Relationship Between Self-efficacy and Performance of Simulated Neonatal Chest Compressions and Ventilation

Lee T. Donohue, MD; Mark A. Underwood, MD; Kristin R. Hoffman, MD

Introduction: Because improved competence in caring for patients is difficult to measure, self-efficacy (the strength of one's belief in one's ability to complete a task) is often used as a surrogate measurement of clinical ability. However, studies in adults and children have shown at best only weak correlations between self-efficacy and performance. This correlation has not been well studied in neonatal resuscitation limiting the utility of self-efficacy as a measurement of the effectiveness of interventions in this population. The objective of this study was to determine whether self-efficacy correlates with performance of simulated neonatal chest compressions and ventilation.

Methods: Sixty-nine neonatal fellows, neonatal nurse practitioners, neonatologists, and nurses completed a 7-point Likert scale in which they reported their ability to perform ventilations and chest compressions. The participants then performed chest compressions and bag-valve-mask ventilation on a mannequin. The performance of participants was compared with the rating of their ability using Spearman rank correlation coefficient.

Results: There was no correlation between participants' self-assessment and performance of chest compressions (r_s = 0.003) or bag-valve-mask ventilation (r_s = 0.08). There was a correlation between experience (years of neonatal intensive care unit experience, number of mock codes, and number of real codes) and the ratings of self-efficacy as well as between the number of mock codes and ventilation performance.

Conclusions: In this study, self-reported efficacy had no correlation to clinical skills in neonatal resuscitation; participants both overestimated and underestimated their clinical proficiency. Prior participation in mock codes in the neonatal intensive care unit was the only factor that correlated with resuscitation performance.

(*Sim Healthcare* 15:377–381, 2020)

Key Words: Self-efficacy, neonatal, simulation.

Self-efficacy is defined as the strength of one's belief in one's ability to complete a particular task.[1] This differs from a similar concept of self-confidence, which is confidence in oneself and abilities.[2] Self-efficacy can differ between tasks but self-confidence does not. Self-efficacy was first described in detail by Albert Bandura as part of his social learning theory. He described 4 components leading to the development of self-efficacy as prior performance outcomes, vicarious experiences, social persuasion, and physiological state.[1] Self-efficacy then influences motivation to perform a particular task, effort applied, preservation in the face of difficulty, and the amount of stress experienced.[1] Successful experiences raise self-efficacy and repeated failures lower self-efficacy.[1] Resuscitation self-efficacy is defined as a judgment of perceived capability to organize and execute the process of care during resuscitation.[3] Self-efficacy is often used as an outcome after an intervention in research on different methods to improve resuscitation skills.[4–15] The ultimate goal of many interventions is to improve the care provided to real patients. However, it is difficult to measure resuscitation performance in real patients or real patient outcomes after resuscitation. Therefore, self-efficacy is often used as a surrogate measurement of ability.

Self-efficacy plays an important role in the ability to provide resuscitation as it influences the initiation, performance, and maintenance of behaviors,[16] but it is not clear whether it can be used as a marker of how well someone will perform. Research has been mixed on how well self-efficacy correlates with performance in resuscitation. Most of these studies have been done in older pediatric patients or adults and many use observation scales as the measure of performance. One study in adult patients using a structured rating scale as assessment of performance found a significant correlation between self-efficacy and performance of chest compressions but not in other cardiopulmonary resuscitation (CPR) skills.[17] Another study showed that CPR performance as measured by structured observation was correlated with self-efficacy in nursing students.

Conversely, there was no correlation between self-efficacy in performance of pediatric airway management by paramedics[18] or pediatric residents.[19] Self-efficacy of internal medicine residents also did not correlate with Advanced Cardiac Life Support performance.[20]

From the Department of Pediatrics (L.T.D., M.A.U., K.R.H.), University of California, Davis, Sacramento, CA.

Correspondence to: Lee Donohue, MD, 2516 Stockton Blvd, Sacramento, CA 95817 (e-mail: ltdonohue@ucdavis.edu).

The authors declare no conflict of interest.

