Using Simulation to Address Hierarchy-Related Errors in Medical Practice

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Abstract

Objective: Hierarchy, the unavoidable authority gradients that exist within and between clinical disciplines, can lead to significant patient harm in high-risk situations if not mitigated. High-fidelity simulation is a powerful means of addressing this issue in a reproducible manner, but participant psychological safety must be assured. Our institution experienced a hierarchy-related medication error that we subsequently addressed using simulation. The purpose of this article is to discuss the implementation and outcome of these simulations.

Methods: Script and simulation flowcharts were developed to replicate the case. Each session included the use of faculty misdirection to precipitate the error. Care was taken to assure psychological safety via carefully conducted briefing and debriefing periods. Case outcomes were assessed using the validated Team Performance During Simulated Crises Instrument. Gap analysis was used to quantify team self-insight. Session content was analyzed via video review.

Results: Five sessions were conducted (3 in the pediatric intensive care unit and 2 in the Pediatric Emergency Department). The team was unsuccessful at addressing the error in 4 (80%) of 5 cases. Trends toward lower communication scores (3.4/5 vs 2.3/5), as well as poor team self-assessment of communicative ability, were noted in unsuccessful sessions. Learners had a positive impression of the case.

Conclusions: Simulation is a useful means to replicate hierarchy error in an educational environment. This methodology was viewed positively by learner teams, suggesting that psychological safety was maintained. Teams that did not address the error successfully may have impaired self-assessment ability in the communication skill domain.

Introduction

Errors of communication have been frequently cited as significant contributors to patient injury, with some reports suggesting that 60% to 70% of errors are communication related.[1-3] One aspect of communication that, until recently, has received little attention is the effect of hierarchy on effective communication. Hierarchy is defined as the presence of a significant gradient in authority between practitioners within a health care team, and errors of hierarchy have been identified as the source of such disparate patient safety threats as wrong-site surgeries, medication overdoses, and failures to diagnose, some of which have resulted in patient death.[4]

One way to consider this situation uses the concept of "power distance," which compares the type of leadership present in a society with the likelihood of subordinates to express disagreement to those leaders.[5,6] Put simply, increased power distance often corresponds to difficulty challenging authority.[7] The effect of this power distance has been described between junior and senior physicians and between physicians and nurses.[4,8-10] One study noted a tendency among critical care nurses to marginalize their thought processes to defuse interdisciplinary conflict.[8] When coupled with an acute situation, this creates an opportunity for serious harm because it effectively silences a portion of the health care team.[11-14]

How, then, can a health care team prevent the detrimental effects of hierarchy? One pragmatic method is high-fidelity simulation.[1,11,15,16] Several years ago, our institution experienced a critical event that was directly attributable to a failure to challenge hierarchy.[11] On the basis of our previous work with high-fidelity simulation, we generated a case designed to replicate this error in an educational environment. In this article, we explore the outcome of our pilot implementation of this case and outline a method by which similar events could be replicated at other institutions using simulation.

Methods

Description of the Clinical Case

The clinical case spurring this intervention centered on the inappropriate administration of amiodarone. A patient presented to our institution with the sudden onset of reentrant supraventricular tachycardia (SVT). Although the patient was clinically stable, the attending physician was concerned about the possibility of hemodynamic compromise and a crisis team was organized. At our institution, verbal orders are considered appropriate in such situations. During the course of therapy the physician leading the team inadvertently requested amiodarone to be administered by fast intravenous (IV) push instead of adenosine, the medication recommended by the American Heart Association Pediatric Advanced Life Support materials for this condition. Unfortunately, the team did not question the order and administered the amiodarone as requested, which resulted in severe hypotension and bradycardia that required resuscitation. When asked about the situation after the event, most team members stated that the amiodarone order concerned them but they felt uncomfortable directly addressing the error to the attending physician.

