

# Identifying Crucial Equipment and Skills Needed to Evacuate Critically Ill Infants During Disasters: Using Nursing Expertise to Guide Training Targets

Megan M. Gray, MD;<sup>1</sup> Anita A. Thomas, MD, MPH;<sup>2</sup> Brian Burns, DNP, RN;<sup>3</sup>  
Rachel A. Umoren, MD, MS<sup>1</sup>

1. University of Washington and Seattle Children's Hospital, Division of Neonatology, Seattle, Washington USA
2. University of Washington and Seattle Children's Hospital, Division of Pediatric Emergency Medicine, Seattle, Washington USA
3. Seattle Children's Hospital, Division of Pediatric Emergency Medicine, Seattle, Washington USA

#### Correspondence:

Megan M. Gray, MD  
Seattle Children's Hospital  
Division of Neonatology  
Mail Stop FA.2.113, PO Box 5371  
Seattle, Washington 98145 USA,  
E-mail: [Graym1@uw.edu](mailto:Graym1@uw.edu)

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#### Abbreviations:

ED: emergency department  
NICU: neonatal intensive care unit  
ICC: intraclass correlation coefficient  
RN: registered nurse  
EVAT: Evacuating Scoring Tool

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#### Abstract

**Introduction:** Unexpected disasters, such as earthquakes or fires, require preparation to address knowledge gaps that may negatively affect vulnerable patients. Training programs can promote natural disaster readiness to respond and evacuate patients safely, but also require evidence-based information to guide learning objectives.

**Problem:** There is limited evidence on what skills and bedside equipment are most important to include in disaster training and evacuation programs for critically ill infants.

**Methods:** An expert panel was used to create a 13-item mastery checklist of skills for bedside registered nurses (RNs) required to successfully evacuate a critically ill infant. Expert nurses were surveyed, and the Angoff method was used to determine which of the mastery checklist skills a newly graduated nurse (ie, the “minimally competent” nurse) should be able to do. Participants then rated the importance of 26 commonly available pieces of bedside equipment for use in evacuating a hemodynamically unstable, intubated infant during a disaster.

**Results:** Twenty-three emergency department (ED) and neonatal intensive care unit (NICU) charge RNs responded to the survey with a mean of 19 (SD = 9) years of experience and 30% reporting personal experience with evacuating patients. The skills list scores showed an emphasis on the newly graduated nurse having more complete mastery of skills surrounding thermoregulation, documentation, infection control, respiratory support, and monitoring. Skills for communication, decision making, and anticipating future needs were assessed as less likely for a new nurse to have mastered. On a scale of one (not important) to seven (critically important), the perceived necessity of equipment ranged from a low of 1.6 (breast pump) to a high of 6.9 (face mask). The individual intraclass correlation coefficient (ICC) of 0.55 showed moderate reliability between raters and the average team ICC of 0.97 showed excellent agreement as a group.

**Conclusion:** Experts rated the ability to manage physiological issues, such as thermoregulation and respiratory support, as skills that every nurse should master. Disaster preparedness activities for nurses in training may benefit from checklists of essential equipment and skills to ensure all nurses can independently manage patients' physiologic needs when they enter the workforce. Advanced nursing training should include education on decision making, communication during emergencies, and anticipation of future issues to ensure that charge and resource nurses can support bedside nurses during evacuation events.

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#### Introduction

Unexpected natural disasters, such as earthquakes and fires, require preparation and planning to address knowledge gaps that may negatively affect vulnerable patients, such as the critically ill and infants. Major storms and wildfires have damaged key hospitals and have required neonatal patient evacuation.<sup>1–4</sup> Safe evacuation under these circumstances requires a clear command structure, appropriate supplies and equipment, methods to assure situational awareness, regional coordination, and flexibility.<sup>5</sup> The unexpected nature of disasters means that there is an ongoing need for disaster preparedness and training to promote readiness to respond to these types of disasters and evacuate critically ill infants safely. Effective training requires careful attention to learning objectives and tools to aid learners in achieving and maintaining their preparedness.

