Identifying Factors That May Influence Decision-Making Related to the Distribution of Patients During a Mass Casualty Incident

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ABSTRACT

Objective: We aimed to identify and seek agreement on factors that may influence decision-making related to the distribution of patients during a mass casualty incident.

Methods: A qualitative thematic analysis of a literature review identified 56 unique factors related to the distribution of patients in a mass casualty incident. A modified Delphi study was conducted and used purposive sampling to identify peer reviewers that had either (1) a peer-reviewed publication within the area of disaster management or (2) disaster management experience. In round one, peer reviewers ranked the 56 factors and identified an additional 8 factors that resulted in 64 factors being ranked during the two-round Delphi study. The criteria for agreement were defined as a median score greater than or equal to 7 (on a 9-point Likert scale) and a percentage distribution of 75% or greater of ratings being in the highest tertile.

Results: Fifty-four disaster management peer reviewers, with hospital and prehospital practice settings most represented, assessed a total of 64 factors, of which 29 factors (45%) met the criteria for agreement.

Conclusions: Agreement from this formative study suggests that certain factors are influential to decision-making related to the distribution of patients during a mass casualty incident. (*Disaster Med Public Health Preparedness*. 2018;12:101-108)

Key Words: mass casualty incidents, decision-support techniques, emergency preparedness

A mass casualty incident typically results in multiple casualties that often have complex injuries and place unique demands on health care systems.[1,2] Managing mass casualty incidents is a challenge due to the uncertain and dynamic nature of these events. Adding to this complexity, decision-makers must act in the face of uncertainty and make rapid decisions in real time.[3,4]

Research studies related to decision-making under uncertainty have been explored by multiple industries, primarily through theories of organization and cognition.[5] Klein[6] presents the naturalistic decision-making approach, which emphasizes the role of experience in complex decision-making in real-world settings. The naturalistic decision-making approach notes that experience enables people to rapidly categorize situations to make effective decisions. Klein found that within a military setting the naturalistic decision-making approach improves performance and supports the development of decision-support technological aids.[6] In addition, the naturalistic decision-making approach has improved training that is focused on decision requirements.[6]

Additional research studies that focus on decision-making in disasters present key findings from descriptive studies or apply decision-support frameworks to actual or simulated events.[7-11] Glick and Barbara[8] conducted structured interview surveys with US Federal Coordinating Officers to define decision-making processes and influential decision-making factors during the initial response period in a presidentially declared Stafford Act disaster. This study's results provided a decision-making process and presented influential factors such as previous knowledge and experience; degree at which the disaster situation is atypical (eg, hazard, severity); quality, amount, and speed of data; ability to integrate data into a mental framework; and urgency. This study purported to support future research on identifying influencing processes and factors to assist with decision-making in high-consequence disasters.[8]

Furthermore, advancements in operations research attempt to address resource allocation, triage, and prioritization of the distribution of patients during a mass casualty incident primarily through modeling.[12-23] Obtaining expert agreement on whether the model inputs were influential to decision-making in mass casualty incidents was not explored. As noted by Klein,[6] and applying the naturalistic decision-making approach, it is important to explore knowledge identified through experience by experts.

No research studies were found that sought agreement by peer reviewers on factors that may influence decision-making related to the distribution of patients during a mass casualty incident. The aim of this formative study was to identify and seek agreement on factors that may influence decision-making related to the distribution of patients during a mass casualty incident.

METHODS

A two-round modified Delphi study was conducted by using a purposive sample of disaster management peer reviewers. A modified Delphi study is a research technique that aims to seek agreement on specific factors among a group of experts and can be conducted through a consecutive series of questionnaires.[24] In this formative study, expertise was defined by participants having either (1) a peer-reviewed publication within the area of disaster management or (2) disaster management experience. This formative study was designed to target a broad audience of disaster management professionals and was not designed to be internationally representative. A broad audience was targeted to generate a robust set of factors and foster increased participation in this formative study, as there is no universally agreed upon criteria for the selection and number of peer reviewers required for a Delphi study.[25]

