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Going vertical: triage flags improve extraction times for priority patients

Abigail W. Cheng BS[1] | Patrick McCreesh MS[1] | Seth Moffatt BS[1] | Ryan Maziarz BS[1] | Duncan Vos MS[2] | Joshua Mastenbrook MD[3]

[1] Western Michigan University Homer Stryker M.D. School of Medicine, Michigan, USA

[2] Division of Epidemiology and Biostatistics, Western Michigan University Homer Stryker M.D. School of Medicine, Kalamazoo, Michigan, USA

[3] Department of Emergency Medicine, Western Michigan University Homer Stryker M.D. School of Medicine, Kalamazoo, Michigan, USA

Correspondence

Abigail W. Cheng, BS, Western Michigan University Homer Stryker M.D. School of Medicine, 1000 Oakland Drive, Kalamazoo, MI 49008, USA.

Email: abigail.cheng@med.wmich.edu

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[Correction added on 17 September 2020, after first online publication: the surname of the author is updated from "Seth Moffat" to "Seth Moffatt".]

Abstract

Objective: The number of mass casualty incidents (MCIs) has been steadily increasing. High-priority MCI patient outcomes are highly dependent on rapid identification, treatment, and transport. Although there are several methods used to mark patients for rapid extraction, most current methods utilize low-profile tags, with no gold standard. This study examines if the use of a vertical cue, a triage flag, to identify high priority MCI patients results in faster extraction times than those with a wrist triage tag alone.

Methods: A prospective randomized crossover study was conducted with medical students trained in basic disaster life support, who completed 2 extraction simulations. Two fields were each arranged with 32 randomly placed, pretriaged manikins (10 red, 17 yellow, 5 black). The manikins were marked with either triage tags alone or with triage tags and flags. The total time elapsed for participants to report all high-priority manikin triage tag numbers was recorded.

Results: Eighty-two participants completed both simulations. The average completion time for the "tags-only" simulation was 94.5 seconds (±16.4 seconds) compared to 70.7 seconds (±13.2 seconds) for the flags and tags simulation. This corresponds to an average decrease of 23.8 seconds ($P < 0.0001$), or a 25.2% reduction in time.

Conclusion: Using a vertical cue decreased the time required to identify high-priority patients. This suggests that a rapidly deployable and visually apparent triage marker may allow faster identification and extraction of patients across a field of victims with varying injury severities than a flat horizontal triage tag, thereby potentially improving patient outcomes.

KEYWORDS

mass casualty incident, triage tag, triage

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1 | INTRODUCTION

1.1 | Background

Mass casualty incidents (MCIs) are defined as events in which the number of patients exceeds the available healthcare resources.[1-3] These incidents may occur within various settings, such as a natural disaster, a vehicular accident, or a mass shooting. MCIs are becoming increasingly common over the past several decades. The number of active shooter incidents per year has increased from 1 incident in 2000 to 20 incidents in 2015, with the number of injuries and casualties increasing from 7 in 2000 to 134 in 2015.[4,5] Although active shooter incidents tend to dominate the news when they happen, other MCI types do occur and are in fact more common overall in the United States. Vehicular accidents involving motor vehicles, motorcycles, and aircraft accounted for nearly 70% of all MCIs analyzed in a 2014 study.[6] The World Health Organization estimated in 2011 that vehicular MCIs were likely to increase by 65% over the next 20 years.[7] Other significant MCI mechanisms identified in the 2014 study include stabbings (6.4%), falls (3.8%), and other categories (10%) such as water transportation incidents and smoke inhalation.[6] As these events are critically affected by the resource limitations that define them, highly organized and efficient emergency response processes are necessary to assess the situation and allocate resources to best serve the needs of the greatest number of patients. A cornerstone of these processes is triaging: the assignment of a treatment and transport priority based upon the patient's medical status as determined by examination in the field.[2,3]

