0.003
Neutral	14 (4%)	13 (4%)	24 (7%)	25 (7%)	
Difficult to use	2 (1%)	2 (1%)	9 (3%)	7 (2%)	
No response	10 (3%)	5 (1%)	19 (6%)	17 (5%)	

Responses in answer to the question, "How easy were the instructions to use?" in all randomized participants by group.

* *P* value calculated from a Fisher's exact test. The results were similar when excluding nonrespondents ($P = 0.01$).

Wipes

To monitor that wipes were used per protocol, the Research Coordinator checked if the packet of wipes was open or sealed (n = 9 unopened) after the patient exited the bathroom. Although an open packet does not guarantee that wipes were used according to directions, when the packet was sealed, we know that wipes were not used, and these participants' urinalysis samples were excluded (Figure 1). Nonuse of wipes predominantly affected the control group (n = 6; Group A). The type of genital wipe did not affect urine culture contamination in this RCT and supports findings from other outpatient research studies that the method of genital cleaning does not alter rates of midstream clean-catch urine-culture contamination.[2]

Limitations

This study has several limitations. This was a single-site RCT with a small sample size. The study did not achieve the planned recruitment target for 2 reasons: (1) The decrease in urine culture contamination across all 4 groups, including in the control group, meant that contamination differences between methods were not as large as expected; and (2) the unexpected discovery that many of the urinalysis samples were obtained outside of the study protocol (1 to 3 hours after enrollment) changed the participant numbers in the 4 groups, with smaller numbers in the 2 funnel collection system arms. This loss of participants at the urinalysis stage also meant we could not use an intent-to-treat (ITT) analysis. Because of the combination of lowered rates of urine-culture contamination, unequal group loss of participants, and the absence of near statistical significance, we elected to stop data collection after the interim analysis.

We did not ask participants about manual dexterity or arthritis in their hands, but given participants' challenges with equipment and difficulty opening the packets of wipes, this would have been helpful to know. Despite these limitations, we believe this study provides useful information about the feasibility of using novel collection methods (funnel-collection system) and novel wipes (colloidal silver-impregnated) compared with traditional practices to obtain midstream clean-catch urine samples in ED settings.

Implications for Emergency Nurses

Emergency nurses assist patients to obtain midstream clean-catch urine samples daily. Although this is a routine test, providing a urine sample was more difficult for patients who were dehydrated with minimal urine output and for patients who had difficulty with novel equipment. Preventing urine culture contamination remains a challenge in the emergency department.

Conclusion

In this RCT, there was no statistical difference in contamination rates from midstream clean-catch urine culture provided by ambulatory adults using 2 different genital cleaning wipes and 2 different urine-collection systems. Many participants randomized to use the funnel-collection system had difficulty providing adequate urine volume and difficulty with the urine-collection equipment. This suggests that the funnel-collection system may not be appropriate for use in the emergency department. Although the percentage of contamination was lowest in the group using both the silver wipe and the funnel urine-collection system, this difference did not reach statistical significance. Further research and innovation will be needed to address the causes of midstream clean-catch urine-culture contamination in the emergency department.

Acknowledgments

Thank you to all the nursing staff of the Stanford Health Care Emergency Department. Thank you to our Clinical

Research Coordinators: Sherry Browne, RN, BSN; Jennifer Muller, RN, BSN; Rebecca Sackman, RN, BSN; Elyse Boyer, RN, BSN; Genevieve Diab, RN, BSN; Victoria Pearce, RN, BSN. Thank you to Alex McMillian, PhD, for conducting the sample size calculation and to Eileen Kiamanesh, MS, for clinical data extraction. We are highly appreciative of the support we have received from the Quantitative Sciences Unit, Stanford University; the Research Informatics Center, Stanford University; and the Office of Research, Patient Care Services, Stanford Health Care, CA.

Author Disclosures

We are grateful for funding from Eblen Charities, Asheville, NC. Thank you for supplies for this study provided by Avadim Technologies, Inc. (Theraworx wipes), by Forte Medical (Peezy), and by Stanford Health Care. Study data were collected and managed using REDCap electronic data capture tools hosted at Stanford University, CA. None of the entities that provided funding, supplies, or services had any role in the design, conduct, or statistical interpretation of the study data. The content is solely the responsibility of the authors.

