Implementation of a 2-Day Simulation-Based Course to Prepare Medical Graduates on Their First Year of Residency

Isabelle Bragard, PhD, Marie-Christine Seghaye, MD, PhD,† Nesrine Farhat, MD,† Marie Solowianiuk, MD,† Mariane Saliba, MD,† Anne-Marie Etienne, PhD,* and Katharina Schumacher, MD†*

Objectives: Residents beginning their specialization in pediatrics and emergency medicine (EM) are rapidly involved in oncall duties. Early acquisition of crisis resource management by novice residents is essential for patient safety, but traditional training may be insufficient. Our aim was to investigate the impact of a 2-day simulation-based course on residents to manage pediatric and neonatal patients.

Methods: First year residents participated in the course. They completed two questionnaires concerning perceived stress and self-efficacy in technical skills (TSs) and non-TSs (NTSs) at 3 times: before (T0), after (T1), and 6 weeks after the course (T2).

Results: Eleven pediatric and 5 EM residents participated. At T0, stress about "communicating with parents" ($P = 0.022$) and "coordinating the team" ($P = .037$) was significantly higher among pediatric compared with EM residents; self-efficacy was not different between the specialities. After training, perceived stress about "managing a critical ill child" and perceived stress total significantly decreased among EM residents, whereas it remained the same among pediatricians (respectively, $P = 0.001$ and $P = 0.016$). Regarding self-efficacy, it had significantly increased in both groups ($P < 0.001$). Specifically, the increase in TSs self-efficacy was significant after the training ($p = .008$) and after 6 weeks ($p < .001$), and the increase in NTs self-efficacy was only significant after 6 weeks ($P = 0.014$).

Conclusions: Our course improved perceived stress, TSs, and NTSs self-efficacy of residents. This encourages us to formalize this as a prerequisite for admission to the pediatric and EM residency.

Key Words: simulation-based course, residents, self-efficacy

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The first year of specialization is particularly stressful with new responsibilities and sleep deprivation.[1–4] In fact, pediatric and emergency medicine (EM) residents starting their specialization are often asked to do their first on call quite soon after their first working day. A consultant is either present or on call at home. They are responsible for the all the patients on the pediatric ward, for the delivery room, and also for the pediatric emergency department. This could be very stressful, given that residents' pediatric acute care experience is limited by the low frequency and variable nature of pediatric situations in the clinical environment.[5] These opportunities were further decreased due to the European Working Time Directive[6] which limits the resident work hours to 48 hours a week. So, they have probably not enough opportunities to train their technical skills (TSs) before being alone on call. Moreover, they have to comanage patients along with numerous subspecialty teams: gastrointestinal, transplant, renal, surgery, and so on.[7] Also, the communication skills of comanaging a patient among several teams (ie, leadership, teamworking) are not often addressed in medical school,[7] although patient outcomes are also related to the teamwork of health care providers.[8]

So, the first year of residency can begin with excitement, which could rapidly be followed by self-doubt and awareness of realistic limitations.[3] In consequence, a lot of residents experience a high level of stress,[3] anger and hostility,[9] or depression during their residencies.[10] That can affect their ability to deliver good patient care, followed by well-documented effects on error rate and adverse outcomes.[11] It seems that a competent pediatrician should not only have TSs, but also non-TSs (NTSs) to perform well. By definition, NTSs are cognitive, social and personal resource skills that complement TSs, and contribute to safe and efficient task performance.[12] The NTSs comprising, among other elements, communication with patients and parents, cooperation, decision making, conflict resolution and workload management, are often tackled in crisis resource management (CRM) courses.[13,14] The CRM courses aim to coordinate, use, and apply all available resources to optimize patient safety and outcomes.[14] However, little emphasis is given to NTSs in medical school.[15] Medical students are also less likely to acquire such skills through training and mentorship than previous generations; because of the increase number of medical students, they spend fewer hours on the wards and more with educational facilitators who had limited medical training.[15]

