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ABSTRACT

Background: Over the last decade, the United States has witnessed an increase in mass casualty incidents (MCIs). The outcome of an MCI depends upon hospital preparedness, yet many hospitals are unfamiliar with their facility MCI procedure. Educational training drills may be one method to improve staff knowledge of policy and procedure.

Objective: This study aimed to improve knowledge gained through educational MCI mini drills of institutional mass casualty policy and procedure in surgery department staff at a level II trauma center.

Methods: A pre-/posttest design was utilized. The hospital implemented MCI mini training drills as a quality improvement project using Plan-Do-Study-Act iterative cycles with prospective data collection. Knowledge scores were measured using a 12-item surgery department MCI policy and procedure questionnaire that was developed by the author and leadership.

Results: A one-way analysis of covariance analysis in participants that mini drilled more than once indicated significant effect on mean cycle score differences among three cycles $F_{(2,21)} = 12.96$, $p = .00$. Multiple comparison using Games–Howell indicated the mean score for Cycle 4 ($M = 96.15$, $SD = 6.54$) was significantly different from Cycle 3 ($M = 59.71$, $SD = 25.15$). Gender, shift, and credentials of participants influenced knowledge improvement.

Conclusion: Implementation of hospital MCI mini drills improved staff knowledge of institutional mass casualty policy and procedure in the surgery department and may be applied to surgery departments with similar policy, procedure, and participant characteristics. Hospital mass casualty response education and preparation is essential to saving lives.

Key Words

Education, Mass casualty incident, Mini drill, PDSA, Surgery department

The United States is witnessing an epidemic in mass casualty incidents (MCIs), with mass shootings being the most common (Melmer et al., 2019). A MCI is an event where the number, severity, and type of casualties require resources beyond what is available, given a sudden surge of injured patients and possible saturation of critically injured patients (Lowes & Cosgrove, 2016; Melmer et al., 2019). Almost a third (31%) of the world's mass shootings have occurred in the United States (Meindl & Ivy, 2017), with a mass shooting incident nearly every 12.5 days (Meindl & Ivy, 2017). Although there was investment into building the response infrastructure since the World Trade Center attack in 2000 (Khan, 2011), many hospitals remain largely unprepared for no-notice trauma-related MCIs and have opportunities for improvement (Hollister, 2019).

The outcome of an MCI depends upon hospital preparedness (Ben-Ishay et al., 2016). Yet, 45% of rural hospital nurses reported that they felt less than familiar with their hospital's disaster preparedness terms and processes, and 40% reported they would be less than effective during an actual disaster (Hodge, Miller, & Dilts Skaggs, 2017). Several studies described staff disaster training drills as being central to hospital emergency or MCI preparedness (Grochtdreis, de Jong, Harenberg, Gorres, & Schroder-Back, 2016; Hang, Jianan, & Chunmao, 2016; Landman et al., 2015).

The standard for frequency of disaster drills for hospitals was established by the Centers for Medicare & Medicaid Services (CMS, 2019) and the Emergency Preparedness Rule requires hospitals to complete two

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emergency preparedness training exercise drills per year that include one full community-based drill if possible, and one tabletop drill. Every surgery department staff member does not have the opportunity to participate in every full facility MCI drill. This may cause variation in our surgery department response and performance during an MCI. Hospital drills are not required to be specific to the surgery department, further limiting staff exposure to MCI education.

Our surgery department was included in a full facility MCI drill in October of 2019 and the after-action report revealed opportunities for improvement in MCI policy and procedure knowledge. It was determined that educational improvement was necessary. The question arose: "Would mass casualty mini training drills in the surgery department improve knowledge of their policy and procedure"? Current literature is limited on the effectiveness of focused mini drills. Mini drills are brief face-to-face interviews with immediate educational feedback on specific details of a department's policy or procedure.

OBJECTIVES

The study aims were: to determine whether MCI mini drills would improve surgery department staff knowledge of institutional mass casualty policy and procedure over the course of education reinforcement; and to correlate the relationship between demographic characteristics and any knowledge improvement.

