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TEACHING SELF-ADMINISTRATION OF SUCTIONING TO CHILDREN WITH TRACHEOSTOMIES

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We examined the effectiveness of using dolls to teach young children with tracheostomies to self-administer a suctioning procedure. Four children between the ages of 5 and 8 years, who had had tracheostomies for 6 months or longer, participated. After skills were taught via doll-centered simulations, in vivo skills were evaluated. All of the training and probe sessions were conducted in the participants' classrooms or homes. Results of a multiple baseline design across subjects and skill components indicated that the performance of all children improved as a function of training. Skill maintenance was demonstrated by all participants during follow-up assessments conducted 2 to 6 weeks posttraining. Results of a questionnaire completed by caregivers and interviews with the children revealed high levels of satisfaction with the training procedures and outcomes.

DESCRIPTORS: simulation training, suctioning, tracheostomy, behavioral medicine

Use of tracheostomy, a procedure involving an incision into the trachea and insertion of a tube below the larynx to establish and maintain a patent airway, has increased markedly in the past two decades (Stool & Beebe, 1973). Infants and children with airway obstruction as a result of defects of the trachea may require tracheostomy for prolonged time periods (Ruben et al., 1982). Concomitantly, increasing numbers of children with tracheostomies are being discharged to live at home with their families (Kennedy, Johnson, & Sturdevant, 1982).

Care of the tracheotomized child can be a demanding responsibility for family members. Suctioning to remove secretions from the child's tracheostomy tube and trachea must be performed regularly. Ideally, children learn to care for themselves, because reliance upon parents or the availability of capable caretakers for assistance with suctioning can interfere with the child's independent functioning in normal environments. Neef, Parrish, Hannigan, Page, and Iwata (1989) noted, however, that teaching self-performance of intrusive medical regimens can present difficulties if it requires invading the body solely for training purposes or if the trainee is likely to make errors that are potentially hazardous.

In these cases, simulation training represents an alternative to in vivo instruction. Hannigan (1979) and Neef et al. (1989) investigated simulation training with a doll in teaching performance of a medical regimen (self-catheterization skills) to children. Results demonstrated skill generalization from

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doll-centered simulations to self-administration. The reported advantages of doll training included minimizing the participant's embarrassment, permitting repeated instructional trials in a manner that facilitates learning through massed practice, and allowing errors to be detected and corrected prior to self-performance, thereby providing a safer as well as a less anxiety-provoking situation in which to learn the procedure.

In general, the procedures reported by Neef et al. (1989) involved the following sequence. After a task analysis of requisite skills and the categorization of skills into logically ordered skill domains, the trainer describes and demonstrates to the child each elemental step. In some instances, simulation training first involves modeling the target procedure with an anatomically correct doll. The child is then required to imitate the demonstrated procedure with the doll while verbalizing his or her actions. Positive reinforcement is delivered by the trainer when the student administers the procedure correctly; remedial instruction, consisting of additional modeling and cuing, is provided subsequent to incorrect responses. As specific skill domains are mastered by the child, periodic review sessions are conducted to promote forward chaining. Repeated practice provides the participant with numerous opportunities to learn the correct responses under conditions that closely approximate criterion situations. When the child exhibits consistent mastery of all critical steps of the task analysis, the trainer systematically fades the frequency of prompts and contingent reinforcers. Skill generalization to the criterion situation is promoted through the use of common stimuli in the same setting in which self-administration is to occur.

The purpose of the present study was to extend the findings of Neef et al. (1989) by assessing (a) the generality of simulation training as applied to self-administration of suctioning by children with tracheostomies, (b) children's subsequent performance of those skills over time and in different environments, (c) the children's and their caregivers opinions of the intervention and its impact, and (d) an analysis of the types of errors that were made by the children during self-administration probes.