Learner Selection

Given the nature of the initial error, we chose the pediatric intensive care unit

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(PICU) and Pediatric Emergency Department (PED) environments as the optimal location for the implementation of the case. Because this pilot was performed in the context of our usual simulation program activities, no specific selection or exclusion of team members occurred apart from deliberately varying the level of experience within a given team to more accurately recreate a "natural" code team. Physician team members consisted of categorical pediatrics and combined medicine/pediatrics residents, whereas nursing team members were drawn from the pool of staff nurses in the PICU and PED, respectively. The final case also required that a *confederate* of the simulation program participate. A confederate is defined as an individual invited to participate in a simulation in order to fill a fixed role or perform a fixed function.[17] Confederates consisted of attending pediatric intensivists and pediatric emergency medicine physicians who were selected on the basis of their perceived level of authority by the participants in the case.

Replicating Reality

When replicating a critical event in the simulated context, environmental fidelity, case fidelity, and personnel fidelity must all be addressed to support the suspension of disbelief.[18] With regard to environmental fidelity, it is imperative that the environment in which the session is conducted closely match the clinical environment in which the error occurred. Although a simulation lab will suffice, it is worth considering whether such a case might be better conducted using "in-situ" methodology. Defined as the use of simulation in actual clinical spaces (as opposed to a separate learning center), in-situ methodology brings the simulator to the learners, allowing them to practice in their own clinical domain.[15,16] This ensures the maximum amount of fidelity possible, which allows learners to more readily picture themselves in a similar "real" situation and potentially increases the value of the simulation.

The next issue is case fidelity. The script for the simulation must accurately replicate the error. This means that the case cannot be run in a rigidly linear fashion, and the script and simulation program must be capable of following branched paths. These paths are determined by the learning objectives. For this case, we determined the following three objectives:

1. Identify sources of psychological pressure generated when trusted authorities give incorrect orders.
2. Identify the appropriate Pediatric Advanced Life Support algorithm for stable SVT.
3. Identify the appropriate pharmacologic and electrical treatment for stable SVT (ie, adenosine and synchronized cardioversion).

To ensure these learning points were reached, we developed a script in which the patient presented with narrow complex SVT and mild hypotension. Once selected, our confederate was instructed to misdiagnose the rhythm as wide complex ventricular tachycardia and, further, to request that amiodarone be given as fast IV push (an inappropriate and potentially dangerous means of administration). The confederate was instructed to change the order after two challenges to encourage the persistence of the team in addressing the error. No timing or personnel restrictions were placed on these challenges, but they were required to be specifically directed toward the confederate. If the order was successfully challenged, the team would most likely choose adenosine as the appropriate medication and the scenario would progress. If the amiodarone was given by fast IV push, the mannequin was programmed to become severely bradycardic and progress to asystole, at which point the scenario ended. This same case, with little modification, could be effectively used to replicate other types of medication error, such as the issues surrounding verbal orders or "sound alike" drugs and weight-based dosage errors.

If the hierarchy issue was navigated successfully and adenosine was chosen, the simulator was programmed to respond