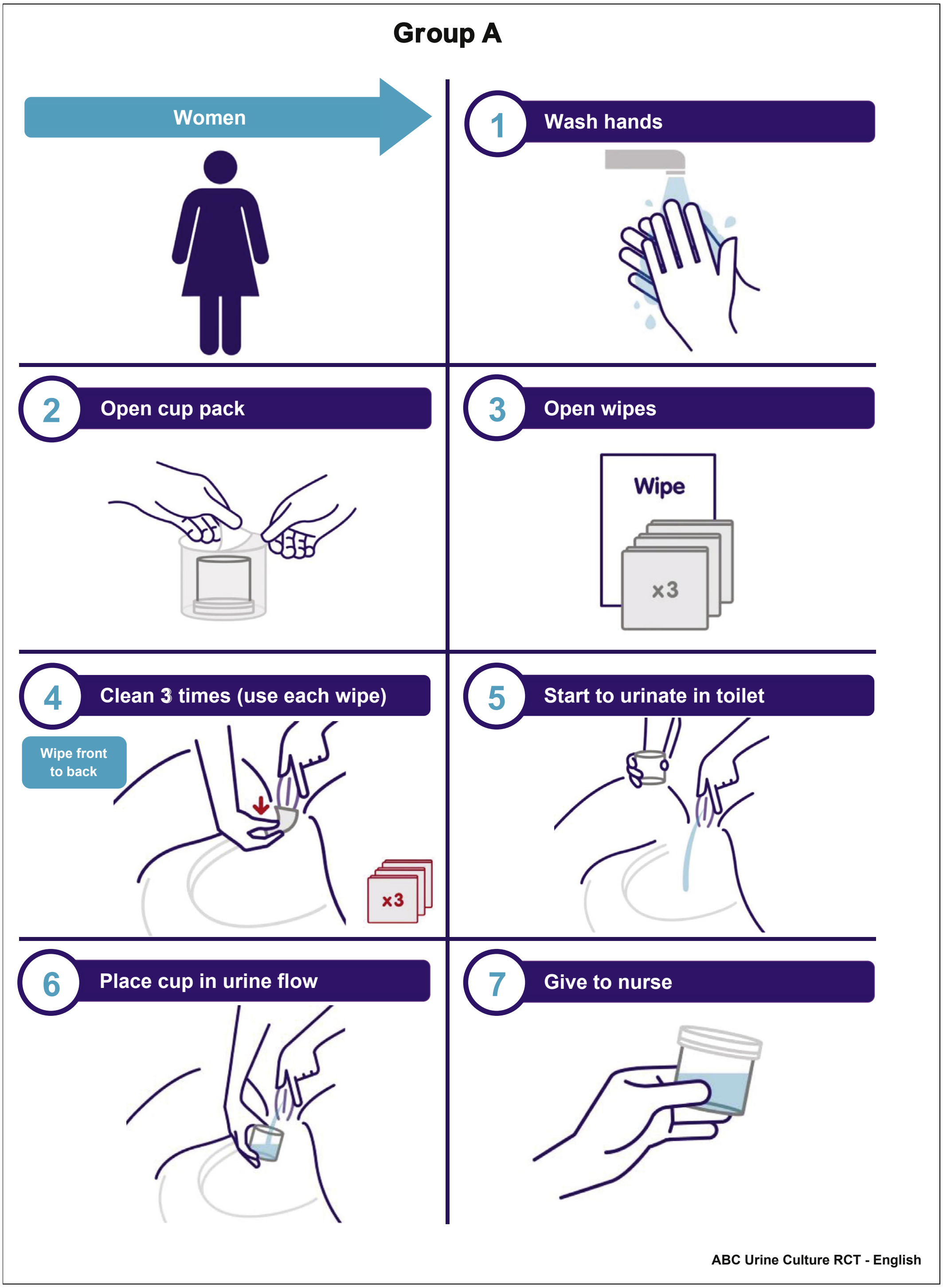
Conflicts of interest

None to report.

