Improving Wound Care Simulation with the Addition of Odor: A Descriptive, Quasi-experimental Study

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Improving problem-solving skills and expertise in complex clinical care provision requires engaging students in the learning process — a challenging goal when clinical practicums and supervisors are limited. High-fidelity simulation has created many new opportunities for educating healthcare professionals. Because addressing malodorous wounds is a common problem that may be difficult to “teach,” a descriptive, quasi-experimental simulation study was conducted. Following completion of a wound care simulation and Laerdal’s Simulation Experience Evaluation Tool by 137 undergraduate nursing students, 50 control subjects were randomly selected and 49 volunteer students (experimental group) participated in a wound care simulation after one of three cheeses with a strong odor was added to simulate a malodorous wound. Compared to the control group, study group responses were significantly better (P <0.001) for eight of the 12 survey variables tested and indicated the addition of odor was beneficial in enhancing the perceived realism and value of the simulation. Students responded that the addition of odor in the simulation laboratory improved realism and they felt better prepared to handle malodorous wounds in a clinical setting. An unanticipated outcome was the enhanced feeling of involvement associated with paired care teams as opposed to working in larger groups. The results of this study indicate that wound care education outcomes improve when nursing students are able to practice using a multi-sensorial wound care simulation model.

KEYWORDS: simulation, wound care, multi-sensorial, clinical education

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the need for creating realistic clinical experiences that link concepts with patients. Simulation provides for these considerations.

High-fidelity simulation is designed to effect a learning environment that is as realistic as possible using mannequins that have life-like features, simulated vital signs, and other interactive features tailored to the simulation experience. Demand for simulation is growing as clinical sites become overused by the many competing health science disciplines. Current high-fidelity simulation utilizes sight, touch, and hearing; the sense of smell has not been included. Humans normally rely on sight 83% of the time, hearing 11%, smell 3.5%, taste 1.5%, and touch 1.5%. Thus, the sense of smell plays a vital role in feelings of well-being and quality of life. It also serves a recognition and assessment function.

Experienced clinical educators know that odors can be overwhelming for students in healthcare programs. Practitioners and researchers need measures that can distinguish among factors that examine healthcare practices, improve patient care, and allow students to have experiences in nonthreatening environments. Student-related incidents and patient embarrassment in the clinical area may be prevented if students have an opportunity to develop strategies for dealing with malodors before encountering them in the clinical area.

A descriptive quasi-experimental study comparing wound care simulation with and without the addition of a malodorous agent was conducted to determine if the addition of a malodor improved the perceived realism for the student and increased the student’s sense of preparedness for real-life wound care situations.

Purpose

The specific aims of this pilot project were to provide a multi-sensorial wound care simulation experience for nursing students and to test a new method of simulation that included the sense of smell. The researchers believed adding odor to the wound care scenario would make the simulation more realistic for students and ultimately enhance their confidence in their ability to care for wounds. In addition, observations of the students’ reactions to malodorous “wounds” (nontoxic agents — three “stinky” cheeses) were videotaped and analyzed to determine whether the addition of malodorous cheese duplicated the odor of infected wounds.

Literature Review

According to a review of the literature, learning is best achieved when students can “say and do” — that is, talk about a concept while doing it. Improving problem-solving skills and expertise in complex clinical behaviors requires engaging students in the learning process. Problem-based learning allows students to have a more interactive role in their learning. Psychomotor and clinical decision-making skills can be honed through small group activities that apply concepts learned in classroom settings. Performing potentially stressful tasks (eg, malodorous wound care) in a safe environment with appropriate support from faculty as facilitators of learning enhances the development of clinical judgment and therapeutic use of self in patient care. Thus, problem-based learning offers students the opportunity to develop problem-solving, communication, and clinical skills in a controlled environment. Moreover, use of problem-based learning scenarios provides the researcher with rich, in-depth insight into the cognitive and behavioral experiences of the participant.