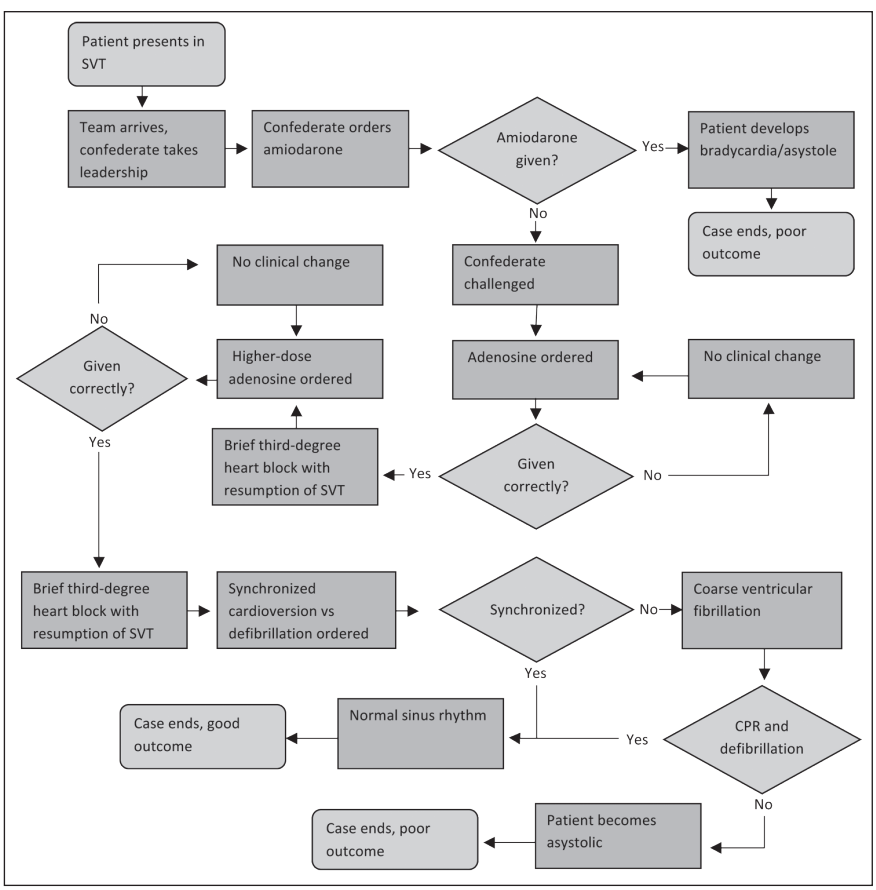

Figure 1. Flowchart depicting the structure of the simulated encounter.

CPR = cardiopulmonary resuscitation; SVT = supraventricular tachycardia.

with a brief period of heart block followed by resumption of the dysrhythmia if the adenosine was appropriately administered, but not to respond at all if it was inappropriately administered. Given the short half-life of adenosine in the circulation, this medication must be given by fast IV push or it will not reach the heart. Thus, this plan allowed us to simulate the effect of appropriate adenosine administration while also allowing us to include synchronized cardioversion. At this point the scenario again branches depending on whether the team chooses synchronized cardioversion vs asynchronous defibrillation. If synchronized cardioversion is chosen, the patient will convert to sinus rhythm and the case ends. If the patient receives defibrillation (a common mistake), then the rhythm will degenerate to a coarse ventricular fibrillation. This is done to replicate an R-on-T phenomenon, a significant risk that occurs when a reasonably organized rhythm such as SVT is treated with asynchronous defibrillation. This resulting dysrhythmia, if treated with cardiopulmonary resuscitation and an additional defibrillation, will convert to normal sinus rhythm, at which point the case ends. The flow of this case is graphically depicted in Figure 1. This branched approach allows the case to end early for debriefing if the hierarchy issue results in a poor outcome but also permits the inclusion of the other learning points should the hierarchy issue be navigated successfully.

Participants were assured that the goal of the simulation was to encourage positive real-world actions regardless of the outcome in the simulated environment.

Finally, steps must be taken to ensure personnel fidelity, which refers in this case to the behavior of the confederate. It must be recognized that the use of a confederate in this way involves a degree of deliberate misdirection of the learner group. In this case, the misdirection began with an announcement in the presimulation briefing in which the team was informed that an attending physician would be entering the simulated environment with them in order to participate in the learning process. No information was given, however, as to the true purpose of his or her presence, which was to precipitate the hierarchy issue. This approach is not without risk and is the subject of active simulation research.[11,18-20] It is questionable, however, whether the error could be precipitated in a convincing manner without this approach.