METHOD

Participants

Participants were 2 males and 2 females between the ages of 5 and 8 years. Each underwent tracheostomy during infancy. Medical diagnoses included Klippel-Feil Syndrome (a syndrome characterized by multiple congenital anomalies, including absence of thumbs, hypoplastic radii, and multiple spinal and rib deformities), bilateral vocal cord paralysis, subglottic and tracheal stenosis (Jay); subglottic stenosis (Tiara); subglottic stenosis and tracheomalacia (Brandon); and subglottic stenosis (Fatiah). Two of the children had undergone unsuccessful attempts to remove the tracheostomy tube (Tiara and Fatiah).

All of the children tested at the 4-year-old level or higher in fine motor skills, with cognitive abilities ranging from 4 to 5.25 years on various tests administered by the schools. Two of the children attended regular elementary schools and 2 were enrolled in private preschools for children with handicapping conditions. Two of the children had private nurses; the medical needs of the other 2 children were managed exclusively by family or by school personnel. Informed consent was granted by the parents and physicians for each of the children.

Settings and Materials

The study was conducted with Tiara and Fatiah in their preschool classrooms and with Jay and Brandon in their homes. Suctioning materials included portable suctioning machines, ambu bags (for hyperoxygenation with room air), catheters, distilled water, saline bullets, and tissue. A 0.33-m plastic hollow doll with a tracheostomy tube inserted in its neck was used during simulation training.

Task Sequence and Response Definitions

A task analysis of suctioning skills based on available procedural descriptions and a series of direct observations yielded three basic skill areas for Jay, Tiara, and Brandon and four basic skill areas for Fatiah: gathering and assembling equipment (two separate skill areas for Fatiah), appli-

Table 1
Sample Target Responses within Four Major Skill Areas

Target steps	Jay	Tiara	Brandon	Fatiah
Gets ambu bag				1
Opens catheter kit	1	1	1	2
Attaches catheter to machine	1	1	1	2
Pulls wrapping off catheter	2		2	
Tests catheter in water		1		2
Opens suctioning machine				1
Gets paper cup and pours water				1
Opens saline bullet				1
Places tissue on neck				1
Turns on machine	2	1	2	2
Gives three breaths by ambu bag				3
Inserts catheter into trach	2	2	2	3
Applies suction	2	2	2	3
Cleans catheter in water	2	2		3
Administers saline to trach			2	3
Disposes waste in trash	3	3	3	4
Cleans machine tubing			3	
Turns machine off	3	3	3	3
Closes bottle of water	3			
Puts bottle away		3		

cation of suctioning, and clean-up. The total number of target steps ranged from 13 to 24. Table 1 shows the skill areas and target steps for each subject.

Experimental Design and Training Procedures

A multiple baseline design across both subjects (nonconcurrent) and skills (concurrent) was used. By way of introduction, participants were informed that they could learn to suction their own tracheostomies. The trainer informed the participants that they would first "help the doll to suction" before suctioning themselves. Simulation training consisted of teaching the three (or four) skill areas for suctioning in the aforementioned order. Participants were informed of steps to be performed for the skill area being trained. The experimenter then modeled the target steps with the doll while verbalizing her actions.

Performance trials were initiated with all materials restored to their normal location and condition; the child was then requested to suction the doll's tracheostomy and verbalize what he or she was doing to the doll. The doll was manipulated from a sitting position on the child's lap, facing forward, to simulate the stimulus conditions for performance of self-suctioning response topographies. None of the children used a mirror during simulation training. Session length ranged from 10 to 20 min.

Correct responses were followed immediately by descriptive praise. After an incorrect response, the trainer provided descriptive feedback and again modeled the correct response with the doll. A remedial trial on the step that had been performed incorrectly was then initiated. This sequence was repeated until the child completed the step independently and correctly, after which the next step for that skill area was initiated.

Procedural adaptations were made on an individual basis. These included application of a visual cue (e.g., stamp or star) on the dominant hands of Tiara, Brandon, and Fatiah (each of whom had not yet established hand dominance) to facilitate their discrimination of the correct hand for holding the catheter. With these children, the experimenter also tapped the child's thumb that was to administer the suction to serve as a reminder for the child to keep his or her "thumb up" (i.e., off) the suction port during the insertion of the catheter into the tracheostomy. Verbal prompts were incorporated into the training procedure for Fatiah to signal repeat and end of suction, because the adult was required to judge the needed frequency of the application of suctioning.