To identify possible factors, a literature review was conducted by using the UC Irvine Libraries from the University of California. The search term "mass casualty incident" with no date limit and the "Libraries Worldwide" selection was used and yielded 2955 resources (ie, videos, e-books, books, and articles). Within these results, the search term "distribution of patients during a mass casualty" returned 85 resources. Criteria for selection of relevant resources included resources that identified factors relating to the distribution of patients during a mass casualty incident. Upon review, 40 resources were selected.[1-4,19,26-60] In addition, gray literature such as government technical and working group reports were also incorporated.[61-72]

From the selected 40 resources, these resources generated a total of 996 factors that when themed resulted in 56 unique factors related to the distribution of patients in a mass casualty incident. Qualitative thematic analysis was used to theme the 56 unique identified factors and these factors served as the foundation questions for the round one questionnaire.[73]

Using purposive sampling, round one began with an invitation sent via e-mail to 40 disaster management professionals who were thought to meet the criteria of participation asking them to participate in two online questionnaires within a 30-day period and to forward the research request to other appropriate colleagues. To complete the round one questionnaire, peer reviewers were asked to rate how much influence, using a 9-point Likert scale, each of the 56 identified factors would have on their decision-making related to the distribution of patients during a mass casualty incident. The peer reviewers were also asked to identify any additional factors of influence that were not included in the round one questionnaire. The online questionnaire tool Survey Monkey[74] was used to collect the data.

Once questionnaire results were collected, the degree of agreement was determined for each factor. The criteria for agreement were defined as a median score greater than or equal to 7 (on a 9-point Likert scale), and a percentage distribution of 75% or greater of ratings being in the highest tertile (ie, 7-9).[25,75-77] The criteria were not shared with peer reviewers to reduce the possibility of the "anchoring effect."[78]

Factors that met the criteria for agreement from the round one questionnaire were considered accepted and removed from the round two questionnaire. The round two questionnaire included those factors that did not meet the defined criteria for agreement from the round one questionnaire plus any newly identified factors from the round one questionnaire. The newly identified factors identified by peer reviewers in round one were included in round two if they were new themes from the factors identified in round one. For the round two questionnaire, peer reviewers were provided with information that included their individual response from the round one questionnaire and the group level dispersion (ie, first, second, and third quartile). The peer reviewers were asked to reconsider their original response in light of the group response, rating again how much influence each factor would have on their decision-making related to the distribution of patients during a mass casualty incident.

Microsoft Excel 2011 version number 14.3.6 (Microsoft Corporation) was used to analyze and manipulate the data. Research Ethics Board review was obtained from Sunnybrook Health Sciences Center, an academic, university-affiliated hospital in Toronto, Canada.

RESULTS

Forty invitations were sent requesting participation in this formative study, from which 17 peer reviewers completed the round one questionnaire. An additional 45 peer reviewers were identified through referral. In total, 62 peer reviewers completed the round one questionnaire, and 54 (87%) of them also completed the round two questionnaire. Of the 54 peer reviewers who responded to both questionnaires, 13 countries were represented with the largest group being 35 peer reviewers (65%) from Canada (Supplemental Table 1 in

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TABLE 1

Round One Questionnaire Factor Agreement (n = 62)[a]