REFERENCES

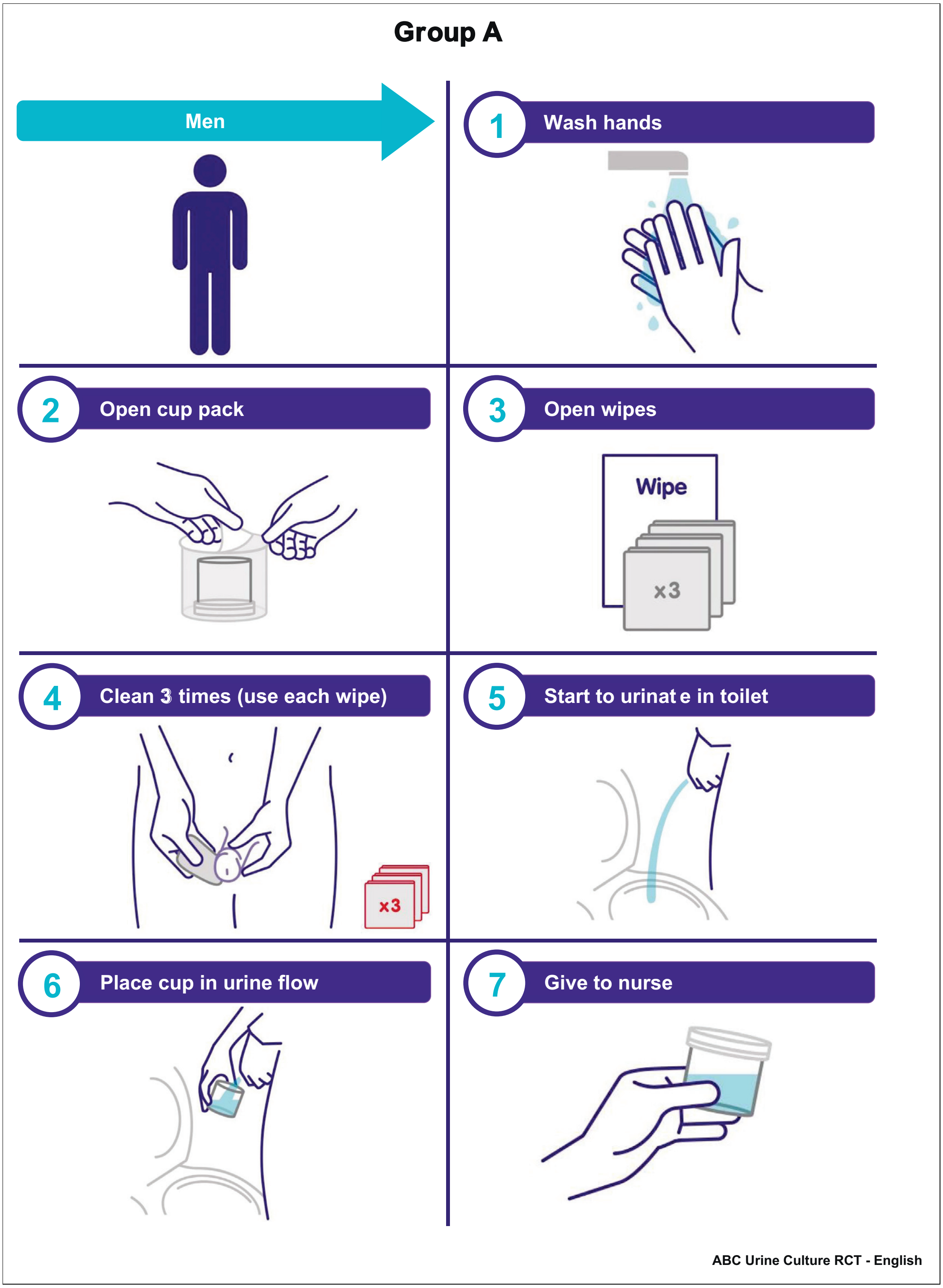
1. Moore BJ, Stocks C, Owens PL. *Trends in Emergency Department Visits 2006-2014. HCUP Statistical Brief #227 September 2017*. Rockville, MD: Agency for Healthcare Research and Quality; 2017. www.hcup-us.ahrq.gov/reports/statbriefs/sb227-Emergency-Department-Visit-Trends.pdf. Accessed March 28, 2019.
2. LaRocco MT, Franek J, Leibach EK, et al. Effectiveness of preanalytic practices on contamination and diagnostic accuracy of urine cultures: a laboratory medicine best practices systematic review and meta-analysis. *Clin Microbiol Rev*. 2016;29(1):105-147. https://doi.org/10.1128/CMR.00030-15.
3. Valenstein P, Meier F. Urine culture contamination: a College of American Pathologists Q-Probes study of contaminated urine cultures in 906 institutions. *Arch Pathol Lab Med*. 1998;122(2):123-129.
4. Bekeris LG, Jones BA, Walsh MK, Wagar EA. Urine culture contamination: a College of American Pathologists Q-Probes study of 127 laboratories. *Arch Pathol Lab Med*. 2008;132(6):913-917. https://www.archivesofpathology.org/doi/pdf/10.1043/1543-2165%282008%29132%5B913%3AUCCACO%5D2.0.CO%3B2. Accessed July 10, 2019.
5. Holliday G, Strike PW, Masterton RG. Perineal cleansing and midstream urine specimens in ambulatory women. *J Hosp Infect*. 1991;18(1):71-75.
6. Blake DR, Doherty LF. Effect of perineal cleansing on contamination rate of mid-stream urine culture. *J Pediatr Adolesc Gynecol*. 2006;19(1):31-34.
7. Houts PS, Doak CC, Doak LG, Loscalzo MJ. The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Educ Couns*. 2006;61(2):173-190.
8. Fisher LA, Johnson TS, Porter D, Bleich HL, Slack WV. Collection of a clean voided urine specimen: a comparison among spoken, written, and computer-based instructions. *Am J Public Health*. 1977;67(7):640-644.
9. Maher PJ, Brown AEC, Gatewood MO. The effect of written posted instructions on collection of clean-catch urine specimens in the emergency department. *J Emerg Med*. 2017;52(5):639-644. https://doi.org/10.1016/j.jemermed.2016.10.010.
