Collection of a Clean Voided Urine Specimen: A Comparison among Spoken, Written, And Computer-based Instructions

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Abstract: In an effort to compare different methods of instructing patients, 99 women 18–25 years of age were given computer, spoken, written, or no instructions for the collection of a clean voided urine specimen. The group who received computer instructions was the most uniform in its performance ($P < 0.002$, F-test) and reported the fewest procedural problems ($P < 0.02$, Fisher test). In addition, this group had fewer contaminating bacteria than the group who received written instructions ($P < 0.03$, Mann-Whitney test). The group who received no instructions had more bacteria ($P < 0.0001$, Mann-Whitney test) than any of the other groups. The effectiveness of the computer instruction was probably related to numerous attributes, including the individualized quality of the dialogue, self-pacing, self-testing, and privacy. (Am. J. Public Health 67:640–644, 1977)

Introduction

In many clinical circumstances, accurate diagnosis and effective management are dependent on skills acquired by the patient. Proper care of diabetes, for example, requires the patient's continuing, informed performance. In urinary tract infection, the subject of this presentation, the patient must participate not only in the treatment but in the collection of clean voided urine samples that distinguish infection from contamination.[1,2] Kunin has suggested that "a conscientious attendant who carefully instructs the patient, is unhurried and provides adequate privacy"[3] is the most important factor in teaching women how to collect clean urine samples. Despite such homage to the education of patients, instructional dialogue is difficult, time consuming, and expensive, and often omitted from the practice of medicine. Some clinics use written instructions in an effort to provide accurate and inexpensive directions. In the absence of dialogue, however, it is difficult to respond to the needs of individual patients, and there is no assurance that the instructions will be read, understood, and followed.

A digital computer, on the other hand, can interact directly with the patient, while providing instructional guidance in an accurate, consistent, and thorough manner. Using principles of patient-computer interaction,[4–7] we have developed a program that teaches patients to provide clean voided urine samples. With relative sparseness of contaminating bacteria as the measure of effectiveness, we have studied this program in an experimental trial.

Questions, explanations, suggestions, and requests were displayed on a screen and patients responded on a typewriter-like keyboard. Responses were stored in the machine and used to determine the course of the interaction. Since progress through the interview was contingent on the patient's answers, the machine could detect misunderstandings and respond appropriately to individual needs. A comparison of this teaching method with the two traditional approaches—written instructions and interpersonal dialogue—was undertaken.

Experimental Design

The women in this study were undergraduates between 18 and 25 years of age and were recruited from five colleges in Boston, Massachusetts. Of 113 volunteers who were initially accepted for participation, 99 completed the study.* Since the study was concerned with counts of contaminating

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*Four were found to have positive urine cultures and were referred to a physician; 10 dropped out because of scheduling conflicts.

bacteria, data from volunteers with positive cultures were not included.

The participants were assigned, in the order in which they volunteered, to one of four groups: computer instruction, spoken instruction, written instruction, and no instruction. Each volunteer visited the laboratory on three occasions at least 24 hours apart and completed her series within three weeks; most completed all three visits within one week. At each visit, the participant received instruction, collected a urine sample, and completed a questionnaire about her reactions to the instruction and problems or omissions associated with any step of the procedure. On the first two visits, each participant was instructed in the manner assigned to her group; on the third visit, all participants received spoken instruction, a standard of excellence for comparison.

Instructions were based on the procedure described by Kunin.[8] Each participant was asked to remove her undergarments, wash her hands, spread her labia, wash her periurethral area from anterior to posterior with three separate sponges soaked in tincture of green soap and rinse in a similar manner with sterile water. A midstream specimen was then collected and covered in a sterile, plastic cup.

A fourth-year medical student (LAF) was in attendance during all sessions. The participants who received spoken instructions met individually with the student. She explained the rationale for a clean voided sample and, with the aim of being consistently thorough, carefully presented the steps of the procedure in a quiet, unhurried setting. Questions were encouraged, and volunteers were asked to repeat the instructions, so that points needing clarification could be identified. Every effort was made to provide the best possible guidance.

The participants who received written instructions were given a sheet of paper that contained a statement of the need for clean voiding and directions for the collection procedure, listed in 12 numbered steps.[8] The volunteers read the instructions in the presence of the attendant, who encouraged questions and was available for discussion.