Preparing and Debriefing the Learners

When learners are deeply invested in the outcomes of a simulation-based educational session, they are also more vulnerable to distress if outcomes are poor.[18] Thus, if deliberate misdirection is to be used, it is critical that psychological safety be assured both before and after the case. We addressed this in the initial briefing by raising issues of communication (including hierarchy) as a way to prepare the team without alerting them to the specific content, which we feared would detract from the fidelity of the event. Once the session concluded we began the debriefing by allowing participants to discuss their impressions of the event. The discussion then proceeded to the communication issues that had been introduced in the briefing, and participants were asked for their sense of how well they had navigated them. Once the hierarchy issue was reached, the presence of the confederate was revealed and the intent of the misdirection was explained to the learners. During the discussion of the error, effort was made to defuse any sense of emotional isolation or lack of safety that may have arisen from the use of misdirection. The discussion concluded with reference to the reality of the situation that had been simulated and suggestions for addressing this error in practice. Participants were assured that the goal of the simulation was to encourage positive real-world actions regardless of the outcome in the simulated environment.[11] Finally, medical issues such as adenosine administration and the use of synchronized vs asynchronous defibrillation were discussed.

Case Implementation

Implementation proceeded according to the process described above in both the PICU and PED. Cases occurring in the intensive care unit were video recorded using our simulation program's overhead camera system. No such system exists in the Emergency Department and so no recordings of those cases were made. Sessions were scheduled to occur within a 1-hour period, with approximately 10 minutes allotted to briefing, 25 minutes allotted to the simulation itself, and 25 minutes allotted to the debriefing. The entrance of the confederate was timed to occur within the first 10 minutes of the case to allow time for the error to evolve before the transition to debriefing.

Session Assessment and Analysis

Demographic information for participants was obtained before each session. The error was considered to be "successfully" addressed if the team directly challenged the incorrect order twice, thereby preventing the amiodarone administration. An "unsuccessful" challenge was defined as one in which the two necessary attempts did not occur and the amiodarone was given as ordered. Session outcomes were assessed by simulation program faculty after the debriefing using the Team Performance During Simulated Crises Instrument (TPDSCI), a validated multirater assessment tool, and a separate crisis resource management skill checklist.[21] Scores of 3 to 5 (good to excellent) were considered acceptable, whereas those of less than 3 (poor to fair) were considered to indicate a need for improvement. Participant impressions of the sessions were also assessed via a quality-improvement survey. This data was descriptively analyzed in subgroups on the basis of the team's success at addressing the error. Video recordings were also analyzed descriptively where available.

The scores of the TPDSCI were also used to calculate a gap analysis for each session. Gap analysis is a means of numerically quantifying participant self-appraisal that has been piloted in several simulation-based educational environments.[22-24] It is calculated by subtracting the self-score from the average faculty score, and the resulting "gap" scores represent a numerical index of participant self-appraisal with numbers of greater magnitude indicating a greater difference between faculty appraisal of the session and participants' perception of their own performance. Positive gaps occur when the learners rate themselves lower than faculty (self-underappraisal), whereas negative gaps occur when learners rate themselves higher than faculty (self-overappraisal). Although no clear cutoff exists in the literature, gaps greater than or equal to 0.5 or less than or equal to −0.5 have been used in prior publications as

boundaries for a meaningful score.[21] Our study was approved by the University of Louisville institutional review board.

Results

Learner Demographic Characteristics

Three sessions were conducted in the PICU and 2 in the PED over a 1-month period. Cases had from 5 to 11 participants with a median of 3 (range = 2-5) physicians and a median of 3 (range = 2-8) nurses. No respiratory therapists or pharmacists participated.

Session Outcomes

The team was unsuccessful at addressing the hierarchy error in 4 (80%) of 5 cases. Trends toward lower crisis resource management scores (87% correct for a successful challenge vs an average of 67% correct for an unsuccessful challenge), communication scores (3.4 for a successful challenge vs an average of 2.3 for an unsuccessful challenge), and communication gap scores (0.66 for a successful challenge vs an average of −0.88 for an unsuccessful challenge) were noted in the cases in which hierarchy was unsuccessfully challenged. Given the small sample size, however, patterns could not be statistically assessed. Table 1 displays these scores. Table 2 displays the flow of 2 representative sessions as derived from the video records.