When compared to adults, infants have significant differences in physiology affecting their medical care due to their small size, difficulty with thermoregulation, variable drug metabolism, and the need for careful fluid management and respiratory support.<sup>6</sup> Such physiological differences are compounded by critical illness. Hospitalized infants are some of the most vulnerable patients in disaster situations, given their reliance on technology, unique medical equipment, and skilled medical staff for their unique care needs related to their size and delicate physiology.<sup>7</sup> Thus, care of the critically ill infant is unique and requires specialized care, particularly in the event of a disaster.<sup>7,8</sup>

Bedside registered nurses (RNs) are essential in the care of pediatric patients and represent the largest group of health care providers in the hospital at any given time of day, yet many feel unprepared to respond to disasters.<sup>9,10</sup> Nurses will be the front-line evacuators, with charge nurses providing valuable leadership in the event of a disaster; however, there is no established methodology, to the authors' knowledge, to address these educational needs of bedside and charge nurses. The study goal was to utilize senior charge nurse expertise in the pediatric emergency department (ED) and neonatal intensive care unit (NICU) to determine the evacuation skills that bedside nurses are required to independently manage during disasters, and to create an essential equipment checklist for evacuation of critically ill infants in order to inform future disaster training.

## Methods

The Angoff method is a commonly used method for setting passing scores for learner evaluations, including clinical skill checklists.<sup>11</sup> For this study, a modified Angoff method was used to determine the expected performance of a minimally competent nurse carrying out an evacuation of a critically ill infant.<sup>11,12</sup> The minimally competent candidate for a specific level in the Angoff method is one who has all the minimal level of knowledge and skills necessary to perform the requirements of that level of practice completely and in a timely manner.<sup>13</sup> A panel of experts, consisting of nurses and physicians who provide care to critically ill infants, routinely supervise bedside nurses, and participate in local and regional disaster management clinical advisory committees, generated a mastery skills list for bedside nurses performing evacuations of critically ill patients during unanticipated disasters. A list of proposed skills was assembled from previous evacuation drills, as limited data exist in the literature around skills for bedside nurses. Proposed skills were chosen to cover the entire range of skills a mastery-level bedside nurse would be expected to perform during an evacuation. Content experts evaluated all proposed skills and agreed to accept, reject, or modify each skill. After two rounds of evaluation and modification, skills with complete agreement to accept were included in the mastery checklist. This process took place in April of 2017 and generated a total of 13 skills expected of a master-level nurse.

The final mastery skills checklist was made into a survey and sent to experienced charge nurses in the NICU and the ED in June of 2017. The anonymous survey was approved by the Seattle Children's Hospital Institutional Review Board (Seattle, Washington USA). For this study, the minimally competent nurse was described as a nurse who meets the minimum requirements for independent care of a patient in a unit, with the provided example of a newly graduated nurse who had just completed orientation. For each skill, the respondents were asked whether a newly graduated nurse would be able to complete the tasks correctly in a reasonable

Years of Experience (mean, SD)	N = 23
Clinical Experience	19 years (SD = 9)
<b>Gender n (%)</b>	
Female	22 (96%)
<b>Roles Regularly Filled n (%)</b>	
Charge Nurse	21 (91%)
Bedside Nurse	17 (74%)
Resource Nurse	9 (39%)
Triage Nurse	8 (35%)
<b>Previous Patient Evacuation Experience n (%)</b>	7 (30%)

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Table 1. Demographics of Survey Respondents

amount of time (score of two), complete some of the tasks correctly and/or take longer than reasonable to complete (score of one), or would not be expected to do the tasks correctly (score of zero).

Skills scores were averaged and tested for normalcy. Skills were ranked according to score, with higher mean scores rendered for skills expected of newly graduated nurses and lower mean scores for skills expected of more experienced nurses. The ranked skills were assembled into a simulation scoring tool with each item having a potential score from zero (tasks not performed or that required excess length of time to perform) to two (tasks able to be performed completely in a reasonable length of time). The sum of mean scores from the Angoff was used to set a passing cutoff score for the tool.

Commonly available bedside equipment was listed in the survey, and participants were asked to rate each item on a Likert-type scale from one (not important) to seven (critically important). Scores were averaged to obtain means, and an intraclass correlation coefficient (ICC) was calculated. The ICC estimates and their 95% confidence intervals were calculated using STATA statistical package version 14 (Stata Corp; College Station, Texas USA). The ICC values were calculated for both individual raters and the group of raters based on a mean-rating ( $k = 23$ ), consistency, two-way random-effects model.