The participants who received computer instruction communicated with a PDP-15 computer by means of a cathode-ray tube screen and keyboard. After explaining how to operate the terminal and proceed with the interview, the screen displayed the reasons for collecting an uncontaminated specimen, together with a brief description of urogenital anatomy. The screen then displayed instructions for collecting the specimen and questions for the volunteers to use in checking their understanding. Incorrect answers resulted in further explanations designed to clarify points of confusion.

The participants who received no instruction were given a collection cup and asked to provide a urine sample for culture.

Each urine specimen was refrigerated at 4° C within five minutes of collection and plated within eight hours. A portion of each initial specimen was cultured on three blood agar plates with the use of serial dilutions and smear plating.[9] In addition, the undiluted specimens were cultured on MacConky's agar and on a *Culturia* dip slide. Organisms were counted and identified by two technicians who did not know the source of the samples.

Results

Total bacterial counts were lowest on urine cultured from members of the group receiving computer instruction. Counts for the computer group were lower than those in the written-instruction group on each of the three visits ($P < 0.03$, Mann-Whitney test, one-tailed) and lower than those in the spoken-instruction group on the third visit ($P < 0.04$), when all participants received spoken instructions (Tables 1 and 2). For each of the first two visits, the differences between the counts for the computer and spoken-instruction groups were large, but not statistically significant because of the high variability of counts within the groups. Counts in the spoken-instruction group were consistently lower than those in the written-instruction group, but these differences were also not significant. Counts in the no-instruction group were far higher than those in any of the groups receiving instructions ($P < 0.0001$, Mann-Whitney test, one-tailed, both first and second visits).

The performance of participants receiving computer instruction was also more consistent than that of the other participants. Bacterial counts in the computer group were less variable than those in groups receiving written or spoken instructions ($P < 0.002$, F-test, for each of the three visits).

TABLE 1—Bacterial Counts from Urine Specimens of the Four Groups*

		Means (Standard Deviations)			Medians		
		Visit 1	Visit 2	Visit 3+	Visit 1	Visit 2	Visit 3+
Group	No.	colonies per ml × 10^{-3}			colonies per ml × 10^{-3}		
Computer	27	10 (23)	15 (36)	11 (34)	3	1	1
Spoken	23	70 (212)	32 (85)	33 (81)	4	3	8
Written	23	91 (163)	46 (76)	24 (64)	8	7	4
No Instruction	26	149 (146)	138 (143)	40 (89)	117	100	5

*Differences in groups: instruction vs No Instruction (visit 1), $P < 0.0001$; Computer vs Written (all visits), $P < 0.03$; Computer vs Spoken (visit 3), $P < 0.04$ (Mann-Whitney, one-tailed). Differences in variability: Computer vs Spoken and Computer vs Written (all visits), $P < 0.002$ (F test). +All groups received spoken instruction on visit 3.

TABLE 2—Distributions of Bacterial Counts, Expressed as Percentages of the Total Number of Participants in Each Group

Group	Visit 1					Visit 2					Visit 3+				
	colonies/ml					colonies/ml					colonies/ml				
	$\leq 10^1$	10^2	10^3	10^4	$\geq 10^5$	$\leq 10^1$	10^2	10^3	10^4	$\geq 10^5$	$\leq 10^1$	10^2	10^3	10^4	$\geq 10^5$
	% of participants					% of participants					% of participants				
Computer	15	22	41	19	4	18	33	22	19	7	15	41	22	19	4
Spoken	9	17	39	22	13	17	9	43	26	4	13	22	30	26	9
Written	0	26	22	26	26	17	9	30	22	22	4	17	57	17	4
No Instruction	0	12	15	15	58	0	12	12	19	58	16	19	35	15	15

+All groups received spoken instruction on visit 3.

We know of no study that describes counts of contaminating bacteria in clean voided specimens from a comparable population of college-age women. Our participants had higher counts than those reported in women by Norden and Kass[10] or in young girls by Pryles and Steg,[11] but the counts were comparable to those in women reported by Stamey.[12] We were unable to detect any extraneous sources of bacteria emanating from the culturing procedure.

Gram-positive cocci, detected in 97 per cent of the samples, were the most commonly found contaminants; diptheroids, gram-negative baccilli, lactobacilli and yeast were detected in decreasing order of frequency. Although gram-negative bacilli were found in 47 per cent of the samples taken on the first visit, these organisms were present in small amounts compared with the abundant populations of nonpathogens in the same cultures.