This article should be attributed to the Department of Pediatrics at the University of California, Davis.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.simulationinhealthcare.com).

DOI: 10.1097/SIH.0000000000000446

The aim of this study was to determine whether there is a correlation between self-efficacy and performance in simulated neonatal bag-valve-mask ventilation and chest compressions among providers in our neonatal intensive care unit (NICU). Our hypothesis was that self-efficacy is positively correlated with performance. The correlations between NICU experience and prior experience in real or mock codes and self-efficacy or performance were also examined.

METHODS

Study Design

The study followed an observational cohort design. Participants included a convenience sample of clinical providers from the NICU. Subjects in the study were first asked to rate their self-efficacy with neonatal chest compressions and ventilation. Subject performance of these skills was then measured. The statistical correlations between self-efficacy and measured performance were then determined.

The study was submitted to the investigational review board at the UC Davis Medical Center, and it was determined to be exempt.

Participants

Clinical providers including nurses, nurse practitioners, attending physicians, and neonatal fellows who work in the NICU at the University of California, Davis, completed the questionnaire and performance tasks. Nurses and nurse practitioners were approached for participation during their normal work periods. If they were able to participate, the facilitator provided the questionnaire so they could complete it at their convenience. The facilitator would return at a predetermined time with the mannequin so that the performance task could be completed. Attending physicians and neonatal fellows were recruited either while they were working clinically in the NICU or present for educational activities. Participants were volunteers who were not constrained to participate.

Intervention

This study was conducted in the NICU at the University of California, Davis, a regional level 4 NICU. The participants first completed the questionnaire. They were then oriented to the neonatal mannequin and equipment. The mannequin was placed on an adjustable-height table on wheels to be able to move it easily from participant to participant in the NICU. They could adjust the height of the mannequin if they desired and could perform chest compressions in ventilations in any way and position. An appropriately sized mask, flow-inflating bag, and oxygen source was provided to perform the ventilations. A flow-inflating bag and oxygen source were the equipment used in the NICU and in the delivery room resuscitation as well as simulated resuscitations at the time this study was performed. The participants performed 1 minute of chest compressions and 1 minute of ventilation on the mannequin. Chest compressions and ventilations were not coordinated as the performance task was completed individually. Performance data were recorded via eCPR. Participants were not able to view their performance during the measurement period. However, they were offered feedback and could view their recorded performance data immediately after completing the task. A single facilitator did all the measurements and was not blinded to the performance of the participants.

Study Outcomes

The Gaumard Premie Blue S108 - Premature Newborn Simulator with SmartSkin and OMNI was used during the study to assess performance. This mannequin can detect the timing and pressures when providing positive pressure ventilation as well as the depth and timing of chest compressions. The measures are recorded and reported through a laptop computer connected to the mannequin running Gaumard eCPR. eCPR records the rate and depth of compressions as well as percentage of effective compressions. eCPR also records the rate, volume, duration, and percentage of effective ventilations. "Effective" compressions and ventilations are intrinsic to the software and based on established target values of depth and full recoil for compressions and volume and duration for ventilations. Full recoil after chest compression is defined as return to baseline position and is also measured by the mannequin and software.

A 7-point Likert scale was developed to measure self-efficacy in performance of neonatal bag-valve-mask ventilation and chest compressions in conjunction with question writing experts at our institution. Our questions and scale were formatted similarly to questions in a validated self-efficacy scale.[21] Participants rated their agreement with the statements "I am independently able to perform chest compressions on an infant effectively" and "I am independently able to perform bag-valve-mask ventilation on an infant effectively" on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The questionnaire also included demographic questions about NICU experience as well as real and mock code experience. The questionnaire was reviewed by neonatologists at our institution. The questionnaire is included as an appendix (see Supplemental Digital Content 1, http://links.lww.com/SIH/A522).

Statistical Analysis

The performance of participants was compared with their rating of their ability to independently perform chest compressions and ventilations using Spearman rank correlation coefficient (r_s). The participant's answers to the demographic questions were compared with their self-efficacy and their performance also with Spearman rank correlation coefficient. The 95% confidence intervals for the correlation coefficients were calculated as a measure of the significance of the correlation. Performance between subgroups was compared with Student t test. Significance in these comparisons was defined as less than 0.05. Microsoft Excel was used to perform the analyses.