During an MCI, accurate and rapid triaging of patients to facilitate rapid extrication, treatment, and transport is critical to minimize fatalities. Although the importance of triage is universally recognized, there is considerable variability in the methods of triage employed both across and within countries.[2,8,9] Many triaging methods use a colored wristband or triage tag that can be placed directly on the patient's body to serve as an identification of the patient's treatment and transportation priority for emergency medical services (EMS) professionals working on the scene. Minimal (green) classification typically refers to patients with no or minor injuries who are functionally able to leave the scene unassisted and are without need for immediate medical treatment.[2] Delayed (yellow) classification indicates patients with injuries that are not immediately life threatening and are able to wait for medical treatment while more seriously injured patients are transported from the scene.[2] Immediate (red) classification is used for patients with serious life-threatening injuries requiring immediate medical treatment, who would be expected to survive if they are urgently transported to a nearby trauma center.[2] Expectant (grey) classification is used for patients who are determined to be so severely injured that they would be unlikely to survive their injuries, given the resources available.[2] Dead (black) is the classification given to patients with no signs of life.[2]

The Bottom Line

In a simulated mass casualty incident, participants were asked to identify red-tagged victims using both traditional mass casualty incident tags and vertical flags. Participants were able to more quickly identify red-tagged victims using the vertical flags. Implications and limitations of the study are discussed.

1.2 | Importance

Although color-coded wrist-applied triage tags can help expedite patient extraction from the initial MCI scene to the casualty collection point, the limited size of and varying anatomical locations used for placement of these tags can hinder EMS personnel from being able to rapidly identify patient triage categories.[10,11] With flat wrist tags, there is no immediately visible way to determine a nonambulatory patient's injury severity status from a distance; each patient must be closely approached, and the tag visually identified on the wrist by the extraction or treatment teams. This can result in confusion and impede the provision of maximally efficient extraction, treatment and transport.[9] As time is critical throughout the assessment and extraction process in the aftermath of an MCI, any mechanism by which the process can be hastened has the potential to save lives.[2] One of the primary temporal challenges faced by first responders is minimizing time spent reevaluating patients who have already been assessed and triaged. Several studies have criticized the efficacy of using low-visibility tags during MCIs, with some further proposing methods to enhance the visibility of these tags, such as enhancing the color of the tags or utilizing colored glow sticks to draw more attention to patients.[10,12] Both of these techniques to increase visibility of the tags were shown to minimize confusion and increase efficacy of extrication.[10,12]

Whereas previous studies have evaluated the effectiveness of flat tags themselves, others have compared different forms of flat tags in use by EMS around the world.[8,13] No study to date has investigated whether employing colored triage flags that are elevated vertically to improve visibility from a distance could decrease the time needed to extract victims to a casualty collection point during an MCI.

1.3 | Goals of this investigation

Our study aims to further investigate if the time required to identify and extract the highest priority patients from an MCI field to a casualty collection point can be significantly shortened with the use of a color-coded vertical marker, a "triage flag." Additionally, we propose that the vertical triage flag will reduce the number of re-evaluations of the same patient during the extraction process.

2 | METHODS

2.1 | Design and setting

We conducted a prospective nonrandomized crossover study on a simulated MCI. This study was approved by the Western Michigan University Homer Stryker MD School of Medicine Institutional Review Board.

2.2 | Selection of participants

Participants in this study included the entire first-year class of medical students from a medical school. Of 85 eligible participants, 1 opted out of the study.

All students had completed training in basic disaster life support (BDLS). This is a 7.5-hour hybrid course with an online precourse component where students learn the core content followed by an in-person small group experience that allows students to apply the learned concepts and complete several virtual Sort, Assess, Lifesaving interventions, Treatment (SALT) triaging exercises. They work through several MCI scenarios, including a biological and chemical exposure event, using the “DISASTER” paradigm taught in the BDLS curriculum.[15] Participation was an optional activity during their Medical First Responder (MFR) Capstone Day course, which took place 2 days after completion of their BDLS course.

2.3 | Interventions

Participants were randomly assigned to start on either the “flags and tags” or the “tags-only” field. Participants were individually brought to the study location based on a randomized list created prior to the day of the study. However, as the trials were conducted, time constraints and limited personnel restricted us from using our randomization schedule and made it more feasible to direct participants to the shortest queue.