In a lot of countries, simulation-based training with debriefing is increasingly used in medical education specifically for teaching CRM principles.[16] It has the potential to supplement workplace training without compromising patient safety.[17] Debriefing in a safe and supportive environment is essential to the learning process.[18,19] Simulation-based training has been recommended as a method to train teams in learning NTSs for pedagogical and patient safety reasons.[13] However, there are limited published training programs for pediatric residents in CRM.[16,20,21] Early acquisition of these critical competencies by novice residents is essential for patient safety, but traditional training methods may be insufficient.[22,23]

Given the number of challenges that residents had to deal with (ie, lack of sleep, little opportunity to use their skills in the field, difficulty to find their place in a multidisciplinary team, and so on), and the stress and self-doubt that these could cause, we have chosen to focus in this study on the perceived stress and the self-efficacy in acute pediatric and neonatal situations. With this background in mind, we developed a 2-day simulation-based training program. The aim of our study was to assess the efficacy of this training program on perceived stress and self-efficacy in TSs and NTSs in acute pediatric and neonatal situations among first year pediatric and EM residents.

METHODS

Participants and Design

All first year residents in pediatric and EM at the University of Liège were invited to participate to this longitudinal study assessing the impact of a 2-day pediatric training program. They have not followed the pediatric advanced life support or neonatal advanced life support, or simulation-based training prior to the training. This

From the *Health Psychology Department, University of Liege; and †Paediatric Department, University Hospital of Liege, Liege, Belgium.
Disclosure: The authors declare no conflict of interest.
Reprints Isabelle Bragard, PhD, Health Psychology Department, University of Liege, Av. de l'Aunaie, 30, 4000 Liège, Belgium (e-mail: isabelle.bragard@ulg.ac.be).

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training program took place before the beginning of the academic year at the Paediatric Simulation Centre, Paediatric Department, University Hospital Liège, Belgium. The institutional review boards (Research Ethics Committee) of the University Hospital, CHU de Liège, Belgium, approved the study (number: B707201318537). Each participant provided a written consent to participate and had to complete questionnaires at 3 times: before (T0), immediately after the training program (T1), and 6 weeks after that (T2).

Training and Materials

The 2-day training program led by senior pediatricians was developed to prepare graduates for their first year of residency. It included (1) theoretical courses, (2) skill stations, and (3) high-fidelity simulation sessions with debriefing using a baby and infant manikin (SimBaby and SimJunior; Laerdal Medical, Norway).

The theoretical courses (3 hours) were about how to recognize the acutely unwell child, the ABC approach in a trauma case and resuscitation of a newborn. The TS stations (3.5 hours) were devoted to pediatric basic life support, neonatal basic life support, the use of a defibrillator, vascular access including intraosseous needle placement and umbilical catheter insertion, foreign body inhalation, and ventilation. The high-fidelity simulation sessions with debriefing (6 hours) were aimed to develop CRM TSs (eg, to recognize a sick child) and NTSs (eg, call for help). They used interactive baby and junior manikins and monitor placed in a realistic clinical environment such as a pediatric ward (a ward) or an EM department. The subjects participated in 8 clinical scenarios encountered in pediatrics and neonatology: bronchiolitis on the ward at night, septic shock, convulsion, cardiac arrest due to hypovolemia, meconium aspiration, 28 weekers premature, apnoea in a premature baby, a newborn who is apparently stillborn. Each 15-minute scenario consisted of 2 or 3 trainees in this high-fidelity simulation environment with a pediatric nurse or midwife or a parent who were played by faculty members. They had the possibility to ask for support from a senior doctor or a nurse if appropriate to the scenario. A video relay to the debriefing room allowed full observation by the other course members and also provided the possibility to do video assist debriefing. During the video assist debriefing, the facilitator choose some sequences showing good and bad NTs and TSs to reinforce good practice, to reflect on their practice and to learn from mistakes. A 30-minute to 40-minute structured debriefing based on Rudolf's model[24] and led by experienced pediatricians, neonatologists, and nurses (who received an EuSim Simulation Instructor Course) followed the scenarios. Debriefing allowed participants to reflect on actions taken in the scenario and discuss them within the team. It included the following steps: a reactions phase in which trainees ("blow off steam") and the instructor gets a first glimpse of what is most concerning the trainees), a

