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Implementation of the RQI System: Baseline Skills and Self-Report Competence and Confidence Data From 12 NLN Inaugural Change Agent Nursing Programs

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Abstract

AIM This article describes the implementation, baseline cardiopulmonary resuscitation (CPR) skills, and competence and confidence in skills of participants in 12 nursing programs piloting the Resuscitation Quality Improvement (RQI) program. Of 1,847 participants, 175 had not previously completed a CPR course.

METHOD Schools could choose the sequence for completing baselines skills and required e-learning modules. For baseline skills, participants did 60 compressions and 12 continuous ventilations with RQI feedback turned off. Self-report competence and confidence in CPR skills data were collected.

RESULTS Forty-five percent of participants achieved passing scores on adult ventilations and compressions; 31 percent achieved passing scores on infant compressions, and 34 percent on ventilations. Forty-five percent were confident in their adult CPR skills; 32 percent were confident in their infant CPR skills.

CONCLUSION Nursing students and faculty, regardless of previous health care experience or CPR courses, need more frequent opportunities for CPR skill practice and assessment.

KEY WORDS Basic Life Support – Cardiopulmonary Resuscitation – Competency-Based Education – Nursing Education – Psychomotor Skills Teaching – Skill Retention

Twelve deans from baccalaureate nursing programs nationwide, known as National League for Nursing (NLN) Change Agents, committed to piloting the Resuscitation Quality Improvement® (RQI®) program, currently used in more than 1,000 US hospitals. Worldwide, the RQI system has trained more than 12 million users (E. Lliguicota, Laerdal RQI, personal communication, February 13, 2024). This program, developed by the American Heart Association (AHA) in 2013, brings innovative cardiopulmonary resuscitation (CPR) instruction to higher education, preparing future nurse professionals to respond to cardiac arrest events competently and confidently. The RQI's innovative e-simulation and skills session modules help learners achieve sustained mastery of high-quality CPR skills and verify competence through short, quarterly practice and review sessions. Mastery of learning is the ability to consistently demonstrate competence for a specific skill (Cheng et al., 2018).

Students admitted to nursing programs are expected to complete an approved CPR course before starting their clinical rotations (Kardong-Edgren et al., 2020), with CPR courses and cards usually valid for a two-year period. The majority of participants in this report had completed a CPR course before beginning the nursing program. However, studies consistently note that CPR skills deteriorate rapidly without the ability to practice frequently (Mota, 2023; Oermann et al., 2022; Rose et al., 2024). The lack of skill retention and proficiency is acute for prelicensure nursing students because they complete CPR training with little understanding of how these skills are used in the clinical setting (Kardong-Edgren et al., 2020). Regular practice is required to maintain competence; even short periods without practice or retraining are known to promote skill decay (Cheng et al., 2018; Dick-Smith et al., 2021).

It is essential that new educational training options are designed and tested to provide baseline data and retention of CPR skills for nursing students from their basic life support (BLS) course. This article describes the inaugural implementation of the RQI system in a volunteer group of US nursing programs and reports uncoached baseline CPR skills and self-report competence and confidence data of participants during the first semester of the program. The adoption of RQI aligns with the general movement toward competency-based education in nursing education. Although we report the data using the

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headings of a research study, the rigor normally employed for a study was not present in the methodology or data gathering.

REVIEW OF LITERATURE

Although the RQI system is being used by hospital systems, most CPR courses continue to be facilitated by human instructors. There is ample evidence that it is difficult for even the most experienced CPR instructors to accurately assess compressions or rescue breaths with their eyes alone (Augusto et al., 2020; Hansen et al., 2019; Staerk et al., 2021). Most learners improve and provide adequate CPR compressions and breaths when visual feedback devices are utilized on manikins (Augusto et al., 2020; Hansen et al., 2019). The AHA also recognizes that chest compressions rate, depth, and recoil are improved with the utilization of some type of biofeedback device (visual or audio), which is now required for instructor-led CPR classes (AHA, 2019). Technology-based learning systems, such as RQI, provide even more accurate assessment than instructors at determining accurate compression depth, respiratory volume, hand movement on the chest, and other outcomes.