Factor Description	Percentage Agreement, %	Median (Q1, Q3)
Number of estimated and actual casualties	95.2	9 (7, 9)
Availability of transportation vehicles (ie, ambulance, helicopter, bus, military, police, private vehicles with medical authorization, nonmedical vehicles)	91.9	8 (7, 9)
Injury characteristics (ie, number, type, severity)	87.1	8 (7, 9)
Standard procedures for mass casualty incidents	85.5	8 (7, 9)
Special considerations (ie, burn, ophthalmologic, neurology, pediatric, orthopedics, CBRN, geriatric, obstetrical, surgical, bleeding disorders)	85.5	8 (7, 9)
Standard procedures for the overall command structure (ie, Incident Management System, roles and responsibilities)	83.9	8 (7, 9)
Human resource availability (ie, number, skills, quality, access)	83.9	8 (7, 9)
Standard procedures for CBRN	82.3	8 (7, 8)
Present and potential scene hazards (ie, fire, electricity, gas leaks, violent persons/gunfire, CBRN, damaged structures, booby traps, potentially dangerous animals)	82.3	8 (7, 9)
Hospital characteristics (ie, number, size, type, capacity, ownership, preparedness, experience)	82.3	8 (7, 9)
Facilities planning (ie, size, quality, scalability, type)	80.6	8 (7, 9)
Skill of responders (ie, knowledge and comfort of clinical, ethical, standard procedures)	80.6	8 (7, 9)
Patient flow (ie, quantity, type, severity, time)	80.6	7.5 (7, 8.25)
Identification and analysis of potential hazards and risks	79.0	8 (7, 9)
Roadway conditions (ie, number of access points, traffic, construction/barriers, damage to roads)	79.0	8 (7, 8.25)
Location of hospital (ie, proximity/distance to other hospitals)	77.4	8 (7, 9)
Central monitoring of system capacity (ie, occupancy/utilization rates)	75.8	8 (6.75, 9)
Prehospital and hospital integration (ie, interoperability)	75.8	8 (6.75, 9)

[a]Abbreviations: CBRN, chemical, biological, radiological-nuclear; Q, quartile.

the **online data supplement**). The 2 most represented practice settings were hospital (39%) and prehospital (31%) settings (Supplemental Table 2 in the **online data supplement**). Twenty peer reviewers (37%) had greater than 15 years of disaster management experience. Twenty-five (46%) had attended 5 or more mass casualty incidents, and 47 (87%) had attended at least one mass casualty incident (Supplemental Table 3 in the **online data supplement**).

Eighteen of the 56 factors (32%) that were identified through the literature review met the criteria for agreement in the round one questionnaire (Table 1). The participating peer reviewers identified an additional 8 factors to be included in the round two questionnaire. A total of 46 factors were therefore presented in the round two questionnaire, and 11 (24%) of these factors met the criteria for agreement (Table 2). The remaining 35 factors from the round two questionnaire did not meet the criteria for agreement (Table 3).

DISCUSSION

It was defined *a priori* that agreement was considered to be met if the median was a rating of 7 or greater and if the total distribution of the responses was greater than 75% in the highest tertile (ie, 7-9). Of the 64 factors identified in this modified Delphi study, 29 factors (45%) met the criteria for agreement upon completion of the round two questionnaire. Overall, the degree of agreement may suggest that certain factors are influential to decision-making related to the distribution of patients in a mass casualty incident.

Factors That Met the Criteria for Agreement

Of the 29 accepted factors, 12 (41%) were related to incident details and 5 (17%) were related to resources. This verifies that incident details and availability of resources are influential to decision-making related to the distribution of patients during a mass casualty incident. To assist with assessing incident need, a checklist of the accepted factors related to incident details and resources could serve as a tool or job aid for error management and performance improvement for mass casualty incidents (ie, a tool to prompt performance and safety measures).[79]

Furthermore, of the 29 agreed upon factors, 12 (41%) were related to systems such as incident management, communication, continuity of operations, policies, and procedures.[19,43,60] This suggests that these system factors are susceptible to influence through proactive system planning, testing, and risk identification (ie, developing standard procedures for mass casualty incidents). The high degree of agreement related to system factors is important as it suggests an opportunity to decrease variability within the response and management of mass casualty incidents. Agreement on the factor *identification and analysis of potential hazards and risks* further illustrates the importance of proactive identification and mitigation of risk prior to actual incidents.