A star chart system was used with all subjects to reinforce participation in the training program. At the end of each training session, the child was given a star if he or she had been cooperative while "helping the doll to suction." At the end of the week, if the child had earned a star during every session, he or she was able to select a special sticker. A small hand mirror was provided to Jay during the application of suctioning so that he could accurately direct the catheter to his tracheostomy.

Training sessions were conducted in this manner until an a priori skill mastery criterion of 100% correct responding was met on all target steps within a given skill area over two consecutive training sessions. Data specific to each child's acquisition of target skills during doll simulation training are available from the first author upon request.

Probes and Remedial Training

Probes assessing the children's performance of both trained and untrained target steps in the task analysis on the doll and on themselves were conducted prior to training and after attainment of mastery criterion on each skill area. During each probe using the doll, the child was asked to demonstrate how to suction the doll. No performance-based feedback or differential consequences were provided other than to acknowledge the child at the end of the probe for helping the doll. If the child did not demonstrate 100% correct completion of trained skills during probes, he or she received additional simulation training on the target behaviors previously taught but performed incorrectly. This remedial process was repeated until mastery within the trained skill areas was demonstrated.

A self-administration probe was conducted following demonstration of mastery during a simulation probe to assess generalization of training effects to the self-administration of suctioning. Each child was asked to demonstrate how he or she would suction his or her tracheostomy, to do the best he or she could, but to stop whenever he or she preferred. The child's care provider (parent, teacher, or nurse) supervised both baseline and posttraining probes. The care provider was responsible for interrupting an incorrect response that was potentially unsafe and for assisting the child, as necessary, to perform the impasse step. As before, no performance-based feedback or differential consequences were provided.

If a child failed to meet mastery criteria during a self-administration probe for the trained skill area(s), he or she received supplemental training on the incorrectly performed behaviors. This remedial training consisted of instructions and modeling of the suctioning procedure with the child, followed immediately by rehearsal by the child while the trainer provided descriptive praise and corrective feedback. Training was repeated until the child demonstrated 100% correct responding on the skill area(s) during training, after which the self-administration probe was administered. If mastery was achieved, simulation training was initiated, where appropriate, for the next skill area in the sequence. Data specific to each child's acquisition of target skills during remedial training sessions (either with doll or on self) are available from the first author upon request.

Data Collection and Reliability

Performance during training sessions and probes. The experimenter scored each step of the task analysis as being performed correctly or incorrectly. A child's performance was scored as correct if the step was performed independently according to the operational definitions. A child's performance was scored as incorrect if the child did not attempt the step, demonstrated incorrect topography (i.e., attempted the step but did not perform it according to the behavioral definition), or committed a sequence error (i.e., performed the step in the incorrect order).

Reliability checks were conducted by the experimenter and trained observers on 56.0% of training sessions and 59.7% of probes for all children. Experimenter and observer records were compared on a step-by-step basis (concurrence on steps performed correctly and incorrectly), with reliability estimates calculated by dividing the number of agreements by agreements plus disagreements and multiplying by 100. The mean level of interobserver agreement across all children during training sessions was 97.0% (range, 92.6% to 100%). The mean agreement score for self-administration probes was 97.0% (range, 96.2% to 99.3%).

Assessment of procedural integrity. The extent to which the training and assessment protocols were conducted as described above was assessed by having an observer record each occurrence of prompts, reinforcement, and feedback as correct or incorrect within each skill area for Fatiah. These checks were performed during 14.0% of training sessions and during 6.2% of probe sessions conducted by the experimenter. Levels of procedural integrity remained at 100% during all assessed training sessions and probes.