The participants who received computer instructions reported fewer problems in providing a clean voided sample (Table 3). Of 198 problems reported for all three visits by participants in the groups that received instruction, 73 related to contamination of the sterile cup, 31 to cleaning the hands, 30 to keeping the labia spread, 18 to midstream voiding—a procedure equally difficult for all three groups—and 46 to miscellaneous problems.

Computer instruction took longer than tne other methods (Table 4). For the first visit, mean times for instruction were 12.3 minutes for computer, 3.7 minutes for spoken and 1.6 minutes for written. In the computer and spoken-instruction groups, mean times decreased with successive visits; in the written-instruction group, the mean time rose from 1.1 minutes on the second visit to 3.1 minutes on the third visit, when spoken instructions were given for the first time ($P < 0.001$, t test, two-tailed).

Sixteen of the 23 participants who received written instructions on the first two visits indicated a preference for the spoken instructions on the third visit. "Although the written might be quick to read, oral instruction makes things more understandable," wrote one. Other comments focused on the opportunity to have points clarified with verbal instruction. Five preferred the written instructions because they found it helpful to visualize the printed words, and two expressed no preference.

Seventeen of the 27 participants who received computer instructions on the first two visits preferred them to the spoken instructions, particularly because of the novelty of the experience. "Both are effective, but the computer is more fun" noted one participant. Several appreciated the anonymity that the computer afforded them: "I felt less self-conscious asking the computer to repeat instructions—to make sure I understood everything—than I would have if a person was giving the instructions." The four who preferred the human teacher indicated that the instruction was more rapid and that it was easier to have points clarified. One participant emphasized the warmth of dealing with a person ("her attitude helps to ease any apprehensions a participant might feel"), and one commented that she would prefer verbal instructions "only if they are as clear as the [verbal] ones I received. Otherwise, computer instructions." Six participants had no strong preference for either computer or spoken instructions.

TABLE 3—Number of Participants Who Reported Problems in Carrying Out the Procedures*

Group	Visit 1		Visit 2		Visit 3	
	No Problems	One or More Problems	No Problems	One or More Problems	No Problems	One or More Problems
Computer	15	12	19	8	20	7
Spoken	5	18	9	14	14	9
Written	2	21	7	16	14	9

*Differences in Groups: Computer vs Spoken, visit 1 $P < 0.02$, visit 2 $P < 0.03$; Computer vs Written, visit 1 $P < 0.0005$, visit 2 $P < 0.006$ (Fisher exact test, one-tailed).

TABLE 4—Instruction Time in Minutes for Each of the Three Visits*

Group	Means (Standard Deviations)		
	Visit 1	Visit 2	Visit 3+
Computer	12.3 (2.3)	3.5 (1.1)	2.7 (0.9)
Spoken	3.7 (0.6)	2.3 (0.7)	2.1 (0.7)
Written	1.6 (0.6)	1.1 (0.4)	3.1 (0.8)

*All differences between means, $P < 0.001$ except: visits 1 vs 2 Written, visits 2 vs 3 Computer, and visit 3 Computer vs Spoken, $P < 0.05$ (t test, one-tailed).

+All groups recieved spoken instruction on visit 3.

Discussion

In evaluation of teaching methods, good measures of student performance are at once important and elusive. As every student knows, examinations are often imperfect measures of mastery, remote from the practical application of what is learned in class. In this study, however, the urine culture and colony count provided an exceptionally apt means of appraisal; it is unusual to have, as a criterion for success in teaching, the very objective of the curriculum.

As indicated by the colony counts, the participants who received computer instructions learned to perform better than those who received written instructions and as well as or better than those who received spoken instruction. Bacterial counts were lowest in the computer group for all visits and members of this group showed the least variation in performance. In accord with their lower and less variable bacterial counts, members of the computer group also reported fewer problems with the clean-specimen procedures—keeping the cup sterile, keeping the labia spread, and washing the hands. Midstream voiding was problematic for all groups alike. Comments by the participants suggest that difficulties could be reduced by providing better instructions on how to direct the urine stream and work within a cramped space.