Skill Decay

Skill decay is a loss or decline of learned or acquired skills (or knowledge) due to periods of non-use (Arthur et al., 1998). Decay is notable specifically in situations where mastery requires the utilization of skills that are not routinely used, such as cardiopulmonary skills. Deliberate and repetitive practice is essential to mastering skills. Cardiopulmonary skills (CPR) and knowledge are taught as essential requirements to provide safe and competent health care, but these skills and knowledge are taught in a single classroom session experience and are often not repeated for up to two years.

The data support CPR skills and knowledge decay beginning at three to six months (Oermann et al., 2022). Retraining is not often provided, likely resulting in the inability for health care providers to proficiently provide CPR (Kardong-Edgren et al., 2019; Oermann et al., 2020). For a 2021 study that compared self-learning to instructor-led retraining, participants were tested at two months post-learning followed by eight months post-learning (Sand et al., 2021). Participants' two months post-learning CPR performance was superior to baseline; however, at the final eight-month evaluation, the results fell between baseline and the two-month test. These results coincide with the documented decline of psychomotor skills, such as CPR, between six weeks and six months post-training, indicating a need for more frequent practice to prevent skill decline.

Learner Self-Reported CPR Competence

Self-report confidence and competence measures are frequently used in nursing education. These measures are based on one's perceived self-efficacy, defined as "personal judgment about one's capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Although these measures are influenced by the Dunning-Kruger effect (Bradley et al., 2022), which highlights the mismatch between perceived abilities and reality (Dunning, 2011), self-report confidence continues to be used because if learners feel that they are not capable, they may not put forth the effort required to learn or improve a new skill. Nurses performing chest compression and ventilations on instant feedback systems, such as the RQI, for the first time routinely discover that their CPR skills have been inadequate (Lee et al., 2023; Liou et al., 2020; Mota, 2023). With a consistent positive relationship found between self-efficacy and CPR performance (Rose et al., 2024), the real-time feedback provided by systems such as RQI may increase confidence and self-efficacy (Lee et al., 2023; Liou et al., 2020).

To summarize, completion of a CPR course every two years may not indicate one's true ability to perform high-quality CPR. Skill decay occurs rapidly, especially when skills are not learned in context. As technology improves, the needed skills of high-quality CPR may be better taught or augmented by technology. Learners must believe they have the knowledge and skills required to perform CPR when called upon to do so. Practice augmented with technology provides consistent/reliable feedback that may build participant self-confidence enough that they may initiate and/or participate in CPR when called upon to do so.

METHOD

Students from the incoming fall semester in 12 volunteer schools in the Change Agent program, and some faculty participated in the implementation. A total of 1,847 participants completed the demographic information including questions about their previous experience with CPR training, and their perceptions of their CPR skills at the baseline data collection. For 175 participants across 12 sites (including 78 at once site; Sharpnack et al., 2023), this was their first CPR course and practice (see Table 1). Some schools permitted faculty to also use the RQI system; six faculty participated. All data were aggregated for final reporting.

Current Skills and Confidence Perceptions

Three questions about current self-perceptions of CPR skills and self-confidence in performing CPR were included in the demographic data built into the RQI system by the developers (see Table 2). A 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*) was used to record learner responses. No reliability or validity testing was done on these questions or the scale.

Description of RQI Scoring

The scoring algorithm and passing score of 75 percent for RQI core skills, per members of AHA's Emergency Cardiovascular Care Committee and Subcommittees and co-authors of the 2013 AHA Consensus Statement on CPR Quality (Meaney et al., 2013), are grounded in clinical evidence. The scoring limits are continuously reviewed based on the most recent evidence and guideline recommendations. In instances where evidence is lacking, established criteria are based on the consensus of experts in resuscitation and education.

Procedure

An institutional review board determined that the deidentified data were not human subjects research and approval was not required. Participants could choose the sequence for completing hands-on baseline data skills. They could begin with the RQI simulation station *or* e-learning module. Data on what participants chose to do first are not available.