METHODS

Study Design

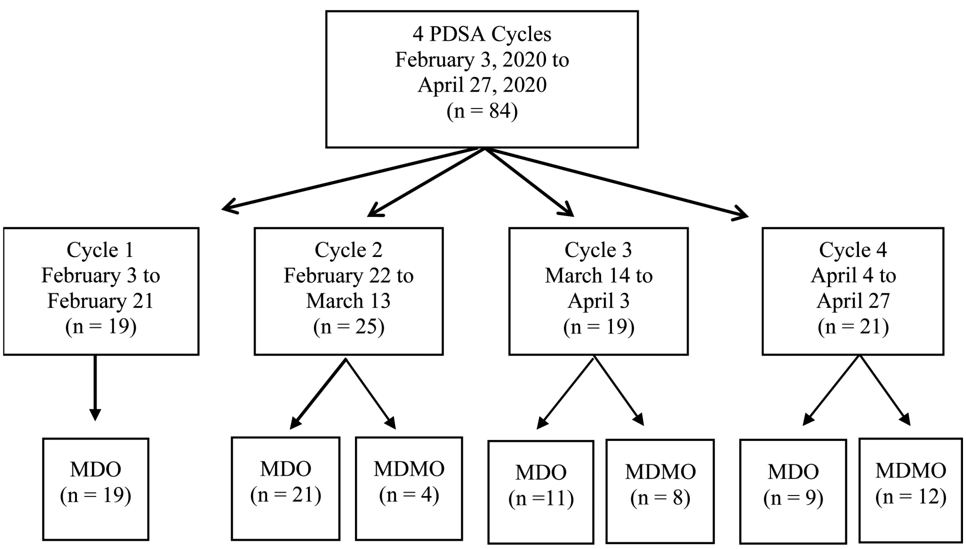
This was a pre-/posttest design. This study was approved by the hospital and university institutional review boards.

Study Procedure

MCI mini training drills were implemented using the Plan-Do-Study-Act (PDSA) model for quality improvement from February 2020 to April 2020 with four 3-week rapid improvement cycles among surgery department staff that were on-duty (Figure 1). A department manager recruited the participants and coordinated the day and time of each mini drill. Each participant in the mini drill was interviewed face-to-face by the same drill leader using the same paper questionnaire, which was developed by the author and the surgery department leader (Figure 2).

Once the mini drill questionnaire was completed by the drill leader, the drill leader immediately provided the correct answers to the participants. The drill leader graded the responses. Each question was worth one point and percentage knowledge scores were determined. The drill leader documented the start and stop time of the mini drill, total time for mini drill, and whether it was day or night shift.

Preliminary data were studied following each PDSA cycle and actions were developed. The PDSA actions after each cycle included (a) the correct answers to the two most frequently missed questions from Cycle 1 were



Note. There were four Plan-Do-Study-Act (PDSA) cycles for the mass casualty mini drill project during the study timeframe of February 3, 2020 through April 27, 2020 with 84 total participants. MCI = mass casualty incident. MDO = participants that mini drilled only once. MDMO = participants that mini drilled more than once.

Figure 1. Mass casualty mini drill PDSA cycle and participant flow diagram.

Age:
Gender: (Circle) Male Female
Education: (Circle) Associates Bachelors Masters Doctorate
Credentials: (Circle) RN Surgical tech other, specify:
What area of the surgery department do you work? (Circle) Pre/post-operative Post-anesthesia care unit (PACU) Surgery
How many disaster drills have you participated in the past?
Do you have experience of working during a real-life MCI? (Circle) Yes No
Have you participated in a previous surgery department mini drill as of January 2020? (Circle) Yes No
Work Status: (Circle) Part time (less than 32 hours a week) Full time
How long have you been practicing in your current profession in the surgery department?
Q1: According to the emergency operations plan, which three people are responsible for declaring a "disaster mobilize?"
Q2: A patient arrives from a Mass Casualty Incident (MCI) with a gunshot wound to the chest, respirations are 4 per minute, and patient is not following commands, would this patient be categorized in the START triage system as? (Circle) Black Red Yellow Green
Q3: A patient arrives walking with a left-hand amputation from an explosion, respirations are 16, cap refill is < 2 seconds, patient is alert and follows commands; what color is the patient triaged using the START triage system? (Circle) Black Red Yellow Green
Q4: Patients that arrive by private vehicle are triaged at which entrance ? (Circle) Ambulance bay Emergency Department patient entrance Entrance #1
Q5: During surge, when the surgical intensive care unit (STICU) is full, what surge location would open to accept critical patients?
Q6: During a disaster surge and inpatient units are full, name a surge location that opens for non-critical patients?
Q7: What color are the walking wounded triaged as according to the START triage system? (Circle) Black Red Yellow Green
Q8: Where is the personnel staging area?
Q9: When there is a disaster mobilize, will elective procedures be canceled? (Circle) Yes No
Q10: Which surgery department operating room location may be used as back-up if the hospital OR is full? (Circle) Randallia North Premiere All three
Q11: During a disaster mobilize, you may be reassigned to care for patients in other hospital departments (that are not surgery departments)? (Circle) Yes No
Q12: Will operating rooms be used to care for patients that do not need surgery? (Circle) Yes No
Drill start time_____ Drill stop time_______ Total time to complete_______ Drill taking place during day or night shift_______ Month number in PDSA cycle (1,2,3,4) __