10. Eley R, Judge C, Knight L, Dimeski G, Sinnott M. Illustrations reduce contamination of midstream urine samples in the emergency department. *J Clin Pathol*. 2016;69(10):921-925. https://doi.org/10.1136/jclinpath-2015-203504.
11. Frazee BW, Frausto K, Cisse B, White DE, Alter H. Urine collection in the emergency department: what really happens in there? *West J Emerg Med*. 2012;13(5):401-405.
12. Jackson SR, Dryden M, Gillett P, Kearney P, Weatherall R. A novel midstream urine-collection device reduces contamination rates in urine cultures amongst women. *BJUI*. 2005;96(3):360-364.
13. Collier S, Matjiu F, Jones G, Harber M, Hopkins S. A prospective study comparing contamination rates between a novel mid-stream urine collection device (Peezy) and a standard method in renal patients. *J Clin Pathol*. 2014;67(2):139-142. https://doi.org/10.1136/jclinpath-2013-201686.
14. Roser LP, Piercy EC, Altpeter T. Targeting zero: one hospital's journey to reduce CAUTI. *Nurs Manage*. 2014;45(12):18-20. https://doi.org/10.1097/01.NUMA.0000456652.02404.b5.
15. *Making Health Information Clear*. http://luto.co.uk/. Accessed May 23, 2019.
16. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377-381. https://doi.org/10.1016/j.jbi.2008.08.010.
17. Gibson B, Wilson DJ, Feil E, Eyre-Walker A. The distribution of bacterial doubling times in the wild. *Proc Biol Sci*. 2018;285:20180789. https://doi.org/10.1098/rspb.2018.0789.
18. Austin PC. Using the standardized difference to compare the prevalence of a binary variable between two groups in observational research. *Commun Stat Simul Comput*. 2009;38(6):1228-1234.
19. *A Language and Environment for Statistical Computing*. http://www.R-project.org/.
20. Lowe HJ, Ferris TA, Hernandez PM, Weber SC. STRIDE: An integrated standards-based translational research informatics platform. *AMIA Annu Symp Proc*. 2009;2009:391-395.

