

Enhancing First Responder Safety in Nuclear Radiological Emergencies: A Systematic Review of Personal Protective Equipment (PPE) Training to Promote Self-Efficacy Among First Responders

ABSTRACT

Objective

Nuclear radiological (nuc./rad) emergencies are classified as low frequency, but high impact events. Radiophobia and fear of deleterious outcomes often evokes hesitancy among responders resulting in high absenteeism rates post event. This review explored PPE use as a protective mechanism for responders' safety and identified tools that promote PPE efficacy among first responders during nuc./rad. events.

Methods

A systematic literature review was conducted using five scientific databases. More than 5,500 articles were screened to identify literature relating to "PPE use" by first responders during "nuclear radiological events".

Results

Regulatory agencies such as the IAEA and the NRC assert that PPE, (when worn correctly and consistently) minimizes exposure to ionizing radiation. Adequate training of first responders emerged as a critical determinant to support appropriate PPE selection and usage during radiological emergencies. This included new employee trainings and refresher courses for existing employees. Pedagogical tools highlighted in the literature included tabletop exercises, safety huddles, trial runs for donning and doffing of new gear (with emphasis on air-fed suits), just-in-time training and virtual reality simulations.

Conclusions

Education on the effective use of PPE is essential to promote self-efficacy among medical staff and other first responders during nuc./rad. events. Comprehensive training will reduce unintended exposures, decrease hesitancy, and maximize employee safety.