KEY POINTS

- To help teach healthcare professionals optimal clinical skills in a safe environment, many clinical educators now utilize high-fidelity simulation models.
- Because wound care simulation models are odorless, the authors compared nursing student responses following use of the model without and with added odor (strong-smelling cheese).
- Students responded well to the addition of odor and their responses suggest that they felt prepared to manage patients with malodorous wounds.
- More information about the value and outcomes of wound care education methods is needed to optimize educational practices and patient outcomes.
Currently, simulation in nursing has been utilized most frequently in nursing anesthesia graduate programs with much of the research focused on the value of the technology.\textsuperscript{1,3} Use of simulation in clinical learning has expanded to all facets of undergraduate nursing education, having been shown to provide a risk-free learning environment where errors can occur without detriment to the patient. Furthermore, repeated use of simulation has been shown to facilitate development of clinical judgment and improved reasoning skills.\textsuperscript{1}

**Malodorous Wounds**

Malodor is a common problem and can occur in many types of wounds. Treatment often is based on thorough assessment and identification of the cause. The effects of living with a draining, malodorous wound can be devastating; based on a review of the literature by Hack,\textsuperscript{7} patients have been reported to experience shame, altered body image, embarrassment, and rejection. Furthermore, patients had individualized reactions to malodorous wounds: some felt less desirable as people, some feared a loss of sexuality, and some avoided certain clothing for fear of revealing their wound. Patients living with venous leg ulcers revealed that prescribed coping methods often were inadequate and that embarrassment and maintaining dignity often were worse when a wound was malodorous. In a quantitative phenomenologic study, Neil and Munjas\textsuperscript{9} found that for nine of the 10 patients with chronic wounds they studied, malodor caused embarrassment and distress. Despite attempts to address smell and oozing therapeutically and with deodorizing products, they remain common problems for people with chronic wounds.\textsuperscript{9} Health professionals must know how to deal with malodorous wounds in a professional manner. The importance of psychological support for the patient should not be underestimated.

**Source of odor.** Most people can become habituated to odors, except the odors produced by putrescine and cadaverine — diamines (amino acids) emitted as a result of necrotic tissue or a mixture of pus and fibrin. Necrotic tissue predisposes a wound to bacterial invasion. Some of the most odorous bacterial organisms that produce putrescine and cadaverine are *Bacteroides, Clostridium, Proteus, Klebsiella, and Pseudomonas.*\textsuperscript{10} The action of bacteria on necrotic tissue in the wound causes malodor.

**Assessment.** The key to successful wound management comprises accurate assessment that includes presence and type of wound odor.\textsuperscript{10} Baker and Haig\textsuperscript{11} developed a scoring tool to aid in objectively describing wound odor using four types of odor description. The descriptions ranged from "no odor" to "strong odor" where a strong odor is defined as odor that is evident upon entering the room (6 to 10 feet from the patient) with the dressing intact. This scoring tool, later adapted as the Odour Assessment Scoring Tool,\textsuperscript{8} may be useful as a means to objectively evaluate what is often a subjective assessment; further testing for reliability and validity should be performed before this tool becomes widely accepted. The literature is scant regarding objective tools for odor assessment.

**Simulating Wound Malodor: Cheese**

A challenge to including the olfactory sense in a simulation is finding a safe malodorous substance that can be added to a wound care model. Use of certain cheeses in simulated wound care is appropriate — the cheese-making process includes the alteration of milk and addition of special bacterial cultures, a process somewhat similar to what may occur in a wound.\textsuperscript{12} The researchers’ clinical experience with wound care supported that odorous cheese could closely approximate the odor of a wound and provide a pungent smell that would be noticed by students performing wound care.

An Internet search was conducted to find cheeses that might approximate the smell emitted from a malodorous wound; appropriate literature was consulted related to cheeses known for their pungent odor. Seventeen “stinky” cheeses were found and three were selected for the simulation project based on pungent aroma and availability: Limburger, Livarot, and Espoisses Appellation d’origine Berthaut.\textsuperscript{13} Limburger is a semi-soft surface-ripened cow’s milk cheese noted for the strong, pungent aroma that develops as the cheese ripens. *Brevibacterium linens,* the bacteria used to ferment Limburger cheese and other rind-washed cheeses, are found on human skin and contribute to body odor.\textsuperscript{12}
Limburger cheese has been used to depict malodor in various media. For example, in Mark Twain’s “The Invalid’s Story,” a package of Limburger cheese was placed atop a casket to emit a smell similar to the stench of a corpse. In the 1918 silent film Shoulder Arms, Charlie Chaplin receives a package of Limburger cheese. Startled by the smell, he puts on his gas mask and throws it over his head into the enemy’s bunker.

Petit Livarot, one of the world’s oldest cheeses, is the product of an ancient cheese-making process. Produced in the Normandy region of France, the cheese is created using a salt-water solution and turned regularly to achieve its spicy flavor (and strong odor). The soft cheese Espoisses Appellation d’origine Berthaut originates from the Burgundy region of France. This handmade cheese is first washed in brine and then cured in humid cellars for 4 weeks. After this brief aging period, the rind is rinsed with Marc de Bourgogne, a liqueur that is a byproduct of the local wine industry. This process yields a cheese with a strong odor and taste.

