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RESEARCH **Open Access**

Dispatch center performance and crisis resource management skills in mass casualty incidents: a prehospital simulation study preparing for 2026 Milan-Cortina Olympics

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Abstract

Background In Lombardy (Italy), Emergency Medical Dispatch Centers (EMDCs) play a crucial role in Mass Casualty Incidents (MCIs). These events put the staff under strain because, in addition to the usual burden of emergency calls, there is also the need to handle the inflow of information and coordinate the incident response. Crisis Resource Management (CRM) skills may strongly influence performance during complex situations. This study evaluates the performance of the Milan EMDC during a series of simulated MCIs and its correlation with staff CRM skills.

Methods Twelve high-fidelity simulations were conducted over 19 months. A set of published Key Performance Indicators (KPIs) was measured as follows: 2 points (correct and timely action), 1 point (correct but delayed action), and 0 points (action not performed or incorrect). The score was then proportioned to the total obtainable and converted into a percentage for comparison. The Ottawa CRM Global Rating Scale (1- to 7-point scoring) was used by two independent raters to evaluate CRM skills.

Results The average KPI score across scenarios was 72.9% (45.8%–95.8%, SD 15.6). The Ottawa scale averaged 73.8% (41.7%–100%, SD 19.0), with an interrater agreement of 88.9% ($\kappa = 0.66$). A strong correlation between KPI and Ottawa CRM scores was found (Pearson correlation coefficient = 0.78).

Conclusions Our findings showed a strong correlation between the performance of the Milan EMDC during simulated MCIs and staff CRM skills.

Keywords Mass casualty incidents, Simulations, Emergency medical dispatch centers, Key performance indicators, Crisis resource management, Ottawa global rating scale

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Introduction

Mass Casualty Incidents (MCIs) generate a disproportion between casualties [1] and resources [2, 3]. These events are unpredictable and represent highly demanding situations for local Emergency Medical Systems (EMS) [4, 5]. To ensure a correct response, Standard Operating Procedures (SOPs) need to be in place [1, 6]. However, in high-income countries, MCIs are infrequent [6], thus impeding staff from familiarizing themselves with local MCI plans. For instance, from September to November 2024, there were 107,072 emergency missions carried out in the city of Milan, but only 4 (less than 0.0037‰) were classified as MCIs.

Given their rarity, simulation exercises are the only way to regularly expose staff to these events in a safe and controlled setting [1, 6–12], apply SOPs, and engage participants at intellectual, methodological, and emotional levels. In Lombardy, the Agenzia Regionale Emergenza Urgenza is in charge of prehospital emergency medical response. The Milan Emergency Medical Dispatch Center (EMDC) is one of the four dispatch centers in the region and is staffed with one physician and a pool of five nurses and nine emergency medical technicians (EMTs) 24/7, 365 days a year (Fig. 1).

Technicians process emergency calls and dispatch Basic Life Support (BLS) ambulances and Advanced Life Support (ALS) teams in fast cars according to an algorithm-based triage system. Dispatch decisions can also be based on the additional assessment of a specialized nurse over the phone. Upon arrival, medical teams provide a report from the scene, which is collected by the nurses at the EMDC under the supervision of the physician on duty; accordingly, decisions on patients' destinations and the activation of additional resources follow, for example, the dispatch of an expert team for MCI management, a stock-lot truck with extra medical equipment, buses for minor-code hospitalization, Urban Search and Rescue, or Chemical, Biological, Radiological, and Nuclear defense (CBRN) teams [13]. Whenever the physician at the EMDC declares an MCI, a rapid reorganization follows, with on-call personnel being activated, if needed, to support ordinary activities. Lombardy adopts a three-step procedure—alarm, emergency, and incident—for emergency management. Based on the general definition of an MCI as an extraordinary event that inherently produces a disproportion between the rescue resources available to the EMDC and the actual operational needs, specific criteria were established to adapt

Fig. 1 Planimetry of Milan EMDC (Emergency Medical Dispatch Center). Positions number: 1–10: EMT (emergency Medical Technician) receiving calls for emergency services (receiver); 11–16: BLS (Basic Life Support) dispatch; 17–22: nurses receiving reports from on-scene teams; 23: nurse evaluator; 24: EMS (Emergency Medical System) coordinator; 25: ALS (Advance Life Support) dispatch; 26: MCIs (Mass Casualty Incidents) dedicated position; 27: physician; 28: nurse coordinator; 29–30: reserve positions

this concept to the local context. Accordingly, an MCI is declared when an incident requires the EMDC to activate exceptional resources and/or procedures due to logistical constraints, the number or severity of casualties, or the need for specialized treatment prior to hospital admission (e.g. CBRN events). MCIs are further classified as white, green, yellow, or red, according to the number of victims and the severity of injuries. Unlike ALS physicians, EMDC physicians have direct and rapid access to on-site sources of information (e.g., emergency calls from bystanders, institutional reports, surveillance cameras), real-time resource availability, and detailed action cards derived from SOPs. Moreover, they serve as the officially designated representatives of the EMDC. Consequently, they are the only actors holding both the authority and the comprehensive situational awareness required to declare an MCI.