There was no cost to participants in the inaugural schools; programs were free to implement the RQI system in a manner that worked best for them. Although there was no uniform implementation plan, this did not impact participant baseline RQI data findings, which were gathered by computerized manikins. In some programs, use of the RQI program was optional for students; in others, it was

Table 1: Demographic Data

Selection	Total Number of Responses	% of Responses
What is your age?		
Prefer not to answer	9	0.49
18–30 years	1344	72.77
31–40 years	317	17.16
41–50 years	140	7.58
51–60 years	31	1.68
61–70 years	6	0.32
How many years have you been in health care?		
Prefer not to answer	153	8.28
<1	724	39.20
1–2	371	20.09
3–5	261	14.13
6–9	157	8.50
10–15	105	5.68
16–20	39	2.11
21–30	30	1.62
31+	7	0.38
What is your role?		
Other	1255	67.95
Registered nurse	247	13.37
Certified nurse assistant	166	8.99
Patient care technician	53	2.87
Licensed vocational nurse	35	1.89
Medical assistant/receptionist	32	1.73
Licensed practical nurse	24	1.30
Emergency medical technician	14	0.76
Nurse practitioner (faculty)	5	0.27
Pharmacy technician	4	0.22
Advanced emergency medical technician	3	0.16
Registered practical nurse	3	0.16
Respiratory therapist	2	0.11
Firefighter	1	0.05
Nurse anesthetist (faculty)	1	0.05

(continues)

Table 1: Demographic Data, Continued

Selection	Total Number of Responses	% of Responses
Public safety telecommunicator	1	0.05
Radiologic technologist	1	0.05
When was the last time you completed CPR training?		
In the last month	166	8.99
In the last 3 months	414	22.41
In the last 2 years	879	47.59
More than 2 years ago	213	11.53
Never	175	9.47
What was the format of your last CPR training?		
Taught by an instructor	1124	60.86
Online and with a manikin	273	14.78
Online and taught by an instructor	251	13.59
Not applicable	180	9.75
Other	19	1.03
How often do you use CPR skills in your job?		
On a daily basis	68	3.68
On a weekly basis	74	4.01
On a monthly basis	170	9.20
On a yearly basis	292	15.81
Never	1243	67.30

Note. CPR = cardiopulmonary resuscitation.

mandated. All participants received detailed instructions regarding the reciprocity of their RQI system data at local hospitals and facilities that used the RQI system. This allowed participants to maintain quarterly CPR certification maintenance if they were currently employed at one of the local hospitals or would be in the future.

The RQI equipment was placed in an area for ease of access, such as the simulation center, so users could reach out to RQI coaches with questions or for hands-on support upon request. In most programs, trained faculty, or staff RQI coaches, were available to help participants use the RQI resources. Each simulation station contained both an adult and infant manikin. All participants performed the baseline assessment for two minutes; it consisted of 60 compressions and 12 bag-valve-mask ventilations on both the adult and infant manikin. No RQI program feedback was provided during the initial baseline data gathering. No debriefing was conducted at the end of the session.

If participants chose to do the e-learning module first, they completed demographic data and were asked to rate their level of confidence about performing CPR on an adult or an infant and about any perceived CPR skill deterioration since their last CPR hands-on session. The system then provided initial cognitive instruction using an adaptive platform about compressions, rescue breathing, ventilation, and automatic external defibrillator usage. If participants chose the hands-on portion first, they received an overview screen of the target metrics and performed 60 compressions and 12 continuous ventilations with the metrics and targeted parameters displayed for each skill.

RESULTS

Demographic information for the total sample of 1,653 is included in Table 1; six faculty members participated in the baseline data measurement. Of the total sample, 90 percent of participants reported having previous CPR training. As use of the RQI system was not dependent on previous CPR experience, various levels of help were needed to utilize the system. Some users needed help to navigate computer access, configure the manikin, and possibly locate the bag mask. Many of the 175 novice CPR learners needed hands-on instruction and support to learn the basic skills of compressions and bag mask ventilation (Sharpnack et al., 2023). However, after a

Table 2: Baseline Cardiopulmonary Resuscitation Data

RQI Measurements No Feedback	AHA Norms	Activity	Mean	Standard Deviation	Number of Participants
Adult compression mean depth	50–60 mm	Adult compressions	50.65	9.72	1,653
Adult compression mean rate	100–120 per minute	Adult compressions	101.81	17.52	1,653
Adult ventilation mean rate	10 per minute	Adult ventilation	16.06	8.02	1,367
Adult ventilation mean volume	400–700 ml	Adult ventilation	503.17	143.69	1,367
Infant compression mean depth	40 mm	Infant compressions	38.09	6.86	1,655
Infant compression mean rate	100–120 per minute	Infant compressions	102.31	21.92	1,655
Infant ventilation mean rate	20–30 per minute	Infant ventilation	27.81	11.56	1,656
Infant ventilation mean volume	40–50 ml	Infant ventilation	48.12	20.94	1,656