Sample Size

The sample size to detect a moderate correlation ($r_s = 0.4$) with a β of 0.2 and α of 0.05 was calculated to be 47. The definitions of weak (0.1–0.3), moderate (0.4–0.6), and strong (0.7–0.9) correlation were used.[22]

RESULTS

Demographics

Sixty-nine participants completed the questionnaire and the performance task (Table 1). The mean number of years of NICU experience was 10.5 with a standard deviation of

TABLE 1. Occupation of Study Participants

Occupation	n (%)
Nurse	54 (78)
Attending physician	3 (4)
Neonatal nurse practitioner	6 (9)
Neonatal fellow	6 (9)
Total	69

Occupation of study participants.

9.0. Participants had participated in a mean (SD) of 5.8 (6.6) mock codes and 10 to 15 real codes in the NICU.

Self-efficacy

The median answer was "agree" (6) when participants were asked to rate their ability to perform chest compressions and ventilation. This was consistent among participants with an interquartile range of 0 for chest compressions and 0.25 for bag-valve-mask ventilation. The measurements in the performance task were more varied (Table 2). There was a weak to moderate correlation between experience (years in the NICU, number of mock, and real codes participated in) and self-efficacy (r_s = 0.24–0.56; Table 3).

Performance

There was no correlation between participants' self-assessment of their ability to perform chest compressions and the percentage of effective compressions (r_s = 0.003; Fig. 1). There was also no correlation between participants' self-assessment of their ability to perform bag-valve-mask ventilation and percentage of effective ventilations (r_s = 0.08; Fig. 2). The upper 95% confidence interval for both values was well below the selected lower limit for a moderate correlation (0.4) supporting the null hypothesis of no correlation. As the number of nurse participants was greater than the calculated sample size of 47, we performed the same analyses for just this subgroup and found similar results (the coefficient for self-efficacy and percentage effective compressions is r_s = 0.02, P = 0.87, 95% confidence interval (CI) = −0.25 to 0.29, and for self-efficacy and percentage of effective ventilations is r_s = 0.03, P = 0.84, 95% CI = −0.42 to 0.30).

There was a weak correlation between the number of mock codes and performance of ventilation (r_s = 0.31; Table 3). A similar correlation was not seen with performance of chest compressions. We also compared percentage of effective ventilations, effective compressions, and full recoil between 2 sets of subgroups: (1) those with more or less than 10 years of NICU experience and (2) nurses compared with all other providers (Table 2). As the study was not powered for these subgroup analyses, these should be considered hypothesis generating (eg, these data suggest the hypothesis that NICU nurses are more likely to effectively perform chest compressions than other NICU providers).

We also examined the subgroup of participants with low self-efficacy for the 2 resuscitation skills. The correlation between self-efficacy and percentage of effective compressions is r_s = −0.07, P = 0.80, 95% CI = −0.56 to 0.46 (n = 15), and the correlation between self-efficacy and percentage of effective ventilations is r_s = −0.03, P = 0.92, 95% CI = −0.46 to 0.50 (n = 17). In both cases, the upper CI is above the lower limit for moderate correlation of 0.4; however, we cannot conclude that the null hypothesis is unsupported given the small number of participants. Rather, this subgroup analysis suggests the hypothesis that there is a correlation between self-efficacy and performance in providers with low self-efficacy; a larger study with at least 47 such providers would be needed to test this hypothesis.

DISCUSSION

We conducted this study to examine the correlation between reported self-efficacy and simulated performance of neonatal bag-valve-mask ventilation and chest compressions. We found no significant correlation between self-efficacy and performance. As expected, there was some correlation between experience and self-efficacy. There was also some correlation between number of mock codes and performance of bag-valve-mask ventilation.