Figure 2. Mass casualty mini drill surgery department questionnaire.

distributed via email, (b) a copy of the surgery department MCI policy and procedure was delivered via email after Cycle 2, and (c) following Cycle 3, surgery staff were provided both (a) and (b).

Study Setting and Population

This is a 451-bed hospital that is verified as a level II trauma center with Magnet nursing designation. The surgery department consists of three areas that include the operating room area, the postanesthesia care unit area, and the pre- and postoperative area. Inclusion criteria for the surgery department participants were (a) on-duty hospital surgery staff who speak English, (b) older than 17 years, and (c) staff in nonleadership positions. Exclusion criteria were (a) nonsurgery department staff, (b) younger than 18 years, (c) staff that were not on-duty, (d) non-English-speaking staff, and (e) staff in leadership positions. The surgery department manager determined the participants based upon the inclusion and exclusion criteria and recruitment materials were not necessary. The participants were classified into two groups: those who mini drilled only once

(MDO/pretest group) during the study and those who mini drilled more than once (MDMO/posttest group) during the study (Figure 1).

Data Collection and Management

The data variables collected were demographic data, and MCI mini drill participant knowledge specific to surgery department MCI policy and procedure. Demographic data included age, gender, level of education, credentials, years of experience, total number of past full facility drills, number of real-life MCI experiences, part-time versus full-time work status, work area (location) within the surgery department, and whether they had participated in a previous surgery department MCI mini drill during the study period. The mini-drill data collected were derived from the 12-item open and close ended mass casualty questions (Figure 2).

Statistical Data Analysis

Data were collected in Excel and exported to SPSS (Version 25, IBM, Armonk, NY) for statistical analysis. Missing cases and/or variables were validated and corrected. The analysis included frequency distribution to reclassify data if necessary, cross-tabulation to characterize background information, and accuracy improvement. One-way analysis of variance (ANOVA) was used to determine mean score differences across the cycles among MDO (pretest group) and MDMO (posttest group) participants. The assumptions of ANOVA were assessed for normal distribution of knowledge scores (histogram) and test for homogeneity of variances (Levene's test) among MDO and MDMO participants. We employed Games–Howell and other tests for unequal variances, as well as Welch's t test for unequal variances and unbalanced design (unequal sample sizes) in MDMO participants to show mean educational knowledge score improvement in MDMO cycles.

RESULTS

Participant Characteristics

Eighty-four MCI mini drill interviews took place in the surgery department during the study period. Of those, 60 were MDO and 24 were MDMO participants. The participants within both groups were predominantly female (n = 76, 90%), registered nurses (n = 63, 75%), worked full-time (n = 68, 81%), day shift (n = 79, 94%), less than a bachelor's degree (n = 45, 54%), participated in a full facility MCI training drill once or never in the past (n = 61, 73%), and never experienced working during a real-life MCI (n = 72, 86%) (see Table 1). The average age and standard deviation of MDO and MDMO participants were M = 40.0, SD = 10.9, and M = 44.0, SD = 10.7 years, respectively.

TABLE 1 Participant Characteristics by Groups, Total = 84

Characteristic	MDO *n* (%)	MDMO *n* (%)	*p* Value
Gender			
Male	3 (5.0)	5 (20.8)	<.05
Female	57 (95.0)	19 (79.2)	
Age group			
<40	28 (46.7)	8 (33.3)	>.05
≥40	32 (53.3)	16 (66.7)	
Shift			
Day	57 (95.0)	22 (87.5)	>.05
Night	3 (5.0)	2 (12.5)	
Work status			
Part-time	13 (21.7)	3 (12.5)	>.05
Full-time	47 (78.3)	21 (87.5)	
Education			
None/diploma/ associate degree	31 (51.7)	14 (58.3)	>.05
Bachelor's degree	29 (48.3)	10 (41.7)	
Experience in surgery department			
0–5 years	36 (60.0)	10 (41.7)	>.05
>5 years	24 (40.0)	14 (58.3)	
Credentials			
Other/surgical tech	14 (23.3)	7 (29.2)	>.05
RN	46 (76.7)	17 (70.8)	
Department			
Pre-/postoperative	21 (35.0)	7 (29.2)	>.05
Operating room	25 (41.7)	7 (29.2)	
Postanesthesia care	14 (23.3)	10 (41.6)	
Previous full drill			
0–1	45 (75.0)	16 (66.7)	>.05
>1	15 (25.0)	8 (33.3)	
Real-life MCI[a]			
No	54 (90.0)	18 (75.0)	>.05
Yes	6 (10.0)	6 (25.0)	