Two outdoor fields were used as the treatment groups, with 1 labeled as “tags only” and 1 as “flags and tags.” The two 1568 square-foot fields were split into 32 7 × 7 ft squares. The 2 fields were physically separated from each other. A manikin was randomly placed in each square. Each manikin was randomly assigned a red, yellow, or black tag for a total of 10 reds, 17 yellows, and 5 blacks in each field, by drawing a prelabeled (red, yellow, black) piece of paper out of a bag. There were 10 red labeled pieces of paper, 17 yellow, and 5 black within the bag from which to blindly pull out a prelabeled piece of paper. In total, 20 manikins were tagged red, 10 per field.

When searching PubMed for peer-reviewed articles to guide our distribution of triage category patients, using the search string “distribution of triage categories at mass casualty incidents,” only 9 articles resulted, with just 1 of these articles providing a distribution of triage categories in the context of incorporating a significant number of real MCIs. The proportional distribution of the patient triage categories we used was based on the median percentages of patient triage categories discussed within a German article that evaluated 244 MCIs in Europe and Turkey between 1985 and 2017.[14] The authors of the aforementioned study found that the median percentage of red, yellow, and black triage category patients was 10%, 17%, and 5%, respectively.[14] For simplicity, we used a number of 100 theoretical patients involved in our MCI, resulting in the need to label 10 manikins as red, 17 yellow, and 5 black.

On the tags-only field, triage wrist tags were attached to each manikin with their corresponding color. On the flags and tags field, triage wrist tags were attached to each manikin with their corresponding color, and commercially available utility marking field flags were inserted into the ground next to each manikin. The utility marking flags were solid in color and included yellow, red, and black, which corresponded to the triage color assigned to each manikin (Figure 1). The metal wire staff of the utility flag measures 15 in. in length. The flag measures 2.5 in. by 3.5 in. A stopwatch that measured to the millisecond was used at each field to time every trial.

Neither the participant nor the investigator was blinded to the course. However, participants were not allowed to view the course, which was enforced by having the participants have their backs facing the course until their times started. Manikins were randomly placed into these fields and randomly assigned a red, yellow, or black tag. Red, yellow, and black tagged manikins were randomly assigned placement in each field. Each participant started on 1 of the 2 fields and crossed over to the other upon completion of their originally assigned treatment group. Before starting each course participants were given the same instruction: “Identify all the red manikins, read the triage tag barcode numbers using the radio when you find a red manikin and indicate through the radio when you feel you have found all the red manikins by saying ‘Done.’” For the flags and tags course, participants were told that the flag color corresponded to the triage tag color. Each participant was timed by a researcher beginning when the researcher said “Go” and ending when the participants indicated via the radio that they had found all the manikins. The researcher recorded the number of correct/incorrect barcodes, and the number of times a manikin was reidentified.

2.4 | Outcomes

The primary end point was the total time required to identify and report, via 2-way radio, the triage tag barcode of each of the red manikins in the study field. Participants used the radio every time they found a manikin, and the timer was stopped when they indicated by radio that they felt they had found all the red manikins. Secondary end points addressed the accuracy of participants in identifying all 10 red manikins and included the number of red manikins missed and the number of red manikins counted twice by each study participant in each field. All data were recorded on a paper table and later transferred to Excel for data analysis.