Methods
A descriptive observation and survey design was used to meet the specific aims of this study. The study was conducted at a large southeastern (US) university in a new, state-of-the-art simulation laboratory in the College of Nursing (CON) following approval from the Institutional Review Board. To avoid conflict with regularly scheduled labs and student and faculty schedules, the team chose to conduct the study on a Saturday. All simulations were completed on the same day with each member of the research team performing the same role to ensure consistency across all simulations.

The research team comprised seven experienced nurses with no less than 18 years’ experience with inpatient wound care. One of the researchers had completed a study exploring the experience of patients living with a chronic wound. All of the research team members were currently working with patients who had wounds in the hospital setting and were teaching undergraduates in the clinical and/or laboratory setting.

The dependent variables were measured using Laerdal’s Simulation Experience Evaluation Tool (nonpublished; used with permission). This tool consists of 12 five-point Likert items with the following response categories: strongly agree (1), agree (2), neutral (3), disagree (4), and strongly disagree (5). For statistical analysis, the scale values were reversed to make “strongly agree” the high score (the more familiar arrangement in Likert scales). Using this scale, participants evaluate their experience regarding level of participation (active), realism of the scenario and environment, ability to identify patient problems and intervene, and ability to incorporate theory into hands-on practice. Furthermore, the participants evaluated how well they were able to determine areas of strengths and weaknesses, level of preparation to participate, and sense of safety during the scenario. Final statements evaluate the perceptions of respect toward participants during debriefing, value of the debriefing session, and confidence in performance of the simulated skill in the clinical area. For the experimental group, the following three additional open-ended questions were added to evaluate the addition of odor to the scenario: 1) How realistic was the experience (as compared to the previous, odor-free scenario completed for class)? 2) Did the addition of odor improve preparation for dealing with malodorous wounds in the clinical setting? 3) To what extent was odor a distraction to performing care?

Sample. All undergraduate first semester nursing students (n = 137) from which the sample was drawn participated in a wound care simulation as part of their academic requirements. In the academic wound care scenario, students performed sterile wound care using a high-fidelity simulation mannequin in groups of four to six. The mannequin would “speak” to the students during care by means of a radio system with a staff member acting as the mannequin’s voice. Two students acted as nurses with the additional group members keeping notes on what they viewed during the wound care scenario. All 137 students anonymously completed the survey to evaluate their experience in laboratory classes. From those completed surveys, 50 were randomly selected to act as the control group for this study. Because the students participating in the study had been exposed to the simulation laboratories, they were less likely to be intimidated or distracted by simulation techniques. Furthermore, the
timing of the study (at the end of the semester) ensured all students participating in the experimental group had seen a simulated wound care scenario and had either seen or actually performed wound care in the hospital setting.

The study was explained to the pool of 137 study candidates. Study volunteers were requested to sign up in pairs on a master schedule to participate in the experimental simulation experience. The student pairs were self-selected and not matched with the control group to streamline the scenario by having fewer people present during the wound care simulation. The research group planned on a target sample size of 50 but did not decline any volunteer’s participation. Originally, 56 students signed up to participate; by the research day, six withdrew and four new students volunteered. The two most common reasons for withdrawal were family obligation or work demands. At the close of the research experience, 49 participated in the experimental arm of the study.

Procedure. The participants signed up in pairs (one acted as the primary nurse and one was the assistant) with 20 minutes per team allotted for the process. In the event a participant did not have a partner, a research team member would assist with the student functioning as the primary nurse. On the designated day, participants met a member of the research team who obtained informed consent. To ensure each participant received the same information, the research team member maintained this role throughout the study day and used a script for consistency.