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TABLE 2

Round Two Questionnaire Factor Agreement (n = 54)[a]

Factor Description	Percentage Agreement, %	Median (Q1, Q3)
Anticipation of bottlenecks within casualty flow (disruption of current departments in hospital at time of incident)	81.5	8 (7, 9)
Ability to gather, analyze, and disseminate intelligence in real time	81.5	8 (7, 9)
Teamwork and attitude	79.6	8 (7, 9)
Incident focus (ie, single- vs multi-focus disaster)	79.6	8 (7, 9)
Standard form of communication for responders and receivers	79.6	8 (7, 8)
Human resource planning (ie, numbers, skill set, resilience)	77.8	7 (7, 8)
Speed and quality of response of prehospital responders	77.8	8 (7, 9)
Control of arrival of resources (ie, human resources and other resources)	77.8	7 (7, 8)
Responder safety (ie, fatigue, traffic hazards, crowding, use of personal protective equipment)	75.9	8 (6.75, 9)
Incident duration (ie, finite vs ongoing)	75.9	8 (6.75, 9)
Arrival rate at hospital and processing times	75.9	7 (6.75, 8)

[a]Abbreviation: Q, quartile.

Factors That Did Not Meet the Criteria for Agreement

Although agreement was not met on a total of 35 factors, it is valuable to analyze where there was potential for agreement and more importantly where there was difference within the responses.

The least amount of agreement of the 35 factors that did not reach agreement was found on the following factors: *associated costs of response*, *forensics*, *patient characteristics*, and *coordination of resources by a single national authority*. The finding that the factor *coordination of resources by a single national authority* was not influential is in contrast to the *Israeli surge capacity essential tasks* that seeks coordination of resources nationally.[1] An explanation for this finding may be the large proportion of Canadians within the sample of peer reviewers (65%) and the challenges to nationally centralize resources due to the geographical boundaries (ie, land size) and political structure in this country. It is important to note that cost was not determined to be an influential factor nor was forensics, which may suggest that potential lives saved are perceived to be more valuable than fiscal restraint and preservation of evidence.

Conducting a subanalysis of only those peer reviewers that identified their practice setting as hospital (n = 21) and prehospital (n = 17) for the 35 factors that did not reach agreement illustrated that agreement would have been met for 5 factors within the hospital setting and 13 factors within the prehospital setting (Table 4). From the abovementioned subanalysis, the following factors would have met the criteria for agreement for both the hospital and prehospital settings: *inventory control and supply chain planning*, *incident characteristics*, *level of incident isolation*, and *standard procedures for knowledge translation*. These factors are operational in nature and focus on response incident details and preparedness. This suggests that incident details (ie, incident characteristics such as event type, scope, scale) may influence the decision-making related to the distribution of patients in a mass casualty incident, particularly for first responders (ie, prehospital) and first receivers (ie, hospital). Specifically, "type of disaster" is noted as a prominent factor in first responder acronyms (ie, METHANE, CHALETS, and HANE)[4] and in the literature.[3,26,35,48,53,71] Furthermore, the factor *standard procedures for knowledge translation* (ie, education, technical training, exercises) is consistent with the World Health Organization's Hospital Emergency Response Checklist and knowledge translation is further noted in the literature as a prominent factor.[2,4,40,49,55,57,67,71]

Limitations

The modified Delphi approach has limitations that should be taken into consideration. One limitation of the modified Delphi approach is the subjectivity in the definition of "expert" as defined as a peer reviewer.[24,67] In this study, the definition of a peer reviewer was designed to target a broad audience of disaster management professionals in order to generate a robust set of factors and foster increased participation. To mitigate excessive diversity among peer reviewers, recruitment was purposive and original invitations to participate in this formative study were sent out to disaster management professionals who were thought to have met the criteria for participation and by peer reviewer referral. This purposive sampling approach may serve as a limitation of this study as peer reviewers are from similar networks and was not designed to be internationally representative. Another potential limitation of the modified Delphi approach is subjectivity in the definition of the criteria for agreement.[24] In order to minimize this limitation, the criteria for agreement incorporated both percentage distribution (ie, 75% or greater of ratings being in the highest tertile) as well as median score (ie, median greater than or equal to 7), as opposed to other Delphi studies that only measure percentage distribution.[76]

Additional limitations of the modified Delphi approach include that it does not allow peer reviewers to expand on

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TABLE 3

Factors That Did Not Meet Agreement After the Round Two Questionnaire (n = 54)[a]