Thus, EMDCs are responsible for the execution of the plan, activation of both mobile and static resources, and ensuring patient tracking, transport, and destination. Notably, to do the most for the greatest number, part of these actions must be undertaken at an early stage of the event, when little or fragmented information is yet available, considering that EMDCs will still have to account for ordinary emergencies.

In complex situations, Crisis Resource Management (CRM) skills, also known as non-technical skills, have been shown to play a key role. First described in the military [14, 15], the literature has outlined their importance in medical emergencies as a main cause of human errors [16].

With the 2026 Winter Olympics approaching in Milan–Cortina, a structured preparedness plan for the increased risk of Mass Casualty Incidents becomes paramount. All personnel working on ALS units attend an 8-hour MCI field management course. However, no further specific training for offsite management is provided to EMDC staff, apart from publication and discussion of SOPs. Moreover, no CRM skills training is provided. The aim of this study was to measure the performance of the Milan EMDC during MCI high-fidelity simulations and examine its correlation with CRM skills, thus providing useful feedback for improving staff training.

Methods

Simulation design

The exercises were designed by the Milan EMDC MCI management team following the approach of the Homeland Security Exercise and Evaluation Program [17]. According to this, simulations can be divided into discussion-based and operation-based exercises. Discussion-based exercises (tabletop, workshops, etc.) are mainly used to practice response roles via group discussion and verbal description of actions in the presence of a facilitator [18]. Conversely, operation-based exercises (drills and full-scale exercises) simulate real event representations where actions are taken in real-time [19]. Since the local SOP for MCI management was revised in 2022, a set of operation-based exercises was designed to validate the plan and measure the performance of the EMDC [12]. The exercises were scheduled taking into account the rotating roster organization of EMDC personnel. The rationale was to expose the highest number of individuals to at least one simulation exercise.

Simulation scenarios and tools

All scenarios were based on a specific risk analysis for the city of Milan. In brief, the simulated events were: (1) building collapse; (2) multi-site terrorist attack; (3) highway bridge collapse; (4) subway incident; (5) riot in an Identification and Expulsion center; (6) multi-car highway incident; (7) liquified petroleum gas (LPG) explosion in a factory; (8) explosion and phenol release in a factory (CBRN event); (9) train derailment; (10) explosion and ammonia release in a factory (CBRN event); 11) explosion and tetrahydrofuran release in a factory (CBRN event); 12) heavy-duty vehicles highway crash. The event storyboards contained a detailed description of timelines, as well as the timing and content of incoming calls, expected actions, and injects. Additional materials are available as supplemental material accompanying the online article [Additional File 1]. A simulation cell external to the EMDC was constituted. There, three instructors were in charge of phone and radio interaction with the EMDC and provided injects as appropriate. A fourth instructor managed the digital mission sheets of the mobile resources dispatched, for example, entering arrival and departure times according to actual distances and real-time road traffic. An exact copy of all the activable mobile (ambulances and personnel) and static (hospitals) resources, as well as the digital phone book, was created in the actual Emergency Management software (Emma, version 6.14.1, 2022) used for the regular management of EMDC missions. All resources and phone numbers were named as they would appear in the real interface, e.g., Ambulance_BLS_33, Local Police Station_ Milan District 3.

All outgoing calls from the EMDC converged into three phone numbers managed by the instructors in the simulation cell. These played the role of either bystanders asking for help, BLS and ALS crews, support personnel (e.g. fire rescuers, police), or hospital staff. All simulation exercises started with a call from the instructors to the technicians processing emergency calls, as if it were a standard emergency call. The exercises took place concomitantly with the regular activities of the EMDC, with no additional personnel other than those on-call envisaged by the local plan.

Simulation implementation

Prior to the 12 simulations included in the analysis, a trial with three extra simulations was carried out. These were announced by e-mail one week in advance, during which the exercise rules were also explained. On the day of the simulations, a pre-simulation briefing was offered, and further clarifications were provided as appropriate. The evaluation plan was also explained. These three exercises offered the staff the opportunity to familiarize themselves with the simulation environment and dedicated tools. Upon conclusion of every simulation, a debriefing was held to collect observations and comments on unclear steps; this permitted refinement of the local SOP before data collection started.