Follow-Up Assessments

Subsequent to achievement of mastery criteria during self-administration probes across all skill components, assessments of skill maintenance were conducted in each child's home and/or school. Follow-up, which varied among children according to their time of entry into the study, occurred after four sessions for Jay, five sessions for Tiara, four sessions for Brandon, and 23 sessions for Fatiah. Follow-up checks were conducted by the experimenter and/or the child's trained care provider in the same manner as during the probes.

Social Validation

A consumer satisfaction questionnaire adapted from one developed by Larsen, Attkinson, Hargreaves, and Nguyen (1979) was administered to the care providers (parents, teachers, and nurses) of the 4 children. The respondents were asked to rate their degree of satisfaction with the training curriculum on 10 Likert-scale items, with anchors ranging from 0 ("extremely dissatisfied") to 5 ("extremely satisfied"). The children were also interviewed by the experimenter or their care provider.

RESULTS

Figure 1 presents the performance of each child during baseline, posttraining, and follow-up assessment phases for doll and self-administration probes. Mean percentage correct responding across all skill areas during baseline for doll and self-administration probes, respectively, was 58.7% and 53.5% for Jay, 45.7% and 42.5% for Tiara, 41.8% and 47.1% for Brandon, and 7.5% and 8.1% for Fatiah. During baseline, the children were most likely to demonstrate skills pertaining to gathering and assembling equipment and cleaning up.

Performance by each child improved immediately following training in each successive skill area. All participants achieved the 100% mastery criterion in all skill areas. Generalization of the effects of doll training to self-suctioning was observed in all skill areas for all children. The extent of generalization from doll training to self-administration was assessed only during the first self-administration probe conducted with each child. Limitations in generalization for the suctioning skill area during the first probe were observed for Tiara (correct performance of 67% of steps), Brandon (86% of steps), and Fatiah (45% of steps). Therefore, remedial training was required to meet criterion for the application of suctioning by Tiara (six sessions), Brandon (one session), and Fatiah (one session), who subsequently exhibited mastery on the probe.

Performance gains were maintained over 2 weeks for Jay, 4 weeks for Tiara, 2 weeks for Brandon, and 6 weeks for Fatiah. Remedial training was not necessary for any of the children during follow-up. For all children, mean percentage correct responding across all skill areas ranged from 91.7% to 100% during follow-up.

The types of errors made by the children during self-administration probes varied according to the experimental condition in effect. During baseline, the error made most frequently by all children but Tiara was a failure to attempt to perform the target response (mean percentage range, 70% to 98.4%).