Group Impressions of the Case

Learners regarded the sessions as useful, informative, and well organized regardless of whether the hierarchy issue was successfully addressed or not, as indicated by a score of 5/5 for the group that successfully addressed the error and

Table 1. Session-specific assessment scores[a]

Session no.	Successful challenge?	Team Performance During Simulated Crises Instrument				CRM skill checklist score
		Global score (1-5 Likert Scale)	Communication score (1-5 Likert Scale)	Global score gap analysis	Communication score gap analysis	
1	Yes	4.1	3.7	**0.7**	**0.7**	87%
2	No	3.4	2	0	**1**	69%
3	No	3.8	2	0	-2	67%
4	No	3.4	3	-0.2	0	60%
5	No	3.6	2.5	-0.4	-2.5	73%

[a] This table depicts session-specific scores as derived from the TPDSCI and the CRM checklist. For the TPDSCI competencies, scores of 3 to 5 (good to excellent) are considered acceptable whereas those of less than 3 (poor to fair) are considered as indicating a need for improvement. For gap analyses, scores greater than or equal to 0.5 are indicative of self-underappraisal of skills, whereas scores less than or equal to −0.5 are indicative of self-overappraisal of skills. The TPDSCI competency scores indicating a need for improvement are highlighted in gray, as are gap analysis scores indicating self-overappraisal. Gap analysis scores indicating self-underappraisal are underlined for clarity. The CRM checklist scores are presented as a percentage of applicable skills performed.

CRM = crisis resource management; TPDSCI = Team Performance During Simulated Crises Instrument.

Table 2. Analysis of representative sessions according to resolution of hierarchy issue[a]

Session 1: Successful	Session 2: Unsuccessful
0:00—Patient's bedside nurse enters, verbalizes that patient is in SVT	0:00—Patient's bedside nurse enters, assesses patient
1:49—Crisis team arrives, confederate arrives and assumes leadership	2:48—Nurse calls team to bedside team; crisis team and confederate arrive
3:51—Confederate verbally identifies SVT and asks for amiodarone 5 mg/kg IV fast push	3:25—Confederate assumes leadership and organizes the crisis team
4:31—Team challenges confederate's order, resident physician assumes leadership	**7:00—Confederate "erroneously" identifies the rhythm as ventricular tachycardia**
5:11—Confederate again advises amiodarone administration, new team leader disagrees and orders adenosine	**7:34—Resident team member challenges this diagnosis, indicates narrow QRS complexes and correctly identifies SVT**
7:52—Adenosine appropriately given with transient resolution	**10:03—Confederate again "erroneously" identifies rhythm as ventricular tachycardia**
9:16—Adenosine appropriately repeated with transient resolution	**12:05—Confederate asks for amiodarone 5 mg/kg IV fast push**
10:00—Decision made to perform synchronized cardioversion	**12:33—Nursing challenges order, stating, "Are you sure he is in V-tach?" and "Shouldn't we give this over 20 minutes?"**
12:35—Amiodarone given as a slow bolus during a 20-minute time frame for refractory dysrhythmia (an appropriate therapy)	**12:44—Attending again asks for amiodarone by fast IV push and it is administered**
15:24—Sedation administered in preparation for cardioversion	12:50—Patient rapidly develops bradycardia and hypotension that progresses to asystole
16:56—Team fails to appropriately synchronize the defibrillator and patient develops ventricular fibrillation	13:05—Bag ventilation and chest compressions started, epinephrine ordered
17:00—CPR started and patient is successfully defibrillated with resumption of normal sinus rhythm. Simulation is halted for debriefing	14:36—Epinephrine given and the simulation is halted for debriefing

[a] This table lists the activities occurring at relevant time points in two representative enactments of the simulation. Time points relevant to the hierarchy issue have been boldfaced for ease of reference.