Exercise evaluation

Three evaluators and one facilitator were present at the EMDC during the exercises. The EMDC performance assessment was conducted using a published set of key performance indicators (KPIs) [20–25] [Table 1].

The scoring system functioned as follows: 2 points for correct decisions (objective completely achieved within the required timeframe), 1 point for partly correct decisions (objective achieved but with delay), and 0 points for incorrect or unmade decisions (objective unachieved). The total score ranged from 0 to 24, with 24 representing the best performance and 0 the worst. All results were recorded on a dedicated spreadsheet by a single evaluator.

The CRM skills were independently assessed by two evaluators through the Ottawa Crisis Resource Management Global Rating Scale (hereinafter Ottawa GRS) [26–28] [Additional File 2] and recorded on a dedicated spreadsheet immediately after the end of the exercise to reduce external influence. This scale consists of six domains: general performance, leadership, problem solving, communication, situational awareness, and resource utilization. Each domain scores a minimum of 1 and a maximum of 7, with a total achievable score of 42 points. Underneath the numeric scale, cues are provided to guide raters during score assignment.

Upon conclusion of each exercise, a debriefing session was offered.

Table 1 Key performance indicators used to evaluate the emergency medical dispatch center during the simulations, with respective time reference

KPI	Measurable performance indicator	Time from alert (min)
1	Declaring major incident	1
2	Declaring level of preparedness for strategic management	3
3	Decision on additional resources to be sent to the scene	3
4	Deciding which hospitals should receive patients from incident	5
5	Establishing contact with incident officers on the scene	5
6	Deciding on guidelines for referring patients to hospitals	10
7	Notify the above guidelines on referring hospitals	30
8	Formulate general guidelines in accordance with guidelines from scene for the medical response	15
9	Ensure that there is information for definitive referral guidelines	20
10	Evaluated if capacity of own organization is sufficient	30
11	First information to media	15
12	Time point at which the dispatch center deactivated MCI plan	/

Statistics

Data were preliminarily processed in Microsoft Excel® (Microsoft Corporation, Redmond, WA, USA). The analysis was subsequently replicated and validated using Stata 14MP® for Mac (StataCorp LLC, USA). Continuous data were expressed as mean ± standard deviation or as median (interquartile range), as appropriate. Normality was assessed via the Kruskal–Wallis test. Bland-Altman's test was used to evaluate the inter-rater concordance between two raters. Cohen's kappa test was used to calculate inter-rater variability between the two Ottawa GRS raters. A linear regression and correlation coefficient were calculated to assess the strength of association between KPIs and CRM skills scores, respectively. A p-value ≤ 0.05 was considered statistically significant.

Ethical clearance

Given the nature of the study (only aggregated data were collected, with no individual, personal, or sensitive information), this study was deemed exempt from institutional review board approval.

Results

From October 2023 to April 2025, a total of twelve high-fidelity drills were carried out, all unannounced. A total of 63 operators were involved: 41 (65.08%) were present only once, 17 (29,98%) were present twice, and 5 (7.94%) were present three times. Table 2 summarizes the type of scenario, number of casualties, and type and number of resources activated. Tables 3 and 4 show, respectively, the KPIs measured and the results of the CRM skills evaluation.

On average, KPIs scored 17.5 ± 3.75 points (72.9% ± 15.6%). The simulations that scored the highest and lowest were, respectively, the CBRN event with phenol release and the subway incident (23 points, 95.8% each), and the CBRN event with ammonia release (11 points, 45.8%). Out of the 144 actions assessed (12 KPIs per simulation), 23 received 0 points (16.0%), 32 received 1 point (22.2%), and 89 received 2 points (61.8%). Each KPI received, on average, 1.46 points. The items that

Table 2 Description of the MCIs simulations. Acronyms: S: simulation; HEMS: helicopter emergency medical services; USAR: urban search and rescue; BLS: basic life support; ALS: advance life support. Simulations: see main text for the description of events

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	Average
Duration (min)	59	55	56	54	46	70	53	62	NA	43	55	76	57
HEMS	//	//	1	//	1	2	1	1	//	1	//	1	0,7
Expert team	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	12 / 12
Stock Lot van	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No	No	6 / 12
USAR team	No	No	Yes	No	No	No	No	No	No	No	No	No	1 / 12
Total BLS units	7	9	9	7	8	6	7	7	6	9	11	16	8,5
Total ALS units	4	5	5	3	4	2	2	3	3	3	5	4	3,6
Total units	12	16	18	11	15	12	11	13	10	15	17	22	14,3
Total casualties	29	18	49	19	40	10	11	9	12	10	7	36	20,8
Units to victims ratio	0,4	0,8	0,4	0,5	0,4	1,2	1	1,4	0,8	1,5	2,4	0,6	0,9
Hospitals alerted	6	5	11	12	5	6	6	5	NA	4	5	7	6,5

most commonly received the lowest scores were media engagement (KPI 11) and patient tracking from the scene to destination (KPI 9) (average 0.9). Declaration of the end of the MCI (KPI 12), hospital early alert (KPI 7), and assessment of the organization's own capacity (KPI 10) scored the highest (1.8 points).