Note. *MCI = mass casualty incident; MDMO = participants that mini drilled more than once; MDO = participants that mini drilled only once; RN = registered nurse.*

[a]*History of working in a hospital during a real-life mass casualty incident.*

Mini Drills Educational Knowledge Improvement Status

Employing the one-way ANOVA, the differences between the mean MCI knowledge scores among MDO participants across the four PDSA cycles were not significant, but were significant in MDMO participants $F_{(2,21)} = 12.96$, $p = .00$, and the effect size for the association between the cycles and knowledge score improvement was large (see Table 2). Welch's *t* tests on MDMO participants revealed that there was a mean score difference of 36 (96.15 − 59.71) between Cycle 4 and Cycle 3, $p < .05$.

Correlation Between Demographic Characteristics and Knowledge Score Improvement

Gender, work shift, and credentials could influence knowledge score improvement in MDMO when compared with MDO participants (see Table 3).

Interview Time

The mini drill time mean and standard deviation between MDO versus MDMO were $M = 5.55$, $SD = 1.14$, and $M = 4.58$, $SD = 1.47$ min, respectively, and were statistically significant at $p < .05$ level.

DISCUSSION

The MCI mini drills were successful at improving knowledge of institutional mass casualty policy and procedure

TABLE 2 One-Way ANOVA: MDO and MDMO Participants

	n	*M*	*SD*	*F*	*p*	η^2
MDO						
Cycle 1	19	47.26	1180	1.17 (3, 56)	.32	NC[a]
Cycle 2	21	52.33	16.99			
Cycle 3	11	46.91	11.07			
Cycle 4	9	57.44	20.84			
Total	60	50.50	15.57			
MDMO						
Cycle 2	4	81.25	14.10	12.96 (2, 21)	.00[b]	.55[c]
Cycle 3	7	59.71	25.15			
Cycle 4	13	96.15	6.54			
Total	24	83.04	21.83			

Note. MDMO = participants that mini drilled more than once; MDO = participants that mini drilled only once.

[a]Not calculated because the F test was not statistically significant.

[b]There was a significant effect of mean score difference across cycles (Cycle 2 through Cycle 4) among MDMO participants $F_{(2,21)} = 12.964$, $p < .00$. Post hoc comparisons using the Games–Howell test for unequal variances indicated that the mean score difference of 36.44 between Cycle 4 and Cycle 3 was significantly different, $p < .05$.

[c]Large effect size.

TABLE 3 Influence of Some Covariates on Mean Knowledge Score Improvement (Subgroup Analysis)

Variable	Subgroup	Participant Status	*n*	*M*	*SD*	Mean Difference (Within Subgroup)	*p*	Mean Difference (Between Subgroup)
Gender	Female	MDMO	19	86.00	16.13	35.46	<.00	13.33
		MDO	57	50.50	15.01			
	Male	MDMO	5	71.80	37.00	22.13	>.05	
		MDO	3	49.67	28.86			
Shift	Day	MDMO	21	87.71	14.79	36.59	<.00	24.92
		MDO	57	51.12	15.39			
	Night	MDMO	3	50.33	38.18	11.67	>.05	
		MDO	3	38.67	17.21			
Credentials	RN	MDMO	17	86.29	20.96	36.51	<.00	14.22
		MDO	46	49.78	15.64			
	Surgical tech/ other	MDMO	7	75.14	23.51	22.29	<.05	
		MDO	14	52.86	15.66			

Note. MDMO = participants that mini drilled more than once; MDO = participants that mini drilled only once. Gender, work shift, and credentials could influence knowledge score improvement in MDMO when compared with MDO participants.

in the surgery department among participants who participated in mini drills more than once. The MDMO participants may be regarded as the posttest group in this study. The surgery staff who participated only once represented the pretest group for this study.