Using two-way radios, the simulation research staff summoned each pair of participants from the informed consent area. Each team received an orientation to the patient care environment. The participants were instructed to conduct wound care with the patient as they would in real life — ie, to read the orders and conduct wound care following principles of sterile technique, to use proper body mechanics, and to interact with the patient. A member of the research team was situated behind a screen and used a radio to portray the voice of the mannequin, as was done in the control wound care scenario. The “patient” (mannequin) greeted the “nurses” and asked questions about wound care during the simulation. These procedures were followed in the control and in the experimental arm of the study. Cheese selection was made by the research team. One cheese had been tested at a time — Petit Livarot and Berthaut were not detectable within 6 feet of the patient nor highly pungent when the dressing was removed. Limburger was quite pungent within 6 feet of the patient and more so when the dressing was removed; therefore, it was chosen for the simulation. Each participant group was videotaped by either a member of the CON Instructional Technology (IT) department or a member of the research team. After completing the simulation, the participants met with the principal investigator of the study to complete the evaluation of the simulation experience and to finalize the survey. At that time, the participants also were asked to rank three cheeses selected for the experience based on potency of malodor. The three cheeses were presented to each participant in the same order (Limburger, Petit Livarot, and Berthaut) simply by opening the sealed package of each brand. The participant had no more than 10 seconds to smell each cheese with a brief interval between each test. The participant indicated which smelled the worst and results tabulated. When the evaluation component was completed, participants received a small honorarium as compensation for their time. Participants were directed down an exit path to prevent contact between the next groups of participants and avoid discussion of the simulation experience.

Data analysis. A nonparametric Mann-Whitney test was used to examine differences between the control and experimental groups. The researchers controlled for the possibility of having one or more comparisons yielding significant results because of multiple significance testing by assigning statistical significance at 0.01. SPSS 13.0 (Chicago, Ill) was used for statistical analysis.

Results

Distribution of responses to the simulation experience were highly skewed (see Table 1). Participants in the experimental group had statistically significant differences from the control group for the items related to active participation, realism, and critical thinking behaviors such as identifying patient problems and incorporating theory into practice. Statistically
nonsignificant ($P < 0.02$) survey items were determination of strengths and weaknesses, level of preparation to participate, sense of safety during the scenario, respect for others during debriefing, value of debriefing, and confidence of the simulated skill performance in a clinical setting.

The additional questions answered by the experimental group showed that: 1) the addition of odor improved the realism of their wound care experience; 2) students felt better prepared to handle malodorous wounds in the clinical setting; and 3) the odor generally did not distract during wound care (see Table 2). As an unexpected benefit of using cheese in a simulated wound, verbal and written commentary by the participants indicated the wound appeared to have exudate, which the participants stated added to the realism of the scenario.

Participants selected the cheese they perceived as the worst-smelling at the close of the scenario. Limburger was perceived as the worst smelling of the three cheeses (see Figure 1).

Twelve videotapes were randomly selected and viewed by the research team to assess for consistency or variation in wound care procedure during the study; little variance was noted. However, the researchers noted areas for improvement for teaching strategies such as emphasizing management of nonverbal expressions (crossed arms, frowning, wrinkling the nose), speaking to the patient during wound care, and awareness of inappropriate laughter, pauses, or hesitancy. The videotapes will be further analyzed for qualitative data at a later date.

**Discussion**

Competition between healthcare programs for quality clinical sites to use in student clinical education is intense. Furthermore, there is a shortage of nursing faculty to supervise and facilitate the education of nursing students in clinical settings.\textsuperscript{17} Simulation has been viewed as a potential solution to remedy some of the shortages as well as a way to provide safe learning environments for nursing and medical students.\textsuperscript{17,18} Simulation must provide a high level of authenticity to adequately prepare students for real-life situations.\textsuperscript{19,20} The prevalence of wounds

**Table 1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Experimental</th>
<th>Mean</th>
<th>% Agreement</th>
<th>Control</th>
<th>Mean</th>
<th>% Agreement</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was an active participant</td>
<td></td>
<td>4.8</td>
<td>98</td>
<td></td>
<td>3.3</td>
<td>48</td>
<td>$&lt;.001^*$</td>
</tr>
<tr>
<td>Scenario was realistic</td>
<td></td>
<td>4.6</td>
<td>96</td>
<td></td>
<td>4.0</td>
<td>80</td>
<td>$&lt;.001^*$</td>
</tr>
<tr>
<td>Environment was realistic</td>
<td></td>
<td>4.5</td>
<td>92</td>
<td></td>
<td>3.9</td>
<td>76</td>
<td>$.001^*$</td>
</tr>
<tr>
<td>Able to identify patient problems</td>
<td></td>
<td>4.5</td>
<td>90</td>
<td></td>
<td>3.8</td>
<td>62</td>
<td>$&lt;.001^*$</td>
</tr>
<tr>
<td>Able to incorporate theory into practice</td>
<td></td>
<td>4.8</td>
<td>98</td>
<td></td>
<td>3.9</td>
<td>74</td>
<td>$&lt;.001^*$</td>
</tr>
<tr>
<td>Valuable learning experience</td>
<td></td>
<td>4.8</td>
<td>96</td>
<td></td>
<td>4.6</td>
<td>94</td>
<td>.02</td>
</tr>
</tbody>
</table>

*$P <.01$ and statistically significant

Response categories: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree

Mean item score, percent agreeing or strongly agreeing, and $P$-value based on the Mann-Whitney nonparametric test
in hospital and community settings requires that realistic wound care simulations be incorporated into educational programs.