Self-efficacy is easy to measure and is often measured before and after an intervention as an assessment of improvement in performance. It is assumed that people with higher self-efficacy for particular tasks are better at performing those tasks. However, our study is consistent with some of the previous work in children and adults and does not support that assumption. There was no correlation between self-efficacy and performance of bag-valve-mask ventilation and intubation of pediatric patients in a recent study.[18] Similarly, self-assessment of performance by graduating internal medicine residents also did not correlate with performance of simulated Advanced Cardiac Life Support scenarios as measured by a skills checklist.[20] In another study, senior pediatric residents were confident in their ability to perform bag mask ventilation, endotracheal intubation, and tracheostomy replacement, yet no residents were able to successfully perform both basic and advanced airways skills in a skills laboratory.[19] In addition, the self-efficacy of nurses did not correlate with performance in another study.[23]

Although self-efficacy does not seem to correlate with performance, it does have an important role in resuscitation. Self-efficacy influences the initiation and maintenance of behaviors. Lu et al[16] showed that higher self-perceived ability to perform CPR predicted willingness to perform bystander CPR. Even clinicians who are knowledgeable and skilled in resuscitation techniques may fail to apply them successfully, unless they have an adequately strong belief in their capability.

TABLE 2. Measurements Recorded by the eCPR Program During the Performance Task

	Mean (SD)	More Experienced (n = 38)	Less Experienced (n = 30)	P	Nurse (n = 54)	Others (n = 15)	P
% Effective chest compressions	60 (12)	59	61	0.42	62	55	0.04
% Chest compressions with full recoil	55 (14)	55	56	0.74	56	53	0.09
% Effective ventilations	46 (11)	47	46	0.51	46	48	0.842

Measurements recorded by the eCPR program during the performance task.

TABLE 3. The Relationship Between Answers to Demographic and Self-Efficacy Questions on the Questionnaire (top) as Well as Self-Reported Mock Code Participation and Measured Efficacy of Chest Compressions and Ventilations (bottom)

	Spearman Rank Correlation Coefficient	P	95% CI
Experience and chest compression self-efficacy	0.56	<0.01	0.37 to 0.70
Experience and ventilation self-efficacy	0.42	<0.01	0.20 to 0.60
No. real codes and chest compression self-efficacy	0.54	<0.01	0.34 to 0.69
No.real codes and ventilation self-efficacy	0.41	<0.01	0.18 to 0.59
No. mock codes and chest compression self-efficacy	0.35	<0.01	0.01 to 0.55
No. mock codes and ventilation self-efficacy	0.24	<0.01	−0.02 to 0.46
No. mock codes and percentage of effective compressions	0.10	0.43	−0.15 to 0.35
No. mock codes and percentage of effective ventilations	0.31	0.02	0.06 to 0.52

There is improvement in the correlation between self-efficacy and performance when self-efficacy is measured immediately after resuscitation training.[24] This may be due to improved self-awareness after performing the task. In our study, we found that the number of mock codes reported by participants does correlate with improved performance of ventilation supporting the value of simulation in this skill. Providers who have participated in more mock codes with feedback on their skills may have improved self-awareness and may be able to more accurately assess their abilities. In addition, participation in mock codes may lead to more familiarity with the mannequin and resuscitative equipment. Future studies that assess both self-efficacy and actual performance before and after serial practice sessions with a mannequin may be of value.

There was a positive correlation between experience and self-efficacy in our participants. Several studies have explored this relationship with similar findings. In one recent study, nurse leaders were asked to rate their self-efficacy. Years of experience was found to be a predictor of self-efficacy.[25] Another study showed that experienced nurse providers were significantly more confident in their resuscitation skills than less experienced nurses but no more competent.[23]

This study does have some significant limitations. Performance was measured using a single mannequin and detection software. It is possible that this does not accurately correlate to performance in neonatal patients. Other methods to measure performance should be compared with the technique used in this study. Ideally, measurement of performance should be done with animals or real patients if possible although this is technically challenging. The questions assessing self-efficacy were not fully validated, so it is conceivable that this is not an accurate measurement of self-efficacy. It would have been valuable to include participants without any experience in neonatal resuscitation. It would also have been valuable to reassess self-efficacy after the performance.