The knowledge scores were normally distributed (normal histogram) and Levene's test for homogeneity of variance was not violated ($p > .05$). These met the key ANOVA assumptions in MDO but not in the MDMO participants. More importantly, their mean knowledge scores did not demonstrate improvement across the cycles as indicated by the F test with $p > .05$. The MDO participants could be regarded as the control in this study. Gender, work shift, and credentials may have influenced MCI knowledge score improvement.

Continual preparedness through regularly scheduled training drills was recommended by Taskiran and Bakal (2019), which could be achieved through repeated mini drills. Disaster training should also be specific to the hospital department and the role of the nurse or staff (Lynn, 2019; Sonneborn, Miller, Head, & Cross, 2018), such as our surgery department MCI mini drills. Focused mini drills could augment the CMS Emergency Preparedness Rule for hospitals.

The outcome of the results could have been impacted by contextual characteristics, such as being a high reliability organization, an organization that utilizes Lean Six Sigma (LSS), or using the PDSA process. The hospital strives to be a high reliability organization with a just culture. Several hospital nursing leaders are trained in LSS principles. Our PDSA quality improvement mini drill project had a hospital administrative sponsor, physician champion, lean leader, and nursing staff support. These multidisciplinary principles supported and allowed the successful implementation of this project as suggested in the literature (Kringos et al., 2015; McCormack et al., 2001).

This study is generalizable to surgery departments with similar policy, procedure, and participant characteristics. Mass casualty mini drills should improve knowledge when coupled with immediate feedback on correct answers to the participants following the mini drill.

LIMITATIONS

This study had several limitations: (a) the use of one-group pre-/posttest design may have been a threat to the internal validity and affected the study generalizability; (b) external validation of the questionnaire was not performed; (c) the coronavirus disease-2019 (COVID-19) pandemic impacted the hospital from March 2020 through the remainder of the study, elective surgeries were halted which caused a decline in surgery cases and limited staff availability for the mini drills, and the pandemic led to staff confusion regarding COVID procedure versus MCI policy and procedure; (d) there were time constraints during the study due to the use of rapid fire improvement PDSA cycles; however, this was consistent with standard hospital quality improvement initiatives; (e) it was unverified whether participants received the action items via email following each PDSA cycle; however, email was a standard form of communication within the hospital; and (f) ANOVA analysis was done on a restricted small sample size of each PDSA cycle.

IMPLICATIONS

Clinically, improving knowledge may enhance the efficiency and effectiveness of hospital staff performance during an MCI and thereby may prevent death and disability (World Health Organization, 2011). Implementing small-scale MCI knowledge changes may continuously improve the mass casualty victim patient care system. Encouraging state health care coalitions or the CMS to adopt mini drills as standard could enhance the system of patient care for MCI victims.

Economically, there is minimal cost to provide MCI mini drills to staff. Most hospitals have emergency preparedness staff and department educators. Each mini drill takes an average of 5 min per participant and interviewer. This cost outweighs any adverse event that may occur if the hospital staff are not prepared for an MCI.

In practice, the study results could change how U.S. hospitals routinely train for MCI response. Along with yearly required drills or online education, MCI mini drills may be implemented in similar surgery departments with similar results. Because staff usually prefer in-person training to computer-based learning, this is an ideal format for future practice. Not only could this be applied to hospitals, but prehospital, nursing homes, rehabilitation centers, and other health care organizations.

CONCLUSION

Repeated mass casualty mini drills in the surgery department improve knowledge of institutional MCI policy and procedure. Mini drill repetition is a factor in success because MDMO participants were shown to have knowledge improvement in comparison to MDO participants. This study may contribute to hospitals seeking ways to improve mass casualty knowledge

KEY POINTS

- Mass casualty incident (MCI) mini training drills improve knowledge of policy and procedure in the surgery department.
- Focused face-to-face MCI mini drills are quicker and more efficient as compared to full facility or tabletop MCI training drills.
- Mass casualty mini drill knowledge improvement is generalizable to surgery departments with similar policy, procedure, and participant characteristics.

because many U.S. hospitals do not feel prepared for MCIs. Because mass casualty events have been on the rise, policy and procedure education is crucial to patient outcomes, and an efficient and effective staff response. Further studies should be undertaken to determine the benefit that MCI mini drills have on full facility MCI drill performance. Recommendations for future implementation of MCI drills are to (a) implement MCI mini drills in similar hospital departments, (b) implement mini drills in other hospital emergency preparedness activities to include bioterrorism, infectious disease, chemical, and natural disasters, and (c) expand MCI mini drills to prehospital, nursing homes, rehabilitation centers, and other health care organizations.

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