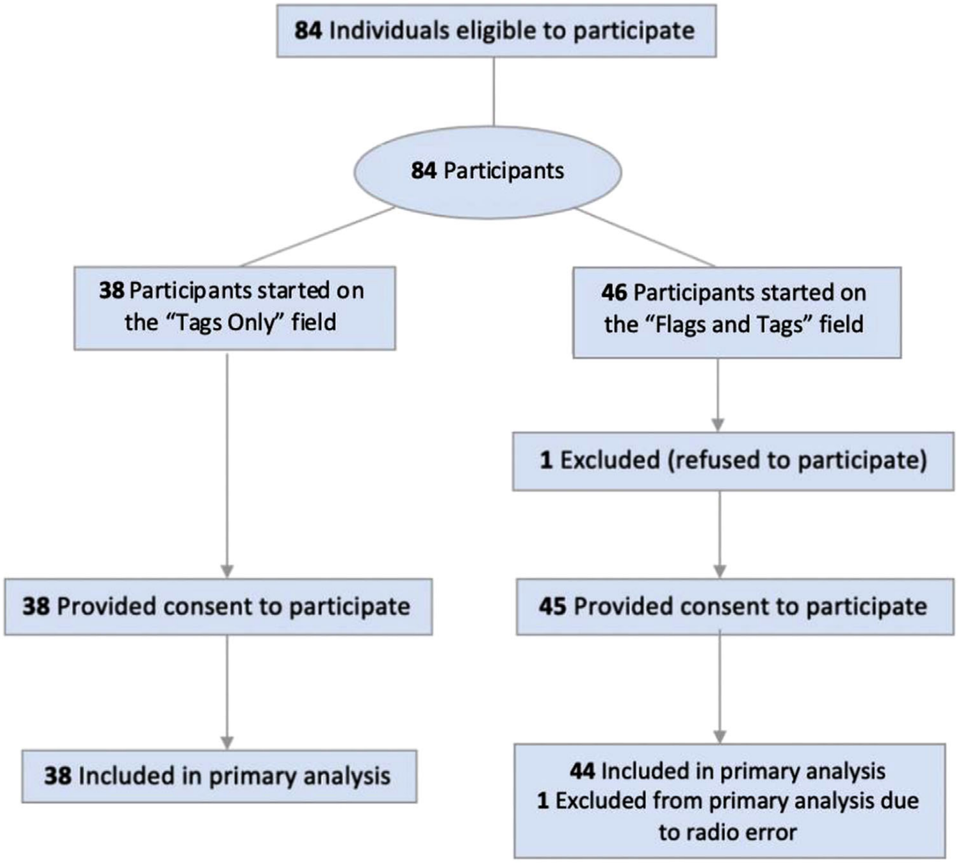

FIGURE 1 (A) "Flags and Tags" field (B) "Tags-Only" field (C) "Tags-Only" manikin (D) "Flags and Tags" manikin

2.5 | Analysis

A 2-period 2-treatment crossover design without a washout period was used. The 2 × 2 crossover design was used so that each subject served as his/her own control in the estimation of the effect of using flags to assist with identification of triaged manikins versus using tags only. A general linear mixed model was used to estimate the treatment effect while accounting for the period effect, sequence effect, and the correlation of repeated measurements within the subject. Significance was declared at alpha = 0.05. SAS v9.4 was utilized for analysis.

Power analysis was used to determine the power to perform a 1-sided *t* test to detect whether the total time for those using the flags was significantly less than that for those using the tags only. Research showed a 2.58 minute decrease for personnel using glow sticks, which corresponds to a 31.8% decrease.[12] The anticipated time to complete the tags-only trial was 90 seconds. A 31.8% reduction corresponds to a decrease of 28.62 seconds. Given the anticipated sample size of 84 students, there was sufficient power of > 80% to detect a decrease of 28.62 seconds for any combination of a standard deviation of 10, 20, 30, 40, or 50 seconds and a correlation between flag round and tag round of between 0.2 and 0.8.

3 | RESULTS

3.1 | Characteristics of study subjects

All 84 participants completed the study. One who could not complete the trials because of a radio issue was excluded from the analysis. Participants ranged in age from 20 to 40 years old and consisted of 43 males and 41 females.

3.2 | Main results

Participants were assigned to start on either the flags and tags field (n = 45) or the tags-only field (n = 38). One student completed the tags-only round but was unable to complete the flags and tags round because of a radio issue (Figure 2).

To determine if the vertical triage flags enabled faster identification of high-priority patients, the time required for identification of all red-tagged manikins was averaged across all participants for each field completed. Participants were much faster at identifying the red—tagged individuals on the flags and tags field compared to the tags-only field, regardless of the order in which they completed

FIGURE 2 Participant recruitment and flow of the “Tags-Only” versus “Flags and Tags” trials