CONCLUSIONS

In this study, self-efficacy, assessed before simulation with the mannequin, did not correlate with performance of either chest compressions or bag-valve-mask ventilation on a neonatal mannequin. The participants both overestimated and underestimated their level of performance of the 2 skills. Therefore, self-reported efficacy does not seem to be a valid predictor of performance.

Experience, number of codes, and number of mock codes did correlate with self-efficacy in a positive way. More experienced participants believed that they were better at performing the tasks than less experienced participants. Participation in mock codes in the NICU was the only factor in this study that correlated with improvement in performance.

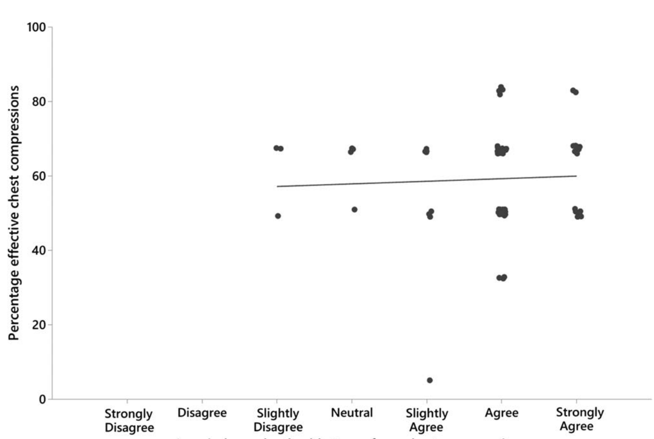

FIGURE 1. The relationship between measured percentage of effective chest compressions and answers to "I am independently able to perform chest compressions" on questionnaire. There was no significant association between percentage of effective chest compressions and self-efficacy (r_s = 0.003, 95% CI = −0.23 to 0.24).

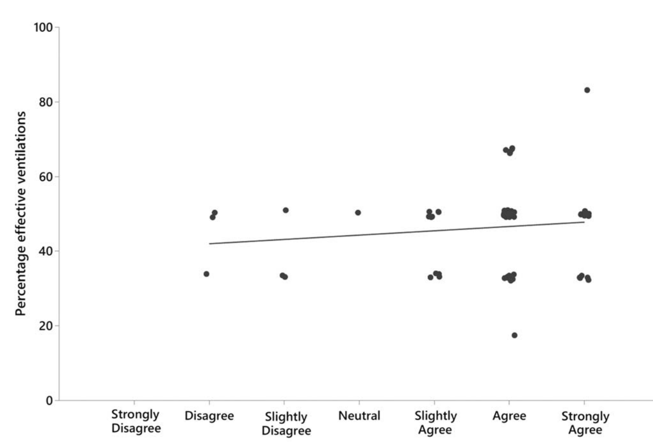

FIGURE 2. The relationship between measured percentage of ventilations and answers to "I am independently able to perform chest bag-valve-mask ventilation" on questionnaire. There was no significant association between percentage of effective ventilations and self-efficacy (r_s = 0.08, 95% CI = −0.16 to 0.31).