## Results

Six experts participated in this iterative method to determine which skills and tasks were necessary for a bedside nurse to successfully evacuate and care for a critically ill infant in a disaster. Thirteen skills had >90% agreement and were included in the final list used for the survey questions, with four skills concerning managing physiologic considerations, four regarding documentation/identification, two around communications, and three addressing decision making/anticipation. The experts found 26 commonly available bedside equipment items that would be likely to be present in the room of a critically ill infant and included these in the survey questions on equipment importance.

Twenty-three of the ED and NICU charge RNs completed the survey with a response rate of 82% (23/28). Among respondents, there was a mean of 19 (SD = 9) years of experience, with 30% reporting personal experience with evacuating patients (Table 1). Content experts rated their bedside nursing group's readiness to evacuate patients during disasters as low, with a mean of 41% (SD = 26%) out of potential score of 100% presently ready.

The skills list scores showed an emphasis on the newly graduated nurse having more complete mastery of skills surrounding managing physiologic considerations such as thermoregulation,

Skill	Mean Score <sup>a</sup> (95% CI)	Category
Ensures patient identification: patient label is secured onto the infant, places label on outside of blankets/wrappings	1.7 (1.4-1.9)	Documentation/Identification
Reduces thermal losses: places hat on infant, wraps infant in blankets, obtains gel warmer if needed/available	1.6 (1.4-1.9)	Managing Physiology
Minimizes infectious risks: packs any necessary personal protective equipment and hand sanitizer	1.6 (1.4-1.8)	Managing Physiology
Supports respiratory needs: checks and brings oxygen tanks if able, packs appropriate size mask and self-inflating bag	1.6 (1.4-1.8)	Managing Physiology
Plans for on-going monitoring: packs stethoscope, uses minimal necessary monitors, obtains portable monitors for critical monitoring	1.5 (1.3-1.8)	Managing Physiology
Anticipates weather issues: provides protection from rain or snow or extremes in temperature	1.5 (1.2-1.7)	Decision Making/Anticipation
Communication: uses SBAR to close loops when communicating with other team members, uses clear and simple language to communicate with family	1.4 (1.1-1.6)	Communication
Teamwork: cross monitors other team members and helps if needed, self-identifies deficiencies and ask for help	1.4 (1.0-1.6)	Communication
Obtains relevant documentation: packs additional patient labels, family contact information, and printed patient information as able	1.3 (1.0-1.5)	Documentation/Identification
Minimizes attached equipment: clamps, caps, or removes non-critical tubes/lines/drains	1.2 (0.9-1.4)	Documentation/Identification
Anticipates emergencies: packs appropriate emergency equipment and medications for the patients' clinical status	1.1 (0.8-1.4)	Decision Making/Anticipation
Assesses environment: identifies high-risk issues including broken gas or water lines or structural damage, assesses people in immediate area for injuries, reports issues to appropriate person	1.0 (0.6-1.4)	Decision Making/Anticipation
Manages on-going medications: determines which medications can be safely pushed (completed) or held, brings critical medications/infusions	1.0 (0.8-1.3)	Decision Making/Anticipation

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**Table 2.** Mastery Checklist for Newly Graduated Nurse with Categorization of Skills

Abbreviation: SBAR, Situation, Background, Assessment, Recommendation.

<sup>a</sup>Score range of two (expected newly graduated nurse to perform perfectly) to zero (not expected to perform tasks complete or in reasonable time).

infection control, respiratory support, and monitoring vital signs. Skills around ensuring appropriate documentation and patient identification, including tasks specific to reunification efforts, had more moderate scores. Skills for communication, decision making, and anticipating future needs were assessed as less likely for a newly graduated nurse to be able to perform (Table 2). The skills were assembled in the ranked order by mean expert scores and the Evacuating Scoring Tool (EVAT) was created (Figure 1). The sum of the mean scores was 18 out of a potential of 26 possible on the EVAT (69%), which established the minimum passing score for the tool.

The equipment ratings revealed opinions regarding the importance of various items during an evacuation; these showed a range in scores from 6.91 (most important) for a face mask for bagging to

1.64 (least important) for a breast pump for the patient's mother. There was a wide-range in variability in some individual items' scoring with standard deviations up to maximum of two points for the personal protective face mask. Equipment of similar scores was grouped into categories by score ranges (Table 3). The individual ICC of 0.55 (95% confidence interval 0.44-0.68) showed moderate agreement between raters, and the average team ICC of 0.97 (95% confidence interval 0.95-0.98) showed excellent agreement as a group ( $F [35.0, 770.0] = 29.38; P < .0001$ ).