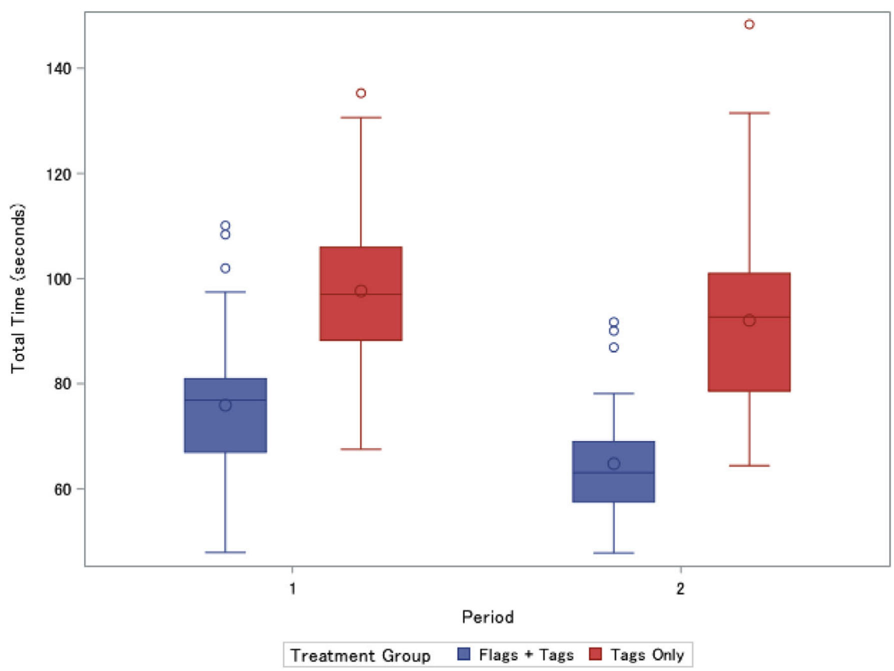

FIGURE 3 Distribution of completion times by treatment group and period

the fields (Figure 3). The average completion time for those who underwent the flags and tags round in the first period was 75.91 seconds (SD 13.44 seconds), and the average completion time for those who underwent the tags-only round in the second period was 92.06 seconds (SD 26.31 seconds). The average completion time for those who underwent the tags-only round in the first period was 97.67 seconds (SD 15.90), and the average completion time for those who underwent the flags and tags round in the second period was 64.76 seconds

TABLE 1 Number of manikins counted twice or missed per treatment group

	Tags only	Flags and tags
Subjects who successfully identified all 10 reds without any duplicates n (%)	49 (58.33)	54 (64.29)
Number of participants who counted red manikins twice, n (%)		
0	65 (79.27)	79 (96.34)
1 manikin counted twice	13 (15.85)	3 (3.66)
2 manikins counted twice	4 (4.88)	0
Number of participants who missed red manikins, n (%)		
0	63 (76.83)	55 (67.07)
1 manikin missed	14 (17.07)	24 (29.27)
2 manikins missed	5 (6.10)	3 (3.66)

Counting a red manikin twice means that the study participant returned to a specific manikin 2 times, not realizing that they had already identified that particular manikin as being a high-priority patient for extraction from the field.

(SD 10.25). Additionally, the time taken to complete the second field was shorter than the time taken for the first field regardless of order (period effect $P < 0.0001$). Overall the use of triage flags led to an average reduction of 24.42 (95% CI 21.11, 27.73) seconds in total time to identify all 10 red manikins. That is, the use of flags and tags led to a reduction of 25.80% in total time to complete the course.

3.3 | Secondary results

To assess if vertical flags improved accuracy of identifying the red-tagged patients, we examined the total time it took participants to accurately identify all 10 red manikins without any duplicate identifications or missed manikins. We defined duplication to mean that the study participant returned to a specific manikin 2 times, not realizing that they had already identified that particular manikin as being a high-priority patient for extraction from the field. Overall, there were 49 (58.33%) subjects in the tags-only course and 54 (64.29%) subjects in the flags and tags course who successfully identified all 10 red manikins without duplicates (Table 1). Of subjects who had duplicate identifications, more subjects identified all 10 red manikins in the tags-only course compared to the flags and tags course (76.83%, n = 63 vs 67.07%, n = 55, respectively) (Table 1). There were more manikins counted twice in the tags-only round with 13 participants (15.85%) counting 1 red manikin twice and 4 (4.88%) participants counting 2 red manikins twice. In the flags and tags round, only 3 participants (3.66%) counted 1 red manikin twice. There were fewer red manikins missed in the tags-only round with 14 (17.07%) participants missing 1 manikin and 5 (6.10%) missing 2 manikins. In the flags and tags round there were 24 participants (29.27%) who missed 1 manikin and 3 (3.66%) who missed 2 manikins (Table 1). The manikin missed most frequently on the flags and tags course was located on the sloped side of a hill on the field.