CPR = cardiopulmonary resuscitation; IV = intravenous; SVT = supraventricular tachycardia; V-tach = ventricular tachycardia.

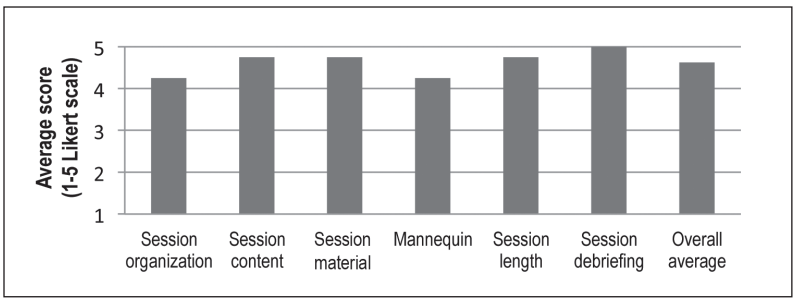

Figure 2. Participant impressions of the case.

This graph depicts the average domain-specific scores given by learners when rating the session after an unsuccessful resolution of the hierarchy issue. Scoring was performed on a 1-5 Likert Scale (1 = poor, 5 = excellent). All unsuccessful sessions were highly rated, with scores between 4 and 5. In the session with a successful resolution, all scores were 5.

an average score of 4.6 (range = 4.25-5) for the groups that did not successfully address the error. Figure 2 depicts these scores. No learners recorded negative comments about the use of misdirection despite the poor outcome of many of the simulations, and many felt that the sessions were beneficial. Table 3 lists relevant comments. Although quantitative data were not gathered regarding the proportion of participants who identified the error before the challenge, many voiced this knowledge during the debriefing, citing lack of confidence in their own knowledge base as a primary barrier.

… the session's goal [is] explicitly defined as the acquisition of a personal experience that will improve future care.

Discussion

Assessment of Our Experience

Using the above process, we were able to successfully replicate errors of hierarchy in the simulated environment. Although the number of sessions we were able to conduct was small, the frequency at which the error was not successfully addressed accords well with previous research regarding this issue.[25,26] Interestingly, many participants stated during the debriefing that they recognized the medication requested as incorrect and potentially harmful but that they had decided to remain silent chiefly owing to a lack of confidence in their own judgment. This also correlates well with the existing literature regarding authority gradients.[4,9,10] Postsession analysis of group characteristics suggested a trend toward lower communication scores in the unsuccessful cases, although this could not be statistically assessed. Gap analyses also suggested a disparity in self-perception, with a gap of 0.66 for the successful group and an average gap of −0.88 for the unsuccessful groups in the communication domain. This indicates that the successful group underrated their communication skills whereas the unsuccessful groups overrated their communication skills, and it further suggests that communication skill may be a "blind spot" in the self-awareness of unsuccessful groups. Attempts to address this issue may be hindered by this relative lack of insight, and focused strategies aimed at enhancing self-awareness may be necessary to potentiate change.[21,23,24] Our team addressed this issue via graphical feedback reports containing faculty assessments, gap analysis data, and specific comments on how to interpret and apply this information to future practice. Those using the simulation approach delineated above may wish to consider the use of a similar technique.