TABLE 1. Self-Efficacy About Technical and Nontechnical Skills Questionnaire

Skills	Item
Technical skills	1. Recognize a sick child
	2. Recognize a child in cardiorespiratory arrest and starting cardio pulmonary resuscitation
	3. Follow the ABCD approach
	4. Treat a patient in respiratory distress
	5. Treat a patient in septic shock
	6. Be in charge of a fitting patient
	7. Know the right treatment to evacuate a foreign body
	8. Choose the most appropriate vascular access (peripheral, intra-osseous or central)
	9. Identify cardiac arrhythmias (shockable and nonshockable)
	10. Take care of a newborn
	11. Take care of a premature newborn
	12. Ventilation of a newborn
Nontechnical skills	13. Use all available resources (equipment, technology and aide-mémoire)
	14. Call for help (colleague, supervisor…)
	15. Be a good leader
	16. Distribute the workload in a good and efficient way (Knowing the strengths and the weaknesses of your multidisciplinary team)
	17. Know my own strengths and the weaknesses
	18. Collaborate with all members of the team in an emergency situation
	19. Communicate effectively with team members
	20. Keep a global view of the clinical case in the emergency situation
	21. Reduce or eliminate stress and anxiety signs
	22. Use a language which is non technical and easy to understand
	23. Adjust the level and quantity of given information
	24. Listen to the parents concerns
	25. Explore parents expectations
	26. Be empathic with a parent
	27. Avoid to re-assure the parents to quickly
	28. Deal with difficult emotions of the parents
	29. Summary all the information that they are easy to understand

TABLE 2. Socioprofessional Data

Socioprofessional Data	Mean	SD	n	%
Age	25.3	0.8		
Sex				
Male			3	19
Female			13	81
Specialization				
Pediatric			11	69
Emergency medicine			5	31

description phase, an analysis phase in which the facilitator and trainees discuss and analyse trainees' performance, and an application phase in which each trainee phrase their take home message.[24]

Evaluation

All participants gave socioprofessional data (age, sex, specialization, year of specialization). They also completed 3 questionnaires specifically developed for the study:

- Perceived stress: A 5-item Visual Analogue Scale ranging from 0 (very stressful) to 10 (not at all stressful) assessed perceived stress in emergencies (eg, communicate with parents in a situation of emergency). Cronbach α coefficient was 0.72.
- Self-efficacy: A 29-item questionnaire (Table 1) scored on a 6-point Likert scale from 1 (very low) to 5 (excellent) (and 0 for "non-applicable") assessed self-efficacy about the use of TSs (12 items, eg, to recognize a sick child) and CRM NTSs (17 items, eg, call for help). Cronbach α were 0.87 for TSs and 0.93 for NTSs.
- Satisfaction: A 14-item questionnaire scored on a six-point Likert scale from 1 (very low) to 5 (excellent) (and 0 for "non-applicable") assessed the trainee satisfaction about the training program (e.g. relevance of the content to my clinical practice). Cronbach α was 0.93.

The choice of the "perceived stress" and "self-efficacy" items was based first on the international guidelines (ie, ABCDE approach sepsis guidelines) and CRM points published by Rall and Dieckmann,[25] second, after analyzing the content of parents' complaints against the pediatric department (ie, bad communication with medical staff), and third, on residents experience (ie, the stress to be on call).

Statistical Analysis

Baseline time 0 data were compared between specialities on questionnaires to test for initial equivalency of groups using Mann-Whitney *U* test for independent samples. Multivariate analyses (repeated measure analysis of variance) were calculated regarding speciality and time of assessment. All statistical tests were 2-tailed, and a *P* value less than 0.05 was considered statistically significant. The analyses were performed with SPSS Version 21.0.[26]

RESULTS

Baseline Results

The 16 residents of the first year pediatric and EM at the University of Liège participated (participation rate of 100%). The demographics of the participants including age, sex, specialities, and year of residency is included in Table 2. Eleven were at the beginning of their first year of pediatrics and 5 of EM. The comparison between specialities showed that perceived stress at T0 was significantly higher among pediatricians compared with EM residents concerning: communicating with parents (U = 4.50, $P = 0.022$) and coordinating the team (U = 6, $P = 0.037$). At T0, self-efficacy was not different between pediatricians and EM residents.