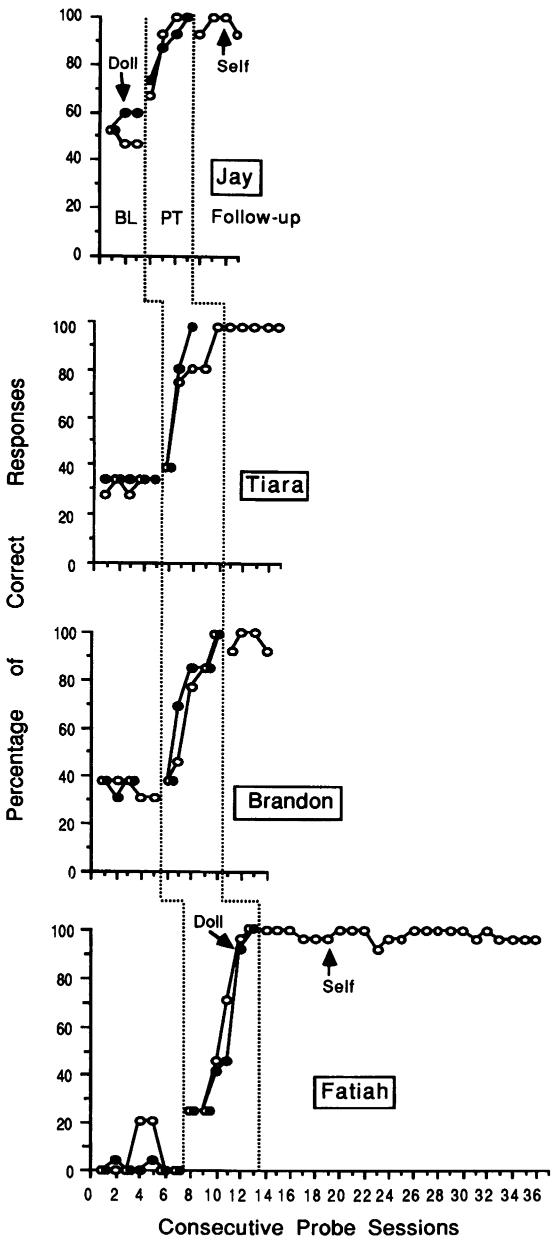

Figure 1. Percentage of correct responses on simulation and self-administration probes across subjects.

With Tiara, a mean percentage of 90.9% of the errors were attributable to incorrect topography. In general, during posttraining and follow-up, the majority of errors for all children were of incorrect topography (mean percentage range, 0% to 75%). However, only Fatiah performed errors of incorrect topography during the suctioning skill area, whereas the other children's errors were limited to the preparation and clean-up skill areas. Overall, sequence errors were a small percentage of error types (mean percentage range, 0.2% to 5.6%) and occurred only in the baseline phase.

For all children, the mean number of training sessions necessary to reach criterion was 8.0 (range, 2 to 24) for the gathering and assembling of equipment (Skill Area 1), 16.5 (range, 5 to 30) for the application of suctioning (Skill Area 2), and 2.75 (range, 2 to 4) for clean-up (Skill Area 3). Conservative estimates of total training time, based on the number and scheduled duration of training sessions, are 1 hr 30 min for Jay, 4 hr 15 min for Tiara, 4 hr 30 min for Brandon, and 18 hr 40 min for Fatiah.

Six of the 11 teachers, nurses, and parents who were asked to complete the satisfaction survey provided ratings regarding the impact of the training program. These data suggested that the consumers were quite satisfied with the quality and amount of training the children received (M = 4.5), as well as with perceived increases in the children's self-esteem (M = 4.3). Copies of the social validation questionnaire, along with means and ranges of the responses to each question, are available from the first author upon request.

Each of the children indicated that he or she enjoyed learning to suction the doll and him or herself. All 4 children agreed that they could help their caregiver with the suctioning procedure after training. Each responded affirmatively to the question of whether other children with tracheostomies should learn to suction themselves.

DISCUSSION

Results indicate that performance of suctioning by all 4 children increased after training and that generalization to self-administration typically occurred after meeting mastery criteria during simulation (doll) training. Acquired skills were typically maintained. Errors of incorrect topography during follow-up were largely limited to the preparation and clean-up skill areas and did not occur during the actual medical procedure. Data regarding amount of training time required to achieve mastery suggest that the curriculum can be incorporated into a daily routine of 10- to 20-min sessions for 1 to 8 weeks.

The passage of P.L. 94-142 has resulted in more children with multiple impairments remaining in the community and attending public schools. Effective self-administration of a prescribed suctioning procedure has implications for decreasing the extent of ongoing specialty care required for a tracheotomized child to attend a regular school. Through use of this curriculum, it may be possible to train many children to perform the preparation and clean-up aspects of the procedure without supervision. Because a tracheotomized child's attendance at school may be limited by the availability of specialized staff members, it can only be beneficial if a child is as independent as possible when performing the suctioning procedure. At school, one specialist on site may be sufficient to supervise the application of suctioning as well as to be available for problematic situations.

Self-suctioning also has implications for decreasing the specialty care requirements of tracheotomized children who reside at home, and has possible consequences for home-care policy and funding. If the child is medically stable and can perform self-suctioning, adult supervision in the home by an aide or parent (instead of skilled nursing supervision) may promote cost containment related to expenses in health care for children with special medical needs. Although some children require ongoing care because of congenital anomalies or recurrent respiratory conditions, many could function in a less supervised situation at home if adequate training were provided. Thus, the ultimate goals of the program are increased access to the community, including educational opportunities and social activities, and cost containment, as the need for 24-hr supervision is reduced.