Note. RQI = Resuscitation Quality Improvement; AHA = American Heart Association.

short in-person lesson with a coach, participants were able to complete the initial skills performance with minimal difficulty (Sharpnack et al., 2023). More than half of the participants had completed an instructor-led course for their last training. Participants who had previously completed an in-person BLS course were able to utilize the RQI system with minimal to no faculty/coaching support.

Table 2 reports baseline data, uncoached by the RQI system. If a learner did not complete all 60 compressions or 12 ventilations, or where there was an error in the system, the system excluded that data. This created the variability in data reporting numbers between various psychomotor skills.

Fifty-five percent of participants did not perform adequate adult compressions and ventilations. The compression overall score incorporated submetrics including chest compression fraction (time off the chest between contractions), compression depth, compression rate and release, and compression hand position. Ventilation scores were calculated by using the ventilation rate and volume. Only 31 percent performed adequate infant compressions and 33 percent performed infant bag-valve-mask ventilation correctly. As seen in Table 2, overall means were within acceptable parameters except for adult ventilation and infant compressions depth.

Thirty-five percent of participants reported their CPR skills had not decreased since their last session; 27 percent were neutral (see Table 3). However, more than half were not confident in their ability to perform high-quality CPR on an adult or child. Only 33 percent reported confidence in performing high quality CPR on an infant.

DISCUSSION

This article reports the baseline of uncoached CPR skills and perceived competence and confidence of participants in 12 inaugural NLN Change Agent nursing programs in the United States. This implementation project's findings support previous research indicating that individuals with previous CPR training formats and individuals new to CPR training may not adequately perform CPR skills. Data regarding the baseline assessment of CPR skills noted that most RQI measurements were slightly above the lower range of the AHA norm, yet 55 percent of those included in the RQI implementation project could not provide high-quality CPR. When reviewing specific skills outside the norm, the adult ventilation rate with bag-valve-mask was a third faster than the benchmark standard of 10 breaths per minute (see Table 2). Additionally, baseline data revealed that the infant compression depth failed to meet the AHA norm.

Two recent CPR studies compared CPR skills to AHA benchmark norms and this implementation project. Data summarized in Table 4 show the adult ventilation rate to be lower yet still too fast to meet AHA standards. While biofeedback devices do help determine the compression rate, values are not truly measured for compressions per minute. All the baseline means improved in our current report compared to recent studies. This may be an artifact of the large sample size, or it may be that CPR instructors are improving their coaching, though not enough to achieve an overall passing CPR score when measured by an objective machine such as RQI. We cannot compare infant data to previous studies because infants were not included in the comparable Oermann et al. (2022) and Kardong-Edgren et al. (2020) studies.

There is a known decline in retention and skill competency as early as weeks to months after initial learning (Oermann et al., 2022; Saad et al., 2019). Our findings suggest the need for more frequent opportunities for CPR practice using an RQI or similar system. Continuing training and skills refreshers are essential to maintaining competency, particularly in nursing students, where a gap exists between theory and practice. Frequent practice allows an increase in both CPR quality and guideline competence as well as confidence in skills (Bhanji et al., 2015; Cheng et al., 2020; Dudzik et al., 2019; Lee et al., 2023).

The Dunning-Kruger effect (Dunning, 2011) was evident in our participants (see Table 3). Many had years of CPR course and practice experience and felt their CPR skills were adequate, but they were not capable of providing quality CPR. Previous research suggests

Table 3: Current Competence and Confidence Perceptions

Selection	Total Number of Responses	% of Responses
"My CPR skills have decreased since my last CPR session"		
Not applicable	175	9.47
Strongly disagree	224	12.13
Disagree	416	22.52
Neutral	492	26.64
Agree	417	22.58
Strongly agree	123	6.66
"I am confident performing high-quality CPR on an adult or a child"		
Strongly disagree	154	8.34
Disagree	263	14.24
Neutral	610	33.03
Agree	562	30.43
Strongly agree	258	13.97
"I am confident performing high-quality CPR on an infant"		
Strongly disagree	217	11.75
Disagree	373	20.19
Neutral	649	35.14
Agree	406	21.98
Strongly agree	202	10.94

Note. CPR = cardiopulmonary resuscitation.

that a coaching session with both audio and visual cues from a system like RQI immediately enhances learner performance; further practice often becomes a game of "beat the machine" to get a better score.