### Discussion

This study of experienced ED and NICU nurses identified the primary skills and equipment required for management of infants in disaster situations requiring evacuation. The basic nursing skills

The nurse...	Tasks not performed or required excess length of time	SOME tasks performed correctly, OR took longer than reasonable length of time	Performed ALL tasks completely in a reasonable length of time	Item not relevant or not able to be assessed
	0	1	2	N/A
<b>1. Reduced thermal losses:</b> -Place hat on infant, wrap infant in blankets -Obtain/place gel warmer if needed/available	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>2. Ensured patient identification:</b> -Secure patient label onto the infant -Place label on outside of blankets/wrappings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>3. Minimized infectious risks:</b> -Pack personal protective equipment, cleaning supplies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>4. Supported respiratory needs:</b> -Check and bring oxygen tanks if able -Pack appropriate size mask and self-inflating bag	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>5. Planned for ongoing monitoring:</b> -Pack stethoscope -Use minimal necessary monitors -Obtain portable monitors for critical monitoring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>6. Anticipated weather issues:</b> -Provide protection from rain/snow/sun or extremes in temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>7. Communicated effectively:</b> -Use SBAR to close loops with other team members -Use clear and simple language to communicate with family	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>8. Worked as part of a team:</b> -Cross monitor team members and offer help -Self-identify deficiencies and ask for help	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>9. Obtained relevant documentation:</b> -Pack additional patient labels, family contact info -Pack hard copy patient/care plan info as able	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>10. Minimized attached equipment:</b> -Assess equipment -Clamp, cap, or remove non-critical tubes/lines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>11. Anticipated emergencies:</b> -Pack appropriate emergency equipment and meds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>12. Assessed environment:</b> -Identify high-risk issues (eg, broken equip, leaks, structural damage, fire risk) -Assess other people/staff in area for injuries -Report issues to appropriate person	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>13. Triage medications and infusions:</b> -Determine which medications can be safely pushed (completed) or held -Brings critical medications and plans for how to administer (portable pump, drip count, intermittent bolus)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Total Score and % out of relevant/observable items</b> Minimum passing score 68%	<b>Total:</b>	<b>%:</b>	<b>Pass? Yes</b>	<b>No</b>

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**Figure 1.** Evacuation Assessment Tool (EVAT) for Scoring Evacuation Simulations. Abbreviation: SBAR, Situation, Background, Assessment, Recommendation.

that were identified as expected for all bedside nurses in disaster situations concerned maintaining physiologic processes including thermoregulation, avoiding infection, respiratory support, and monitoring vital signs. These skills are critical because infants have poor physiological regulation. World-wide, hypothermia is a contributing factor in all the major causes of neonatal mortality, including neonatal asphyxia and infection.<sup>14</sup> During evacuation, critically ill infants may require close monitoring of their respiratory effort due to the risk for apneic events that would go undetected, leading to respiratory compromise.<sup>15</sup>

Skills for communication, decision making, and anticipating future needs are crucial for care of infants in these situations, but these skills were assessed as less likely for a newly graduated nurse to have mastered. These skills should be educational targets for the more senior or charge nurses. While nurses with varying levels of experience may be involved in evacuating infants in the setting of a disaster, most units will have at least one more senior or charge nurse present per shift who can share their knowledge and perform the higher-level skills for a larger group of nurses. As an example, a well-prepared charge nurse can use their communication skills to