REFERENCES

1. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev* 1977;84:191–215.
2. Rosenberg M, Kaplan HB. *Social Psychology of the Self-concept*. Arlington Heights, IL: H. Davidson; 1982.
3. Maibach EW, Schieber RA, Carroll MF. Self-efficacy in pediatric resuscitation: implications for education and performance. *Pediatrics* 1996;97:94–99.
4. Gordon CJ, Buckley T. The effect of high-fidelity simulation training on medical-surgical graduate nurses' perceived ability to respond to patient clinical emergencies. *J Contin Educ Nurs* 2009;40:491–498.
5. Olson KR, Caldwell A, Sihombing M, Guarino AJ, Nelson BD, Petersen R. Assessing self-efficacy of frontline providers to perform newborn resuscitation in a low-resource setting. *Resuscitation* 2015;89:58–63.
6. Roh YS, Lee WS, Chung HS, Park YM. The effects of simulation-based resuscitation training on nurses' self-efficacy and satisfaction. *Nurse Educ Today* 2013;33:123–128.
7. Stellflug SM, Lowe NK. The effect of high fidelity simulators on knowledge retention and skill self efficacy in pediatric advanced life support courses in a rural state. *J Pediatr Nurs* 2018;39:21–26.
8. McRae ME, Chan A, Hulett R, Lee AJ, Coleman B. The effectiveness of and satisfaction with high-fidelity simulation to teach cardiac surgical resuscitation skills to nurses. *Intensive Crit Care Nurs* 2017;40:64–69.
9. Roha YS, Lima EJ, Issenberg SB. Effects of an integrated simulation-based resuscitation skills training with clinical practicum United Kingdom: Pearson Education Limited. on mastery learning and self-efficacy in nursing students. *Collegian* 2016;23:53–59.
10. Surcouf JW, Chauvin SW, Ferry J, Yang T, Barkemeyer B. Enhancing residents' neonatal resuscitation competency through unannounced simulation-based training. *Med Educ Online* 2013;18:1–7.
11. Hoadley TA. Learning advanced cardiac life support: a comparison study of the effects of low- and high-fidelity simulation. *Nurs Educ Perspect* 2009;30:91–95.
12. Magura S, Miller MG, Michael T, et al. Novel electronic refreshers for cardiopulmonary resuscitation: a randomized controlled trial. *BMC Emerg Med* 2012;12:18.
13. Walker D, Cohen S, Fritz J, et al. Team training in obstetric and neonatal emergencies using highly realistic simulation in Mexico: impact on process indicators. *BMC Pregnancy Childbirth* 2014;14:367.
14. Rezmer J, Begaz T, Treat R, Tews M. Impact of group size on the effectiveness of a resuscitation simulation curriculum for medical students. *Teach Learn Med* 2011;23:251–255.
15. Biese KJ, Moro-Sutherland D, Furberg RD, et al. Using screen-based simulation to improve performance during pediatric resuscitation. *Acad Emerg Med* 2009;16(Suppl 2):S71–S75.
16. Lu C, Jin YH, Shi XT, et al. Factors influencing Chinese university students' willingness to performing bystander cardiopulmonary resuscitation. *Int Emerg Nurs* 2016;24:28–34.
17. Roh YS, Issenberg SB. Association of cardiopulmonary resuscitation psychomotor skills with knowledge and self-efficacy in nursing students. *Int J Nurs Pract* 2014;20:674–679.
18. Youngquist ST, Henderson DP, Gausche-Hill M, Goodrich SM, Poore PD, Lewis RJ. Paramedic self-efficacy and skill retention in pediatric airway management. *Acad Emerg Med* 2008;15:1295–1303.
19. Nadel FM, Lavelle JM, Fein JA, Giardino AP, Decker JM, Durbin DR. Assessing pediatric senior residents' training in resuscitation: fund of knowledge, technical skills, and perception of confidence. *Pediatr Emerg Care* 2000;16:73–76.
20. Wayne DB, Butter J, Siddall VJ, et al. Graduating internal medicine residents' self-assessment and performance of advanced cardiac life support skills. *Med Teach* 2006;28:365–369.
21. Chen G, Gully SM, Eden D. Validation of a new general self-efficacy scale. *Organizational Research Methods* 2001;4:62–83.
22. Dancey CP, Reidy J. *Statistics Without Maths for Psychology*. United Kingdom: Pearson Education Limited; 2014.
23. Wynne G, Marteau TM, Johnston M, Whiteley CA, Evans TR. Inability of trained nurses to perform basic life support. *Br Med J (Clin Res Ed)* 1987;294:1198–1199.
24. Gonzi G, Sestigiani F, D'Errico A, et al. Correlation between quality of cardiopulmonary resuscitation and self-efficacy measured during in-hospital cardiac arrest simulation; preliminary results. *Acta Biomed* 2015;86(suppl 1):40–45.
25. Van Dyk J, Siedlecki SL, Fitzpatrick JJ. Frontline nurse managers' confidence and self-efficacy. *J Nurs Manag* 2016;24:533–539.