Factor Description	Percentage Agreement, %	Median (Q1, Q3)
Incident characteristics (ie, event type, scale, scope)	74.1	8 (6, 9)
Level of incident isolation (ie, rural, urban, indoor, outdoor)	74.1	8 (6, 8.25)
Early establishment and clarity of command and control structure (ie, incident management system)	74.1	8 (6, 9)
Environmental conditions (ie, weather)	72.2	7 (6, 8)
Incident access/egress routes	72.2	8 (6, 8.25)
Availability of reliable and sustainable internal and external communications systems (ie, satellite phones, mobile devices, landlines, internet connections, pagers, two-way radios, unlisted numbers)	72.2	8 (6, 9)
Responder knowledge and skill to match equipment (ie, know how to properly don PPE)	72.2	8 (6, 9)
Inventory control and supply chain planning (ie, type, volume, placement, maintenance, usability, quality)	70.4	7 (6, 8)
Establishment of a central emergency operations center to coordinate communications and resource distribution with the scene command post	70.4	8 (6, 9)
Availability of non-transport-related equipment (ie, type, quantity)	68.5	7 (6, 8)
Standard procedures for knowledge translation (ie, education, technical training, exercises)	68.5	7.5 (6, 8)
Patient/casualty safety (ie, language barrier, standards of care, infection control, proper technique)	68.5	7 (6, 8)
Density of population in incident area	68.5	7 (6, 8.25)
Loading of casualties for transport (ie, assignment of ambulance parking point officer, ambulance loading point officer, helicopter landing pad/fixed wing aircraft landing spot)	68.5	7 (6, 8)
Standard policy for medical and legal standards of care (ie, scope of practice, mutual aid agreements, licensing and credentialing)	66.7	7 (6, 8.25)
Security at the scene	64.8	7 (6, 8.25)
Availability of situational awareness and decision support tools (ie, information management, resource tracking, syndromics)	64.8	7 (6, 8)
Interaction and coordination with the public health system	64.8	7 (6, 8)
Availability and quality (resources, scale and infrastructure) of an Advanced Medical Post	63.0	7 (6, 8)
Standard procedures for continuity of operations during disasters (ie, non-disaster-related emergencies)	61.1	7 (5, 7.25)
Incident timing (ie, time of day and day of the week)	59.3	7 (5, 8)
Early public communication providing notification of the event and messaging to the broader community	57.4	7 (5, 8)
Design of incident site (ie, evacuation vs sheltering, area setup and zones)	55.6	7 (6, 8)
A national emergency response framework that identifies activation criteria, clinical algorithms, situational awareness, and decision support tools	53.7	7 (5, 7)
Design of the triage system	51.9	7 (5, 8)
Reliable mode of transfer of accountability (ie, documentation, patient handover)	51.9	7 (5, 8)
Role and management of volunteers	51.9	7 (5, 8)
Availability and access to antidotes	50.0	6.5 (5, 8)
Standard procedures for family reunification	50.0	6.5 (5, 7.25)
Identification of qualifications on scene (ie, identification vests)	40.7	6 (4.75, 7.25)
Availability and management of blood supply	37.0	6 (5, 7)
Coordination of resources by a single national authority	31.5	5 (3, 7)
Patient characteristics (ie, age, sex, culture, language, allergies, medication, past illness)	31.5	6 (5, 7)
Forensics (ie, preservation of the scene)	7.4	5 (4, 5)
Associated costs of response (ie, cost of staff, stuff, structure)	3.7	3 (2, 5)

[a]Abbreviations: PPE, personal protective equipment; Q, quartile.

their view as they would in a face-to-face setting. However, this may also be considered a strength in this study, as it may help to mitigate the "bandwagon" effect.[24] Also, merely because a factor met the criteria for agreement in this study does not mean that wide consensus exists or that it is the correct answer.[24] In terms of generalizability, the results should be interpreted with caution owing to the large proportion of Canadian respondents (65%) and the fact that this formative study was not designed to be internationally representative. Finally, due to the complex and uncertain nature of mass casualty incidents, it is not known how well the identified influential factors in this study would perform in the field, nor whether participating peer reviewers would respond differently in a true mass casualty incident than they indicated through their responses in this study.