A true baseline evaluation of the RQI system's ability to successfully instruct novice CPR learners may be challenging to achieve. Sharpnack et al. (2023) had to provide educator support for CPR first

Table 4: Adult Cardiopulmonary Resuscitation Benchmark Mean Comparisons Across Recent Studies

Benchmark Baseline Data and Desired Norms	AHA Benchmark Norms	Current Study (2023) *N* = 1,653	Oermann et al. (2022) *N* = 201	Kardong-Edgren et al. (2020) *N* = 467
Compression depth mean of all groups and *SD*	(50–60 mm)	50.65 (72)	46.77 (7.6)	43.51 (10.02)
Compression rate mean of all groups and *SD*	(100–120)	101.81 (17.52)	100.8 (17.25)	101.6 (18.74)
Ventilation volume	(400–700 ml)	503.17 (143.69)	471.6 (182.2)	481.3 (174.4)
Ventilation rate	(10 per minute)	16.06 (8.02)	23.45 (11.25)	24.86 (11.40)

Note. AHA = American Heart Association.

timers. In other cases, third-party human coaching was needed by some learners at their sites, even though they possessed a CPR card. It is unclear whether this was because of the RQI program instructions or an issue within the RQI program itself. Future research is required in this area.

Implications for technology involved in RQI adoption are not limited to CPR. Emerging objective technology like RQI has implications for psychomotor skills teaching for students in general. The general movement in nursing education is toward competency-based education. Integrating technology and simulation, students can intentionally apply theory to deliberate practice, receiving immediate and objective feedback. This approach provides many opportunities for repetition, allowing students to enhance their skills, build confidence, and achieve skill competency.

Although CPR training programs use evidence-based theory content to support skill development in health care providers, participants frequently lack the ability to perform or maintain the desired level of skill performance (Bhanji et al., 2015; Cheng et al., 2018; Mota, 2023; Rose et al., 2024). Skills deteriorate rapidly without continued practice. This skills decay may be a contributing factor in low survival rates after cardiac arrest (Anderson et al., 2019; Saad et al., 2019). The AHA now requires the use of CPR feedback devices (such as RQI) and frequent refreshing of BLS skills (Rose et al., 2024).

LIMITATIONS

This implementation report has several limitations. First, there was variation in how each school implemented the RQI program. Each program was free to determine who could participate in the RQI system adoption and data collection. In some cases, faculty were included. In past studies of this kind, some faculty were very skeptical of e-learning and evaluation systems and were encouraged to try them out.

Implementation of the RQI program at each school did not employ a traditional research methodology. Pragmatically, each program chose the implementation strategy that worked best for them. Some programs allowed participants to choose to complete their hands-on skills before completing the e-learning modules accompanying the program. Others required e-learning module completion before performing CPR skills on the manikin. This variation may have influenced the initial confidence and competence self-report finding, though it would not have impacted the objective RQI skill reporting data collection. It is unclear how many learners needed human coaching in the use of the RQI system, including the novice CPR learners.

CONCLUSION

This implementation report provides support for previous research studies that suggest that nurses at all levels, from novices to experienced learners, have completed CPR courses but cannot perform high-quality CPR (Dick-Smith et al., 2021). A computerized technology-enhanced learning option for objective validation and training of such skills, the RQI system, was evaluated in 12 NLN Change Agent nursing programs. Initial baseline data reported here suggest that though most learners arrived with a valid CPR card, their CPR skills were lacking. Participants exhibited the Dunning-Kruger effect, believing they were both competent and confident in their skills. Although the RQI system is designed to teach novice CPR learners, our reports suggest that in many cases, instructors were needed for guidance. More data will be reported as programs implement the coaching and three-month skills refresher training provided by the RQI system. The use of real-time coaching systems, such as RQI, is a promising approach to achieving and maintaining CPR competency and self-efficacy.

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