Impact of Training

Because pediatricians and EM residents were different at baseline, we used a multivariate analysis with repeated measure on time (T0, T1, T2), and group (pediatricians vs EM residents) as independent variable. The results indicated a significant effect of time of evaluation (F = 2.86; $P = 0.004$), of group (pediatric and EM) (F = 4.33; $P = 0.036$), and of interaction time by group (F = 2.16; $P = 0.027$). Post hoc analysis revealed effect of time for stress concerning managing a critically ill child (F = 6.35; $P = 0.006$), and self-efficacy in TSs (F = 5.09; $P = 0.014$). Analysis revealed specific effect of group for stress concerning managing a critically ill child (F = 7.19; $P = 0.019$), stress concerning communicating with parents (F = 5.93; $P = 0.030$), coordinating the team (F = 31.08; $P < 0.001$), being a leader (F = 40.44; $P < 0.001$), and total stress (F = 19.23; $P = 0.001$). Analysis revealed specific effect of interaction time by group for stress concerning managing a critically ill child (F = 8.91; $P = 0.001$) and stress total (F = 4.84; $P = 0.016$) (Table 3).

TABLE 3. Perceived Stress and Self-Efficacy Among Pediatric (n = 11) and Emergency Medicine Residents (n = 5) at T0 (Before Training), T1 (After Training) and T2 (6 Weeks After Training)

	Pediatricians Residents			Emergency Medicine Residents		
Items	T0 Mean (SD)	T1 Mean (SD)	T2 Mean (SD)	T0 Mean (SD)	T1 Mean (SD)	T2 Mean (SD)
Perceived stress total	2.2 (1.1)	2.1 (0.7)	1.9 (1.2)	3.6 (1.2)	4.2 (1.0)	5.1 (0.9)
Managing critical child	2.0 (1.7)	2.0 (0.9)	1.7 (1.2)	2.0 (2.2)	4.6 (1.8)	4.8 (1.1)
Managing a new-born	2.0 (2.2)	1.8 (1.1)	1.8 (1.8)	3.3 (2.8)	2.7 (2.1)	4.6 (1.6)
Communicating with parents	2.5 (1.4)	3.2 (1.3)	2.8 (1.9)	4.2 (1.0)	3.8 (0.4)	5.1 (1.5)
Coordinating the team	2.4 (1.2)	2.1 (1.1)	1.8 (1.3)	4.4 (1.2)	4.9 (0.9)	5.6 (0.9)
Being a leader	2.1 (1.5)	1.6 (1.1)	1.6 (0.8)	4.2 (1.4)	4.8 (1.3)	5.2 (1.0)
Self-efficacy						
Technical skills	2.3 (0.5)	3.3 (0.3)	3.3 (0.5)	2.8 (0.4)	2.8 (0.3)	3.4 (0.2)
Non-technical skills	3.1 (0.6)	3.2 (0.4)	3.5 (0.4)	2.9 (0.5)	2.6 (1.8)	3.3 (0.2)

Concerning perceived stress: visual analogue scale: 0, stressful; 10, not stressful.

Concerning self-confidence : Likert: 0, not confident; 5, very confident.

Perceived stress decreased in EM residents after training, although it remained the same in pediatric residents. Self-efficacy in TSs increased in both groups.

Because self-efficacy increased in both groups, we have also used a multivariate analysis with repeated measure on time (T0, T1, T2) in the whole sample for this variable. This additional analysis confirmed a significant effect of time of evaluation ($F = 13.18$; $P < 0.001$). Post hoc analysis revealed a significant effect of time for self-efficacy in TSs ($F = 9.59$; $P = 0.001$) and a marginal effect of time for self-efficacy in NTSs ($F = 2.84$; $P = 0.074$). More specifically, the increase in TSs was significant after the training ($P = 0.008$) and after 6 weeks ($P < 0.001$), and the increase in NTs was only significant after 6 weeks ($P = 0.014$).