Likewise, the mean Ottawa GRS was 31 ± 7.99 points (73.8% ± 19.0%). The simulation with the highest score (42 points) was the subway incident, while the one with the lowest (17.5 points) was the multisite terrorist attack. Out of the 144 evaluations (6 Ottawa GRS domains per simulation, 2 evaluators), no item received 1 point, 4 received 2 points (2.78%), 22 received 3 points (15.3%), 22 received 4 points (15.3%), 27 received 5 points (18.7%), 36 received 6 points (25.0%), and 33 received 7 points (22.9%). The Ottawa GRS domains that received the lowest scores were, on average, communication skills (4.7/7 points) and leadership (4.9/7 points). Resource utilization and general performance received an average of 5/7 points each. The domains that received the highest scores were problem-solving (5.5/7) and situational awareness (5.7/7). Overall, the average score given to the six domains by the two evaluators was 5.17.

Cohen's kappa was 0.66 (agreement of 88.9% vs. 67% expected) [Figure 2].

The correlation coefficient between KPIs and Ottawa GRS was + 0.78 [Figs. 3 and 4].

Discussion

There is a pressing need to evaluate medical MCI response using a common terminology and standardized data collection tools. This study appears to be the first assessing the performance of an EMDC through the measurement of published KPIs in a series of simulated MCIs and how they were influenced by the CRM skills displayed by the staff.

Overall, the performance of the Milan EMDC was good compared to that reported in the literature [20, 22, 23]. However, some important issues arose, in particular related to patient tracking from the scene to hospitals. This problem was present in nearly all simulations, highlighting the need to further emphasize the importance of patient identification (with demographic data or, in its absence, with bracelet numbers) before transportation. Likewise, media management proved suboptimal. In MCI events, media engagement is expected even at the earliest phase of disaster response. Therefore, the agency communication officer must be properly informed of the MCI declaration as well as periodically updated on how the situation unfolds. This shortcoming was also addressed during debriefing sessions.

Some encouraging results included the timely declaration of MCI and rapid assessment of the local actual response capacity, which varied depending on the

Table 3 KPI results for the 12 MCI simulations. Acronyms: S: simulations; AVG: average; SD: standard deviation; KPI: key performance Indicators. Simulations: 1: Building collapse; 2: multi-site terrorist attack; 3: highway Bridge collapse; 4: subway incident; 5: riot in identification and expulsion center; 6: multi-car highway incident; 7: LPG explosion in factory; 8: explosion and phenol release in factory (CBRN event); 9: train derailment; 10: explosion and ammonia release in factory (CBRN event); 11: explosion and tetrahydrofuran release in factory (CBRN event); 12: heavy-duty vehicles highway crash

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	AVG	SD
Total KPI	20	15	17	23	20	14	16	23	17	11	14	20	17,5	3,75
KPI %	83,3	62,5	70,8	95,8	83,3	58,3	66,7	95,8	70,8	45,8	58,3	83,3	72,9	15,64

weekday, time, and the number and severity of concurrent events. This likely reflected both good knowledge of the local SOP and staff awareness of the consequences of delayed activation of the rescue chain, namely, a higher chance of harm for casualties. An additional strength was the correctness of hospital alerts in terms of timing and report content. This aspect is important since the appropriateness of the activation of hospitals' MCI plans depends on the accuracy and promptness of the information shared by the EMDC. Effective information management also mitigates the back-and-forth of calls between hospitals and dispatch centers, which would only add stress to an already overstrained EMDC.

As for CRM skills, they were defined by Prineas et al. as "a set of generic cognitive and social skills, exhibited by individuals and teams, that support technical skills when performing complex tasks" [29]. To mitigate individual judgment, CRM skills were evaluated by two independent observers via the validated Ottawa GRS. The interrater variability was low, thus supporting the reliability of the measurements. Overall, good results in most Ottawa GRS domains were attained. Unsurprisingly, the multisite terrorist attack scored the lowest in Ottawa GRS; this could arguably be explained by the fact that, since the scenario evolved in a real fashion, gaining awareness of what, where, and why was happening took longer and created more confusion than a "regular" single-site MCI.