Future Research

A suggestion for future research may be to develop decision-support tools (eg, job aids) to assist decision-making for first responders and receivers in assisting with the distribution of patients during a mass casualty incident. These tools could be created by using the factors that achieved the highest levels of agreement as found in this formative study. Furthermore,

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TABLE 4

Subanalysis of the 35 Factors That Did Not Reach Agreement for Only Those Experts That Identified Their Clinical Setting as Hospital (n = 21) and Prehospital (n = 17)[a]

Setting	Factor Description	Percentage Agreement, %	Median (Q1, Q3)
Hospital	Incident characteristics (ie, event type, scale, scope)	85.7	8 (8, 9)
Hospital	Level of incident isolation (ie, rural, urban, indoor, outdoor)	85.7	8 (8, 9)
Hospital	Environmental conditions (ie, weather)	81.0	8 (7, 8)
Hospital	Standard procedures for knowledge translation (ie, education, technical training, exercises)	76.2	8 (6.5, 8)
Hospital	Inventory control and supply chain planning (ie, type, volume, placement, maintenance, usability, quality)	76.2	7 (6.5, 8.5)
Prehospital	Incident access/egress routes	88.2	8 (8, 9)
Prehospital	Early establishment and clarity of command and control structure (ie, incident management system)	88.2	8 (8, 9)
Prehospital	Standard procedures for knowledge translation (ie, education, technical training, exercises)	82.4	8 (7, 8.5)
Prehospital	Inventory control and supply chain planning (ie, type, volume, placement, maintenance, usability, quality)	82.4	7 (7, 8)
Prehospital	Availability of non-transport-related equipment (ie, type, quantity)	82.4	7 (7, 8)
Prehospital	Patient/casualty safety (ie, language barrier, standards of care, infection control, proper technique)	82.4	8 (7, 8)
Prehospital	Establishment of a central emergency operations center to coordinate communications and resource distribution with the scene command post	82.4	8 (7, 9)
Prehospital	Availability of reliable and sustainable internal and external communications systems (ie, satellite phones, mobile devices, landlines, internet connections, pagers, two-way radios, unlisted numbers)	82.4	8 (7, 9)
Prehospital	Incident characteristics (ie, event type, scale, scope)	76.5	8 (6.5, 9)
Prehospital	Level of incident isolation (ie, rural, urban, indoor, outdoor)	76.5	8 (6.5, 8.5)
Prehospital	Density of population in incident area	76.5	7 (6, 8)
Prehospital	Loading of casualties for transport (ie, assignment of ambulance parking point officer, ambulance loading point officer, helicopter landing pad/fixed wing aircraft landing spot)	76.5	7 (6.5, 8)
Prehospital	Interaction and coordination with the public health system	76.5	7 (6.5, 8)

[a]Abbreviation: Q, quartile.

computational modeling using the factors that achieved agreement in this study may assist planners and policy-makers in determining and testing distribution options for patients during a mass casualty incident.

CONCLUSIONS

Fifty-four disaster management peer reviewers assessed factors that may influence decision-making related to the distribution of patients during a mass casualty incident. More than 86% of the peer reviewers agreed that the number of estimated and actual casualties was influential to decision-making, as were the availability of transportation, understanding injury characteristics, and whether the patient had any special considerations such as burn, ophthalmologic, neurology, pediatric, etc, and that reducing risk through proactive system planning is influential, through the creation of standard procedures for mass casualty situations. Overall, the degree of agreement suggests that certain factors are influential to decision-making related to the distribution of casualties in a mass casualty incident. Practically, the factors that achieved the highest levels of agreement as identified in this formative study could be used to create decision-support tools (ie, job aids) to assist with connecting and protecting first responders and receivers. These tools, guided by the accepted factors, may assist with developing principles for distribution of patients and may assist planners and policy-makers with standardizing response processes and plans. Furthermore, the additional factors that did not reach agreement may serve as a mechanism for discussion and further assist with planning and education. The agreed upon factors may decrease variability within the response and management of mass casualty incidents.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/dmp.2017.43

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