Appendix

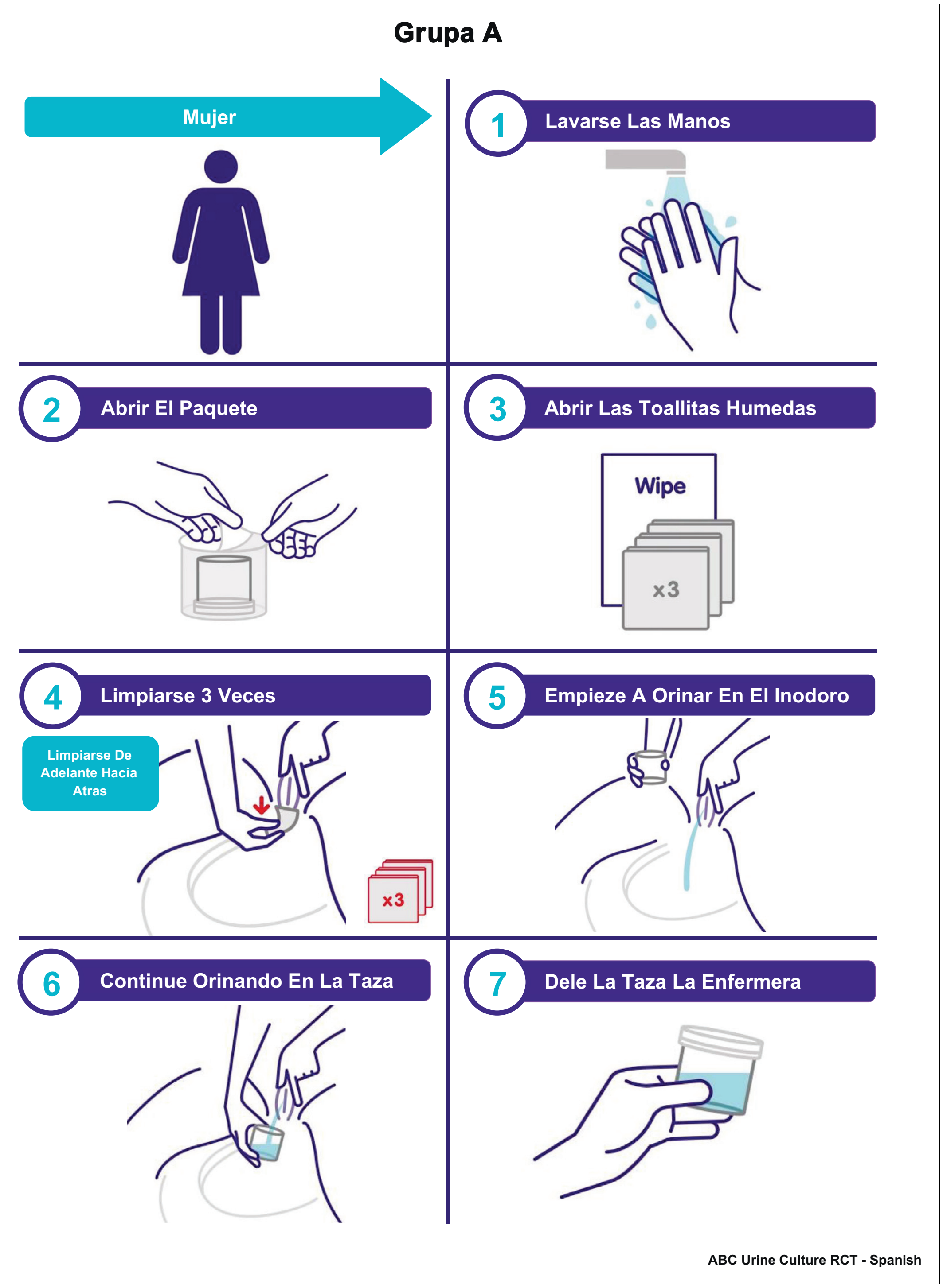


SUPPLEMENTARY FIGURE 1

Urine collection for females (English). Copyright: Stanford Health Care, 2019.