Equipment	Mean Score(95% CI)	Category
Face mask for bag, self-inflating bag	6.9 (6.7-7.0)	Most Essential(Score 6-7)
Portable oxygen tank	6.7 (6.4-7.1)	
Weight-based code medication sheet	6.6 (6.3-6.9)	
Syringes full of current meds running on pump	6.3 (5.8-6.8)	
Patient ID tag	6.2 (5.7-6.7)	
Pen or marker	6.0 (5.6-6.6)	
IV pole with pumps, physical chart (consents, contacts, ID stickers)	5.9 (5.4-6.7, 5.1-6.4)	Fairly Essential(Score 5-6)
Gloves	5.6 (4.9-6.2)	
Hand sanitizer	5.4 (4.7-6.1)	
Saline flushes	5.3 (4.8-5.8)	
Extra blankets/linens	5.2 (4.5-6.0)	
Alcohol/IV sterilization wipes	5.0 (4.5-5.6)	
Code documentation sheet (blank)	5.0 (4.0-5.7)	
Hat	4.8 (3.9-5.5)	
Flashlight/penlight	4.7 (4.0-5.6)	
Nursing hand-off/sign-out sheet	4.6 (3.8-5.5)	
Scissors, roll of tape, CO2 detector (pedi-cap, colorimeter)	4.3 (3.8-4.8, 3.8-4.9, 3.6-5.1)	
Ventilator, empty syringes	4.0 (3.3-4.9, 3.3-4.9)	Less Essential(Score 4-5)
Caps for IV lines, protective face masks for staff	3.6 (3.1-4.6, 2.7-4.5)	
Portable suction for replegle	3.5 (2.7-4.3)	
Replegle clamp, extra diapers	3.2 (2.6-4.3, 2.5-3.7)	
Pacifier	2.7 (2.0-3.4)	
Baby wipes, equipment cleaning wipes, measuring tape	2.5 (2.0-3.1, 1.7-3.1)	
Sterile glucose water	2.4 (1.7-3.2)	
Pedialyte, ready-to-feed formula	2.0 (1.4-2.7, 1.3-2.7)	
Breast pump for mother	1.6 (1.2-2.1)	

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**Table 3.** Ratings of Bedside Equipment for Patients Requiring Evacuation during a Disaster  
Abbreviations: ID, identification; IV, intravenous.

lead a huddle to communicate information on the situation, explain expectations for bedside nurses as they prepare to evacuate, make decisions on environmental safety, anticipate potential safety issues for the group, and make preparations such as bringing a code medication kit.

Simulations involving evacuations and disasters provide valuable opportunities for nurses to practice these vital skills. The equipment and skills discussed in this study can be used both to design learning objectives for disaster training exercises and to evaluate simulation performance. The EVAT scoring tool provides a method for evaluating performance during evacuation simulations, and the cutoff score for passing can be used to ensure newly graduated nurses are meeting the competencies expected of them.

Disaster preparedness activities for nurses may benefit from checklists of essential equipment and skills to ensure all nurses can independently manage patients' physiologic needs during an emergency. The development and use of an equipment prioritization checklist and skill set using the strategies outlined in this study is feasible for any specialty or unit. The pre-emptive identification of necessary equipment and the availability of evacuation checklists can enable prompt evacuation with critical equipment, and it may also assist adequate preparation and

stocking of this equipment at receiving facilities who may receive evacuated patients without essential equipment.

#### Limitations

The study had several limitations. It was conducted at a single facility, and the results may not be applicable to other facilities with different or limited resources; however, the methodology used to generate the ranked list of equipment and skills could be used by any facility to create their own list. Past performance and candidate data are not available to validate the cutoff point, but a future study is underway to ensure an expected percentage of practicing nurses obtain passing scores with the cutoff point determined with the Angoff method. This method relies on expert opinion and is subject to biases that could result in under- or over-valuing certain equipment or skills. The individual ICC for this study showed only moderate agreement, potentially due to a lack of training phase or quantitative feedback on individual versus group ratings. Future iterations of the equipment rating may benefit from rater feedback to increase agreement, potentially via a two-phase Delphi or a training phase on a subset of items if a smaller team of raters is to be used to represent the group. Alternatively, a large team of



raters should be used to rate all items in order to obtain the high average consistency.

### Conclusion

Experts rated the ability to manage physiologic issues, such as thermoregulation and respiratory support, as disaster management skills that every nurse should master. Disaster preparedness activities for nurses in training may benefit from checklists of essential equipment and skills to ensure all nurses can independently manage patients' physiologic needs when they enter the workforce. Disaster

training for advanced or charge nurses should include education on decision making, communication during emergencies, and anticipation of future issues to ensure that charge and resource nurses can support bedside nurses during evacuation events. Nurses participating in simulated evacuation events can have their performance scored on the EVAT to determine whether they have met the minimum expected performance in caring for patients in disasters requiring evacuation, and to identify skills to improve upon as they advance.

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