The successful performance of the computer as teacher can be attributed to several factors. The computer approach combines advantages of both spoken and written instruction. Like spoken instructions, student-computer dialogue can be personalized; questions, answers, explanations, and advice can be provided in response to the needs of the individual. Like written instruction, computer instruction is paced by the student. It is self-administered, standardized, and therefore free of the bias that may be communicated between student and teacher by nonverbal cues and variations in wording.

In the computer group, the greater uniformity of student performance, one indication of preceptorial success, was perhaps related to the machine's consistency in interactive instruction. Furthermore, the computer can facilitate self-testing, an important component of the learning process.[13] Unlike the physician, who may be embarrassed to ask a patient to repeat information that may be difficult to understand, the computer is not hesitant to display repeated tests for comprehension or to re-present information that has already been provided. The computer protects the patient who is self-conscious about appearing unintelligent to another person or is reluctant to request extra time from the physician. Similarly, the computer protects the patient who is uncomfortable about discussing intimate matters. Like earlier participants in computer interviewing[6, 14–16] several members of this group commented on the absence of embarrassment.

Finally, the computer group spent the most time receiving instruction. The machine is not pressed for time; it can interact with student after student without loss of effectiveness from boredom or fatigue.

Clearly, unique characteristics of presentation are associated with each of the teaching methods in this study. We saw no way to achieve uniformity of content without forcing one of the methods to conform, at a loss, to the attributes of another. If the spoken and written instructions had been presented in the structured, branching format well suited to the computer, unnatural constraints would have been imposed on the interpersonal dialogue, and participants receiving written instructions would have been forced to follow a complex network of text, designed for selective, individualized presentation and poorly suited to the printed page. Accordingly, every effort was made to use each medium to good advantage. In the spoken sessions, LAF attempted to provide optimal instruction in an unhurried, friendly manner. She was tutored in advance by a nurse experienced in the collection of clean voided samples and was convinced that her desire to be a good teacher more than balanced her interest in the computer. The written instructions were based on those developed by Kunin,[8] which are clear and concise. In the computer program, we could not resist the academic's compulsion to begin with anatomy. However, only 41 per cent of the computer group found the section on genital anatomy helpful, and only 30 per cent considered the section on the bladder and kidney to be of use; the rationale for the collection process, on the other hand, was helpful to 85 per cent of the group. Anatomical considerations could probably be dropped from the program or made optional without loss of effectiveness and with savings of time.

At present, the good performance that can be achieved with computer instruction would entail increased expenditure for initial cultures. If the computer operated at capacity levels to minimize the cost to the clinic, 12 minutes would require between one and two dollars—much less than the total cost of each visit, but more than either spoken or written instructions. In addition, symptomatic clinic patients might require more time at the computer than was needed by our population of healthy young women. On the other hand, the added cost would be more than offset if reductions in contaminating bacteria, as a result of computer instruction, could serve to clarify diagnoses and to decrease the discomfort, inconvenience, and expense of return visits for repeat cultures.

Clinic patients can be expected to do well with the program. In our experience with medical histories, computer interaction has been a plesant, helpful experience for patients from a variety of socioeconomic backgrounds.[14] People with little formal education seem to relate particularly well to the

machine (computer experts and members of the health professions are sometimes more critical). It is likely that patients could learn a number of important clinical skills by computer instruction. Clearly, the larger the ambit of available programs, the more cost-effective would be the approach. Most computer-assisted instruction in the health fields has been written for student professionals.[17] The patient, who is also in need of assistance, has received little attention. We were pleased by the good feelings expressed for this program. "The program was clear and concise, easy to follow"; "I wasn't as self-conscious about the procedure with the computer . . . could proceed at my own pace to digest all the material it had to offer"; and "It was very different and interesting, I enjoyed working with the computer" were among the written comments. For most patients, 12 minutes of time spent at the machine would be much less than the usual time spent in the waiting room. From their point of view, computer instruction might be a welcome alternative to reading last year's magazines.

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True Greatness

If you wish to be great, you must begin where you are and with what you are, now. He who can give to his city any blessing, he who can be a good citizen while he lives here, he who can make better homes, he who can be a blessing whether he works in the shop or sits behind the counter or keeps house, whatever be his life, he who would be great anywhere must first be great in his own community. Right here. Right now.

Russell H. Conwell, *Acres of Diamonds*, Kansas City, Missouri: Hallmark Editions, 1968, p. 60.