To determine whether the overall findings were affected by the inaccuracy of participants returning to and reporting the same manikin(s) twice or missing a manikin, a subgroup analysis was performed to compare times for those individuals who accurately identified all 10 red manikins without duplication in both courses (n = 33). For participants who did not miss any red manikins and did not count any manikins twice on either field, the average total identification time on the flags field was 23.71 seconds less ($P < .0001$) than that for those on the tags-only field. This provides support that the time saved by using the triage flags was not because of the red manikin being consistently missed, but instead is likely due to the increased visibility of the triage flags.

Based on the model used, the carryover effect was not significant ($P = .2821$), indicating that there was no significant difference in the carryover effect between the 2 treatments. The sequence effect was not significant ($P = .0922$), indicating that the total time did not significantly differ between the 2 sequences of treatments. The significant period effect ($P < .0001$) indicates that the total time to complete the course significantly improved by period, likely owing to learning and no-washout between periods.

3.4 | Limitations

Several limitations may affect the interpretation of the data. This study used a crossover design, which has certain advantages and disadvantages. Crossover designs typically have greater power than parallel designs because of the within-subject analysis utilizing each subject as his/her own control. Crossover designs also minimize the effect of potential confounding factors. Two key assumptions for a valid crossover analysis are that the carryover effect is not present or is negligible and the sequence effect is not present or negligible. Our study indicated that both the carryover ($P = .2821$) and the sequence effect ($P = .0922$) were not significant. However, based on the relatively lower P value for the sequence effect, there was some detection of a systematic difference between the first and second treatment periods in the total time to complete the course. This suggests that there was a greater learning effect with respect to the completion time of the flags and tags course in the second period. That is, the flags and tags treatment showed a greater reduction in total completion time in the second period than in the first period, which may suggest that the learning effect was greater for those utilizing flags in the second period.

Blinding was not possible in our study given our trial size, study site, and the visual nature of our intervention. However, a different study site could enable blinding of participants with the use of physical barriers. The ability to blind could lead to a lower potential for bias. The environmental circumstances of our study were not representative of many MCIs owing to the myriad of circumstances in which MCIs occur and design choices made to preserve participant safety. Our study was run between 2 relatively small outdoor spaces with few ground-level hazards, good lighting, and only minimal spacing between manikins; this differs greatly from MCIs where victims are widely dispersed across a large area with numerous environmental hazards, limited lighting, or from MCIs that occur indoors. Although it is likely those differences could make the identification of vertical cues more challenging, we believe those differences should affect traditional ground-level triage tags equally, preserving the decrease in identification time demonstrated by our study.

One key environmental consideration is that our simulation was run during daylight hours in an open area with few environmental factors impeding scene visibility, which may not occur in other MCIs. These conditions may have exaggerated the positive effect of vertical flags. However, we believe that any environmentally derived limitations on flag visibility as a result of poor lighting or field debris would equally and proportionally affect tags, with the vertical cue of flags possibly offering even greater advantage in scenarios where ground-level views are obstructed. Another environmental variable to consider is how the utility flags used in our study require insertion of a wire base into soft ground, which limits their application in scenarios where victims are located on hard surfaces like cement or asphalt. This limitation could be remedied by using flags with weighted or tripod bases that are less dependent on a soft surface to be placed while still offering a vertical cue. This aspect of flag design could be tested in a future study that also investigates the amount of time needed to perform the initial triage process, including the setup of the flags.

Our sample consisted of first-year medical students, likely with variable EMS experience. This may have been a confounder and a limitation as it was not a controlled variable. However, we feel this is less likely to have affected our data significantly, as our trials solely measured the time it took to identify red manikins either via tags or flags. If our study included triaging and extrication, then this would be a greater confounder.