Satisfaction About Training

All residents were satisfied with the facilitators (mean = 4.3/5; SD = 0.6), the presentations (mean = 4.1/5; SD = 0.7), the training content (mean = 4.4/5; SD = 0.7), and the simulation sessions (mean = 4.2/5; SD = 0.6). There was no significant difference between pediatric and EM residents. Here you have a few illustrative narrative comments from the participants: "The training was really useful in preparation of our first on call," "We wish that all the graduates who begin their residency have the opportunity to follow the same program," "The neonatal program was not sufficient and need to be done more in details."

DISCUSSION

The objective of our study was to develop a 2-day simulation-based training program and assess its impact on perceived stress and self-efficacy in technical and NTSs among first year pediatric (N = 11) and EM (N = 5) residents in acute pediatric and neonatal situations.

Our results show that a 2-day training course about dealing with the acutely unwell child using presentations, skill stations, and high-fidelity simulation had a positive impact among residents at the beginning of their first year of specialization. All residents were satisfied with the course.

At baseline, perceived stress about "communicating with parents" and "coordinating the team" was significantly higher among pediatric compared with EM residents. After training, perceived stress decreased in EM residents, although it remained the same in pediatric residents. Two hypotheses may be raised to explain the differences between pediatricians and emergency physicians in terms of stress. First, it can be assumed that the EM residents were reassured by the basic skills received in the training. These skills could be sufficient to handle the few pediatric cases they will have to deal with in their department. Moreover, they could call in many cases a pediatrician for help if necessary. In contrast, it seemed that the basic skills learned in the training were not sufficient to reassure pediatricians who would be on call next week and could be the leader of such situations until their supervisor arrives. Second, it seemed that EM residents are more used to adapt well to situations that are risk laden as described by Bascom et al.[27]

Regarding self-efficacy, there was no difference between the specialities at baseline. After training, self-efficacy increased in the whole sample. Specifically, there was a significant increase in self-efficacy in TSs after the training and after 6 weeks, and the increase in self-efficacy in NTs was only significant after 6 weeks. It can be assumed that using the technical and NTSs taught in the training for 6 weeks had increased and strengthened the feeling of confidence and being able to use them. Based on self-efficacy theory, clinicians are less likely to initiate and sustain behaviors for which they lack confidence. This performance-based confidence can be distinguished from knowledge and skills necessary to perform the behavior.[28] Self-efficacy has important implications for pediatric resuscitation for example. Even those who are knowledgeable and skilled in resuscitation techniques may fail to apply them successfully unless they have an adequately strong belief in their capability.[28]

Simulation-based training in a safe environment provides controlled, deliberate practice, which is a critical ingredient for learning that is frequently absent in other forms of teaching[29,30] and has been shown to enable training to mastery.[31] Adult learning models suggest that experiential training results in greater learning and retention compared with didactic teaching.[32,33]

Our pilot study had some limitations: to give the same training to pediatric and EM residents, regardless of their different training levels; the lack of a control group that did not receive the training; and the use of subjective questionnaires. We could integrate a control group by staggering and having some of the residents receive the training right away and others receiving it 2 months later and then comparing these 2 groups. The few improvements in perceived stress and self-efficacy shown in this pilot study must be confirmed by measuring first, in simulation, the improved perceived stress, TSs, and NTs self-efficacy of residents with a checklist-based assessment of their skills just after the training and 3 months later, and second, the extension of the performance achieved in simulation to patient care practices in the clinical setting.[23] Our outlook is to improve training using more varied pediatric scenarios, focusing more on certain basic clinical skills, such as a correct ABCD approach, offering a 2-day of core curriculum for pediatricians and EM physicians, and a third day for pediatricians only, where neonatology is taught.

In conclusion, our simulation-based training focusing on acutely unwell child had a positive impact on stress and self-efficacy in technical and NTSs of future first year residents. This first experience encourages us to propose to formalize this course as a prerequisite for admission to the pediatric and EM residency.

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