Institutions desiring to address hierarchy using the outlined methodology should be aware that educational techniques using deliberate misdirection or unplanned patient death have received ethical criticism and are currently subjects of active research and debate in the simulation community.[19,20,27-29] Given the significant emotional stress that can be induced, it is imperative that the psychological safety of learners remain a primary concern. One important factor in creating a safe environment is a careful consideration of the learners.[27] For less experienced clinicians or students, educators should consider mitigating the consequences of the case or giving a more explicit warning in the initial briefing as to the possibility of a confederate.[11] Clinicians participating in our sessions were drawn from both the residency program and our experienced PED and PICU nursing staff, so we elected to maintain both the surprise nature of the confederate and the severity of the negative outcome because these groups represent relatively experienced learners. Our data indicate that the experience was perceived as valuable by participants regardless of the outcome, supporting our choice. Furthermore, comments indicated

Table 3. Positive and negative comments regarding the simulated experience

Strengths of the simulated experience	Areas for improvement
• Real-life scenario, debriefing session, education after event, teaching how to question hierarchy	• Not being videotaped helps anxiety, being able to see the monitor better would help and better bed positioning
• Real-life situation	• More mock codes, more multidisciplinary codes, have the different staff members switch roles: ie, nurses and physicians, nurses being team leader.
• Presented a very relevant topic	
• Used real-life experience to come up with applicable situation	
• Placed us in a situation that would question authority and mimicked a real-world event	
• Good experience	

This table lists comments provided to the simulation team by learners after their session had ended. Despite the negative outcome present in most situations (80%), no criticism regarding the use of misdirection was offered.

an appreciation of the applicability of the case to their practice, which seemed to directly stem from the case's roots as an actual clinical event.

Another critical factor is the level of facilitator training in debriefing technique, as significant experience is needed for emotionally charged cases such as this.[27] It is common for novice clinician-educators to debrief in a didactic style, recounting to the learner team a list of things that were done well and things that were done poorly. This strategy does not address the psychological frames of reference that lead to inappropriate decisions. One useful approach to addressing these reference frames is termed advocacy-inquiry. This approach begins with the facilitator stating his or her personal judgment regarding each action of the team but then proceeds to more open-ended questions regarding participant thought process.[30,31] The goal of this approach is to allow the facilitator to clearly state what may have gone wrong in the situation while simultaneously allowing the learners to explore the underlying beliefs and assumptions that may have led to this action. A number of other useful strategies in the literature are oriented toward the same end.[32-34] Readers interested in these debriefing techniques are encouraged to use our references as a starting point. Newer simulation facilitators may also wish to obtain formal training.

When addressing the emotional state of the learners, we find that maintaining a future-focused orientation regarding the case is an effective strategy, with the session's goal explicitly defined as the acquisition of a personal experience that will improve future care. An additional strategy is the use of similar errors in which the facilitator may have been involved to "normalize" the situation. Carefully placed humor can also defuse tension. Above all, learners should leave the environment focused not on the simulation but on their newly acquired empowerment to recognize and address this issue during real patient care.

Limitations

This pilot has several limitations. First, our sample size is quite small, rendering comparative statistics meaningless and all descriptive statistics tentative at best. Another possible issue concerns the faculty and gap assessment data, which were obtained after the debriefing. It is quite possible that this approach could introduce biases in the data. Another limitation stems from the heterogeneity of experience built into our teams. Although it is more realistic, this precluded us from analyzing the effect of practitioner experience on the error. Finally, our assessment methodology did not include specific means of determining the effect of this intervention on subsequent practice. Such assessments should form a part of future studies.

Conclusions

Hierarchy is an unavoidable part of the medical field that has the potential to cause significant patient harm. Using simulation, we were able to recreate a hierarchy-related event that occurred at our institution. Learner groups that did not successfully challenge the hierarchy tended toward self-overappraisal in communication-related performance domains, indicating the potential for poor insight in this area. All participants perceived the sessions as valuable. Further research is needed to confirm the effect of approaches such as this on practice patterns. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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A Hundred Small Steps

We always hope for the easy fix: the one simple change that will erase a problem in a stroke. But few things in life work this way. Instead, success requires making a hundred small steps go right—one after the other, no slipups, no goofs, everyone pitching in.

— *Better: A Surgeon's Notes on Performance,* Atul Gawande, MD, b 1965
American surgeon and journalist