In addition, triage categories were not changed during the simulation, tags were standardized, the simulation was short, and documentation of treatment was not required. This likely reduced our observed effect size. However, the overall percentage of time saved is comparable to other studies that altered the visibility of tags; thus, it is likely that improving visibility of triage tags significantly improves the time required by extraction team personnel to identify patients in critical condition. Although participants were not informed of the differences between courses, the visible nature of the flags used in this study may have introduced bias related to participants knowing the experimental group. Additionally, there was no washout period between the first and second course. The 1 red-flag manikin that was most consistently missed by study participants is a potential study confounder and could have affected the times measured for the flags field. However, our subgroup analysis demonstrated that the time saved on the flags and tags field was not because of the red manikin being missed.

Our subgroup analysis showed a significant period effect, indicating there may have been learning effects that confounded results in the crossover. However, the subgroup analysis also showed no carryover effect and only a marginal sequence effect, suggesting the flags and tags field saved time independent of learning.

4 | DISCUSSION

During a mass casualty incident, accurate and rapid triage of patients is critical for facilitating rapid extrication, treatment, and transport to minimize fatalities.[3] Reducing the time spent by EMS personnel on inadvertent repeated triage of high-priority patients may give these patients a better chance at survival.[11] Efficient triage relies on simple algorithms that use visual signals to sort patients into various triage categories. Experience during MCIs suggests there are problems using triage tags in the field, and evidence supporting the use of triage tags is limited.[11] Simple changes to the tagging process that make the high-priority status of specific patients more visible may reduce the time required to identify and extract the high-priority patients. This study examined the impact of elevating the triage tag using colored flags. Our results suggest that this method of creating a vertical component to the triage status allows for more efficient visualization of the high-priority patients and may subsequently result in significantly less time for personnel to locate the higher priority patients compared to traditional flat triage tags.

Because of the relative simplicity of this trial, the time saved by utilizing colored utility flags to identify patient triage categories was small, only about 30 seconds. However, this represented about a 25% absolute reduction in average total time saved to identify all 10 red-triaged patients across all study participants. Participants were required only to identify these immediate priority patients with our study design and did not have to determine a triage color status as we had already prestaged the manikins with triage tags or tags and flags. Based on the increased visibility of the triage flags, we feel that the initial triaging process may also be reduced, as providers are more readily able to see which patients have already been assessed, thereby limiting the number of retriages. We did not evaluate this process in our study but would propose that this methodology be evaluated in future investigations. We also did not evaluate the time required to place flags during initial triage. This is an important consideration, and qualitatively we did not experience any obvious difficulty during our setup process. It was not specifically part of the investigative aim of this study; however, it is an excellent candidate for future evaluation.

Crossover designs typically have greater power than parallel designs because of the within-subject analysis utilizing each subject as his/her own control. Participation was optional for the first-year medical students recruited from a single medical school. The results could have been skewed had only part of the class participated; however, the entire first-year class participated aside from 1 student. Therefore, we feel it is unlikely that our results were skewed. The use of the radio to report manikin triage tag barcode numbers in our study resulted in 1 participant's data being excluded because of a radio malfunction; the 800 mHz radio lost connection to the radio tower and therefore would neither transmit nor receive voice messages. A new radio was brought to the study site within several minutes to allow for the next participant to begin their trial on the tags-only field. Reporting triage tag barcode numbers via the radio was incorporated into the study design in order to remove the time it would take to physically move a red-triaged manikin from the simulated scene to a casualty collection point and rather focus solely on the duration to identify all 10 high-priority manikins. Other studies have identified how new triage tools, like unmanned aerial vehicles, can assist in initial triage of an MCI.[16] Use of a more apparent triage marker like a flag may help when using unmanned aerial vehicles to allow for better scene awareness by the incident commander and more accurately and quickly count patients in each triage category.

Accuracy in terms of identifying high-priority patients correctly and not missing any patients affects patient outcomes. Vertical triage flags may allow the providers to better map out the layout of red-triaged patients within the field compared to traditional triage tags. As an extraction team is tasked with quickly removing injured patients from an MCI scene to a casualty collection point for ultimate transport to definitive care, it is important to reduce the number of times patients within the immediate MCI scene are re-evaluated for their triage classification color. This "double counting" wastes time. Vertical cues allow for more apparent identification of triage classification than do wrist triage tags, which require extraction team members to come in close proximity to each patient. If a methodical approach to clearing the MCI field is not taken, extraction team members may return to the same patients to re-evaluate their triage tag color multiple times, as suggested by our results, and thus increase the amount of time spent on the field extracting priority patients.