SYSTEMATIC REVIEW PROCESS

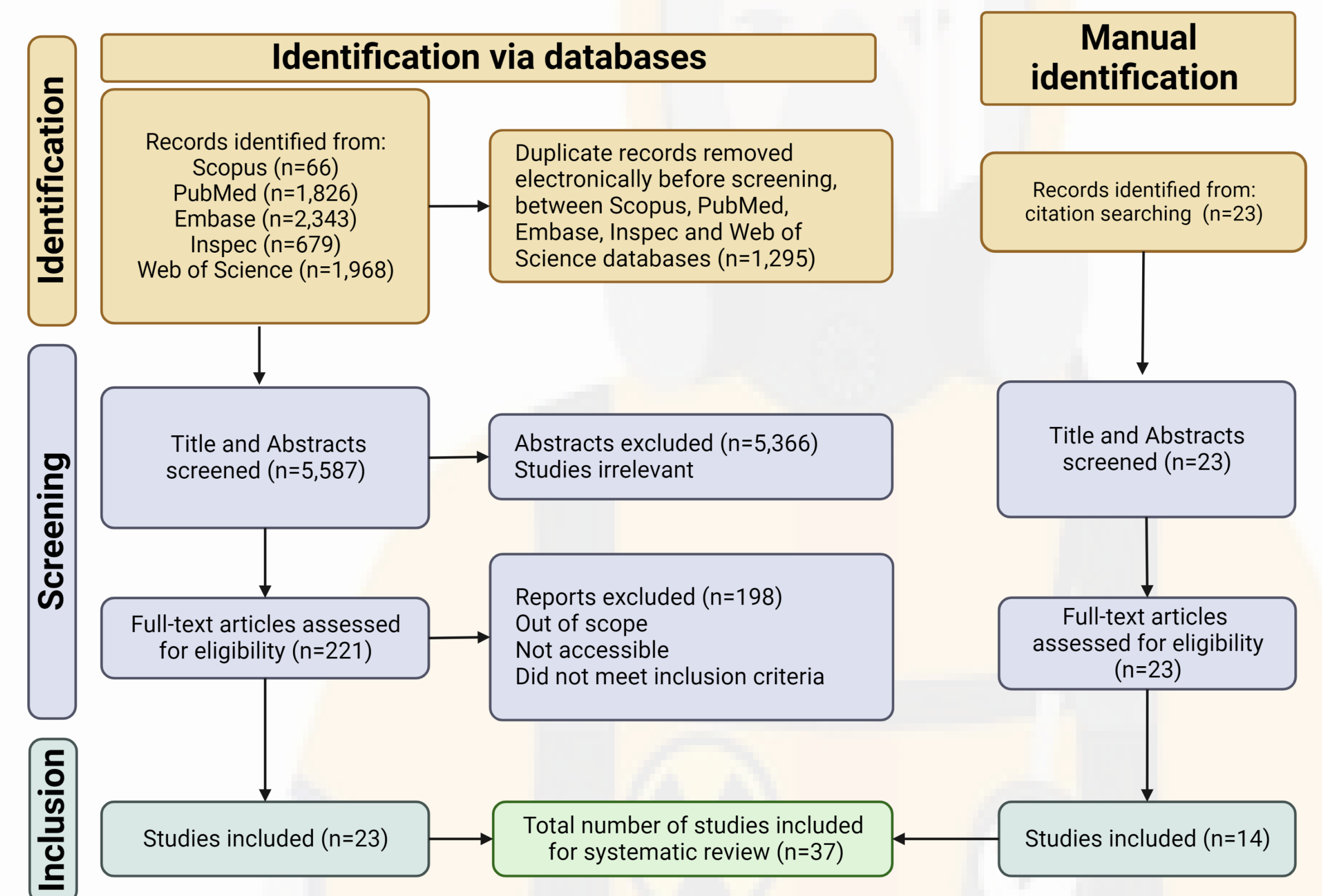


Figure 1. Flowchart illustrating the PRISMA Systematic Review Process utilized for this study

RESULTS AND DISCUSSION

PPE Recommendations that Emerged from the Literature



Figure 2. Tree Chart of the Articles of PPE Recommended or Used in the Articles Reviewed. The size of the box is representative of the number of times the PPE was recommended or utilized for first responders during emergency response to maximize safety. *Although "other" has 22 references in the literature, each article of PPE was mentioned ≤ three (3) times.

BACKGROUND/ INTRODUCTION

Some literature from the Fukushima Daiichi Nuclear Power Plant meltdown (Japan 2011) suggests that timely delivery of medical care to injured plant workers proved futile

- Ambulance/Fire staff refused to transport patients- cited safety concerns, radiation levels beyond their transportation cutoff; Medical facilities declined to accept patients¹

Hesitancy from first responders to accept patients who were contaminated and injured was unsettling

- Japanese National Institute of Radiological Sciences (NIRS) was providing radiation emergency for first responder courses since 1959; NIRS reports ~400 workers/year complete training
- The curriculum for their radiation emergency courses for medical professionals and first responders included desktop drills, and practice managing contaminated patients¹

Worker hesitancy to respond to nuc./rad. events continue to be of concern worldwide

- Members of the public health and medical communities are not adequately prepared to respond to nuc./rad. threats²
- Radiophobia, fearmongering and lack of communication fosters anxiety and other psychosocial effects. This presents as workers non-compliance to perform tasks that they perceived to be "high risk", or not showing up to work at all³

Comprehensive training and education is essential to maximize responder efficacy and improve emergency outcomes

- Past CBRN events suggest that when responders lack training of how to manage these types of emergencies situation, overall outcomes are worsened⁴
- Responders who received training recently are more familiar with emergency guidelines and more willing to respond to large scale nuc./rad. accidents⁵

Education/ Training Method	Description
Education Modules	<ul style="list-style-type: none"> Many responders report receiving an all-hazards training which lacks detail for efficient nuc./rad. response.³ Incorporating radiological preparedness in the opportunities for CME credits. Specialized training that are responder or role specific or train the trainer opportunities were also evident.⁴
Tabletop Exercises	<ul style="list-style-type: none"> These exercises are among the most common tools for preparedness training. They have opportunities for large scale impact as they bring together many (if not all) of the relevant stakeholders for the emergency scenario. Nuc./rad. exercises are encouraged once to twice per year.⁷
Just-in-Time Training	<ul style="list-style-type: none"> In emergencies response, mechanisms are mobilized from external sources. Just-in-Time training provides timely, brief education that equips responders with necessary skills for the emergency. Delivery methods include incident specific modules delivered to cellphones en route to the site, recorded modules, and on-site training.⁸
Simulations	<ul style="list-style-type: none"> Some responders never don or doff different PPE and are ill-prepared for its physiological burden. Issues identifying appropriate gear for the event are also common. Simulations provide hands-on practice allowing responders to optimize response mechanisms. Better preparedness will ensue.⁹
Virtual Reality	<ul style="list-style-type: none"> Provides a realistic training platform where responders can experience the desired environment without being exposed to ionizing radiation. Some packages include dose maps and virtual dosimeters to illustrate the effect of the decisions made to varying stimuli on site.^{10,11}

Table 1. Table illustrating the pedagogical tools that emerged from the literature to facilitate training/ education of different classes of responders for nuc./rad. Emergency event response. Even though education and training are emphasized, we must acknowledge that it is not infallible⁶

CONCLUSION

There are many educational and training tools that can be that can utilized to enhance responder preparedness for nuc./rad. events. An approach that incorporates multiple strategies will maximize responder readiness, promote self-efficacy, and reduce hesitancy in nuc./rad emergency response settings.