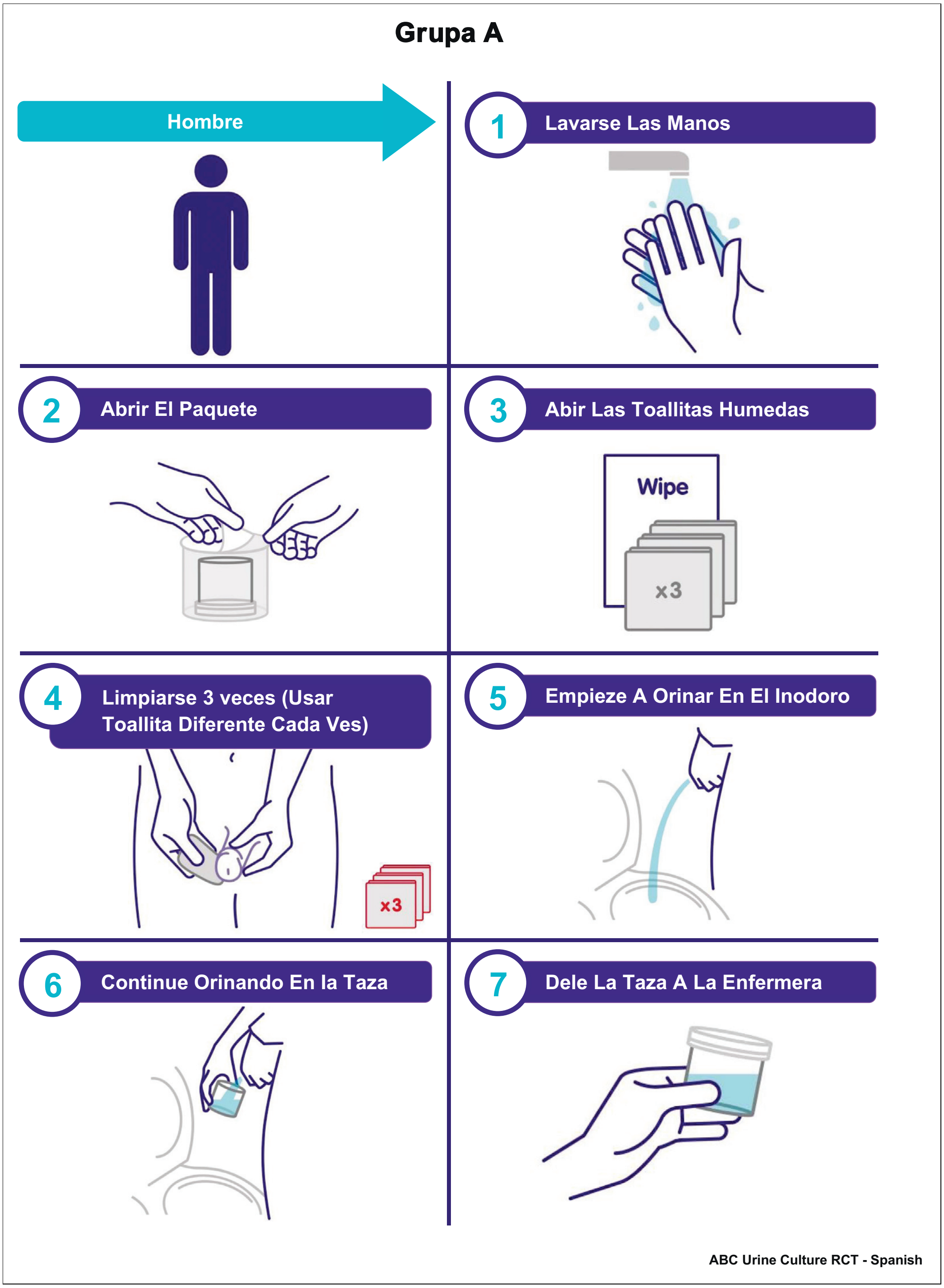


SUPPLEMENTARY FIGURE 2
Urine collection for males (English). Copyright: Stanford Health Care, 2019.



SUPPLEMENTARY FIGURE 3

Urine collection for females (Spanish). Copyright: Stanford Health Care, 2019.



SUPPLEMENTARY FIGURE 4

Urine collection for males (Spanish). Copyright: Stanford Health Care, 2019.