Doll training appears to be a viable tool for training the self-administration of suctioning. Use of the doll provides increased training opportunities, motivates the child to participate in training, prevents exposing the child to potentially dangerous or frightening conditions prior to the acquisition of skills, and provides opportunities to improve manual dexterity and competence prior to self-suctioning. Perhaps most importantly, doll training facilitates the child's refinement of the self-administered technique without the possibility of harmful consequences.

The training paradigm is not intended to be used as a standard package that can be applied consistently with all tracheotomized children. Target steps must be individualized for each subject depending on his or her suctioning procedure, behavior patterns, and developmental level. During all training phases, it is imperative to involve the child's parents and, where applicable, the child's teachers, aides, and nurses. The goal of promoting the child's self-administration of the prescribed medical regimen is to augment the child's self-efficacy and to diminish the burden of care borne by the child's adult providers, not to displace the providers altogether. Adult caregivers must continue to monitor the suctioning skill to ensure quality of performance and to intervene if emergency situations arise.

Simulation training with a doll has been shown to be effective in self-catheterization (Neef et al., 1989) and menstrual hygiene (Richman, Ponticas, Page, & Epps, 1986; Richman, Reiss, Bauman, & Bailey, 1984). Overall, results suggest that simulation training with a doll may be a useful technique for teaching the self-administration of medical procedures and promoting increased independence. The present study supports the premise by Neef et al. (1989) that doll training provides numerous training opportunities and may offer an efficient means of training. Like the study by Richman et al. (1984) for menstrual care, the training can be implemented by available staff members who are trained in the experimental procedure. Doll training also makes it possible to modify the training procedure to assist the behavior patterns displayed by individual subjects and to attenuate stress, because dolls are often associated with play activities.

Although the present data indicate that simulation training may facilitate generalization to self-suctioning, they should be interpreted with caution. Because each of the participants had been exposed repeatedly to the suctioning procedure prior to the experiment, it is possible that such prior practice, although not sufficient, was necessary for generalization to occur. Furthermore, a more extensive assessment of generalization was precluded by the need to provide remedial training. The isolated effects of simulation training per se on skill acquisition, generalization, and maintenance are yet to be established.

REFERENCES

Hannigan, K. F. (1979). Teaching intermittent self-catheterization to young children with myelodysplasia. *Developmental Medicine and Child Neurology,* **21**, 365–368.

Kennedy, A. H., Johnson, W. G., & Sturdevant, E. W. (1982). An educational program for families of children with tracheostomies. *Maternal Child Nursing Journal,* **7**, 42–49.

Larsen, D., Attkinson, C., Hargreaves, W., & Nguyen, T. V. (1979). Assessment of client-patient satisfaction: Development of a general scale. *Evaluation and Program Planning,* **2**, 197–207.

Neef, N. A., Parrish, J. M., Hannigan, K. F., Page, T. J., & Iwata, B. A. (1989). Teaching self-catheterization skills to children with neurogenic bladder complications. *Journal of Applied Behavior Analysis,* **22**, 237–243.

Richman, G. S., Ponticas, Y., Page, T. J., & Epps, S. (1986). Simulation procedures for teaching independent menstrual care to mentally retarded persons. *Applied Research in Mental Retardation,* **7**, 21–35.

Richman, G. S., Reiss, M. L., Bauman, K. E., & Bailey, J. S. (1984). Teaching menstrual care to mentally retarded women: Acquisition, generalization, and maintenance. *Journal of Applied Behavior Analysis,* **17**, 441–451.

Ruben, R. J., Newton, L., Chambers, H., Jornsay, D., Liquori, J., Stein, R., & Lawrence, C. (1982). Home care of the pediatric patient with a tracheostomy. *Annals of Otology, Rhinology, and Laryngology,* **91**, 633–640.

Stool, S. E., & Beebe, J. K. (1973). Tracheostomy in infants and children. *Current Problems in Pediatrics,* **3**, 3–33.

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