The results of this study indicate nursing students benefited from the addition of odor to the wound care scenario. Of the 49 participants, 48 (98%) felt they actively participated in the wound care scenario as opposed to 24 (48%) in the control group (see Table 1). Study participants found the scenario and environment that included “wound odor” more realistic than the control group (47, 96% versus 40, 80% and 45, 92% versus 38, 76%, respectively [see Table 1]). Using paired participants (as opposed to groups of eight to 10 students in this wound care simulation) was preferred. Other studies\(^\text{19}\) of clinical simulations using pairs were shown to provide more opportunity for active participation and thus improved learning. The participants in this study agreed that working in pairs facilitated more active participation.

With regard to critical thinking, participants indicated confidence in their ability to determine patient problems and incorporate theory into the wound care scenario (44, 90% versus 31, 62% and 48, 98% versus 37, 74%, respectively [see Table 1]). Based on the additional survey items used only with the experimental group, the participants expressed increased confidence in their ability to care for malodorous wounds following participation in the study (see Table 2).

The survey results for the study group indicated the addition of odor was beneficial (see Table 2); however, a difference was noted between study and control scenarios (in addition to odor) that may be responsible for the variance in the two groups. Study participants rated their active participation much higher than the control group. Because it has been found that most students benefit from active participation in a learning setting and prefer hands-on activities to lecture or observation,\(^\text{21,22}\) it is reasonable to conclude the increased participation as a result of being in a smaller group coupled with perceptions of improved realism made the study wound care simulation a more valuable learning experience for the participants. Students may feel less threatened when fewer participants in the wound care simulation are present.\(^\text{19}\)

Survey items that were not statistically different between the two groups indicated both groups felt prepared to perform the scenario, respect for others was maintained, and level of confidence improved. Both groups rated the debriefing session as valuable.

The last portion of the experience requested that participants (n = 49) rank the cheeses according to odor. The participants felt that Limburger was the worst with Livarot a close second (22 to 17). All three cheeses received some votes (see Figure 1). The researchers will probably use Limburger exclusively in future wound simulations — it is pungent, easy to obtain, and not expensive.

**Limitations**

The simulation was similar to how the students perform wound care in their educational laboratory experiences but involved two paired students rather than larger groups. Potential for variance in each pair’s experience was limited by the use of scripted introduction, informed consent, and closing evaluation. The research team members overseeing the dressing change exercise were careful to maintain similar instructions and level of assistance with each pair of participants. By allowing participants to choose their partner for the study, the researchers hoped to reduce discomfort a participant might have experienced while performing for the camera and in front of research team members. Of note: the effect of partner selection on the outcomes was not measured and may have contributed to the participant’s perception of realism if their partner was someone they usually provided patient care with in clinical settings.

Although first semester undergraduate nursing students would not be qualified in most cases to determine if the simulation experience closely

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**TABLE 2**

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Mean</th>
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<tbody>
<tr>
<td>Odor made wound care realistic</td>
<td>4.59</td>
</tr>
<tr>
<td>Now better prepared to handle malodorous wounds</td>
<td>4.51</td>
</tr>
<tr>
<td>Smell of wound was distracting during wound care</td>
<td>2.49</td>
</tr>
</tbody>
</table>

*Scale range 1 (strongly disagree) to 5 (strongly agree)*
matched a real clinical setting, the purpose here was to increase, in their limited experience, their perception of the realism of the simulation. Experienced clinicians on the research team were satisfied with the realism but wanted to evaluate the impressions of the students participating in the simulation. Future research projects could compare first semester student perceptions to those of more experienced upper classmen and nurses experienced in wound care for validation.

**Conclusion**

High-fidelity simulation in clinical education is a viable and productive way to enhance preparation for patient care, evaluate skill, and improve student socialization in a professional role. Students feel comfortable learning in a simulation laboratory experience and receive feedback to hone nonverbal and verbal expression skills as well as the psychomotor task at hand. Introduction of odor to a wound care scenario is an inexpensive means to enhance the realism of simulated wounds. As one departing student stated, “You should have all wound care done like this [with cheese]. It will not surprise the student when they [face] a bad wound in real life.” - OWM

**References**