In our study, flags were associated with a 10% relative increase in red-triaged manikin identification accuracy, with 64% of participants in the flag group correctly identifying all priority manikins compared to 58% in the tags-only group. The absolute difference of this effect corresponded to $\approx$ 5 participants, or 6% more total participants correctly identifying red-triaged manikins in the flags group. However, this improved visibility may introduce at least 1 negative consequence into the triage process. More missed manikins were observed in the flags group. Flags may lead first responders to think that all patients in the MCI field have already been triaged, leading to a less comprehensive environmental survey and missed patients. In support of this idea, the manikin missed most frequently on the flags field was not readily visible owing to being on the slope side on a small hill at the edge of the field. The increased number of double counts in the tags group suggests that tags may lead to patients being "checked" more often to see if they had already been triaged, which wastes time in 1 respect but with a resultant benefit from increased identification of patients who may decompensate or improve over the course of the MCI. Typically, this later process of retriaging occurs within the casualty collection point (cold or warm zone) rather than in the midst of the immediate scene itself (hot zone). There were fewer manikins re-evaluated twice in the flags field, which we propose is because of better visibility of each manikin's triage category and the ability for the extraction team to visually map out the field from a distance. Because we did not have participants physically remove the red-triaged manikins from the fields, it is not known if this would decrease the number of manikins that were counted twice.

When the impact of inaccuracy is removed from our study results, participants who identified all 10 red manikins without misses or double counts were significantly faster on the flags and tags' field than the tags-only field ($P < 0.0001$). This finding, together with the reduced double counting of manikins within the flags and tags group, suggests that using visible triage flags is an effective means to reduce the time spent on identification for extraction from the scene to a casualty collection point by EMS providers and may improve efficiency in locating and transporting the more critical patients. This hypothesis is supported by the work of others that have shown increased visibility of triage tags improves extraction time. A study comparing time to complete triage with the use of different types of triage tags found differences of up to 3 minutes between different tags.[17] Another similar study found that adding glow sticks to triage tagged patients reduced the time to relocate and extract priority patients back to a casualty collection point by about 2.5 minutes, a 31% reduction.[12] Our results show that use of a vertical readily visible triage flag leads to a reduction of 25.80% in total time required to identify high priority patients. Our results were statistically significant but not clinically significant. We believe our investigation can serve as a model for future research projects that have the means to hold longer trials on larger fields and with more realistic features. Additionally, we believe that the use of flags during the initial triage process may decrease the number of retriages during initial patient triage and could therefore further reduce the overall time from the beginning of triage to the final extraction of the patient to a casualty collection point. However, further study would be needed to investigate this hypothesis.

In summary, using a vertical cue, such as a triage flag, that increases the visibility of a patient's triage status may decrease the time required for providers to identify high priority patients. This suggests that use of a portable, rapidly deployable, and visually apparent triage marker may enable faster identification of specific patients across a field of multiple victims of varying injury severity and can potentially improve patient outcomes in MCIs.

AUTHOR CONTRIBUTIONS

Abigail Wen-Yu. Cheng, Patrick McCreesh, Seth Moffatt, Ryan Marziarz, Duncan Vos, and Joshua Mastenbrook conceived the study and designed the trial. Abigail Wen-Yu. Cheng, Patrick McCreesh, Seth Moffatt, Ryan Marziarz, and Joshua Mastenbrook conducted and supervised data collection. Duncan Vos performed data and statistical analysis. Abigail Wen-Yu. Cheng, Patrick McCreesh, Seth Moffatt, Ryan Marziarz, Duncan Vos and Joshua Mastenbrook drafted and revised the article.

CONFLICTS OF INTEREST

The authors report no conflicts of interest, financial or otherwise.

ORCID

Abigail W. Cheng BS https://orcid.org/0000-0002-2315-8877

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AUTHOR BIOGRAPHY

Abigail W. Cheng holds a Bachelor of Medical Sciences degree from the University of Western Ontario, and is a current fourth-year medical student at Western Michigan University Homer Stryker M.D. School of Medicine.

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