The lowest scores were recorded in both leadership and communication domains. Ford et al. pointed out that good performance in trauma resuscitation is associated with strong leadership [30]. A systematic review by Kuzovlev et al., for the Education Implementation and Teams Task Force of the International Liaison Committee on Resuscitation, concluded that leadership might improve patient outcomes in the context of advanced life support [31]. Similarly, a randomized clinical trial by Karimi et al. demonstrated that training in communication skills improved professional performance of prehospital emergency staff [32]. Even though the literature on the determinants of performance for EMDCs is scarce, it is reasonable to think that the correct functioning of a dispatch center, where hundreds of events are regularly managed, requires strong leadership, all the more when a major incident strikes. Although this study was not specifically designed to explore the determinants of staff performance in CRM skills, several factors might help to explain the relatively low scores observed in the leadership and communication domains. First, although most evidence in the literature focuses on communication between healthcare providers and patients, it is consistently reported that communication skills among healthcare professionals remain suboptimal. Nevertheless, targeted training interventions have shown promising results in enhancing these competencies [33]. In

Table 4 Ottawa GRS results for the 12 MCI simulations. Acronyms: S: simulations; AVG: average; SD: standard deviation; ev: evaluator. Simulations: 1: Building collapse; 2: multi-site terrorist attack; 3: highway Bridge collapse; 4: subway incident; 5: riot in identification and expulsion center; 6: multi-car highway incident; 7: LPG explosion in factory; 8: explosion and phenol release in factory (CBRN event); 9: train derailment; 10: explosion and ammonia release in factory (CBRN event); 11: explosion and tetrahydrofuran release in factory (CBRN event); 12: heavy-duty vehicles highway crash

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	AVG	SD
Ev1	31	17	32	42	33	25	31	34	40	19	23	40	30,6	8,17
Ev2	33	18	34	42	38	30	28	34	41	20	22	37	31,4	8,02
Mean	32	17,5	33	42	35,5	27,5	29,5	34	40,5	19,5	22,5	38,5	31	7,99
AVG %	76,2	41,7	78,6	100	84,5	65,5	70,2	80,9	96,4	46,4	53,6	91,7	73,8	19,0

particular, simulation-based training has been shown to improve teamwork and communication skills across various contexts, including MCIs [34, 35]. A second possible explanation is the lack of specific training for EMDC staff in the off-site management of MCIs. It could be argued that strong leadership is unlikely to emerge in an unfamiliar context, where most available resources tend to be directed toward accomplishing technical tasks. Lastly, it should be noted that EMDCs in Lombardy operate under a partially dual leadership model. While the physician is responsible for clinical decision-making and serves as the official EMDC representative, the EMS coordinator plays a key role in managing technical aspects, including logistics, radio and wired communications, and the allocation of additional BLS/ALS units (e.g., from neighboring EMDCs). Thus, it is possible that such a model becomes impractical when a single team leader is required to assume full command.

In contrast, problem-solving and situational awareness received the best scores. It is important to underline that MCIs represent dynamic situations during which compelling actions must be taken in response to unexpected events. For example, when an apparently confined fire is declared but then a sudden explosion occurs, or when MCIs take place in logistically difficult locations such as penitentiary facilities or nursing homes [13]. In these cases, problem-solving skills are of paramount importance, as they require the ability to adapt basic MCI management principles to the nuances of each scenario. Likewise, regular EMDC activities must continue, as prehospital health assistance needs to be guaranteed for the general population at all times. In this regard, situational awareness is essential to avoid losing sight of the bigger picture while the complex event is being managed.

As expected, KPI scores correlated with CRM skills. This was particularly clear in CBRN scenarios; the scenarios with phenol and ammonia release obtained high and low KPI scores, respectively. Also, the scenario with tetrahydrofuran release scored low. These results are remarkable because the specific management of CBRN incidents is explained in detail in the local SOP. However, the declaration of a CBRN incident, with all that entails in terms of resource utilization (i.e. CBRN defense teams, dedicated hospitals) and self-protection operations adds complexity to an already complex situation such as an MCI. Hence, despite the detailed CBRN SOP, adopting the required operational approach might require a higher level of leadership skills than other MCIs. Therefore, differences in performance in these scenarios might have been, at least partially explained, by the varying levels of CRM skills displayed. Notwithstanding, to reinforce the knowledge on this specific topic, a CBRN MCI management course has been developed, and it is being delivered to all EMDC staff. Regardless, in most scenarios, CRM

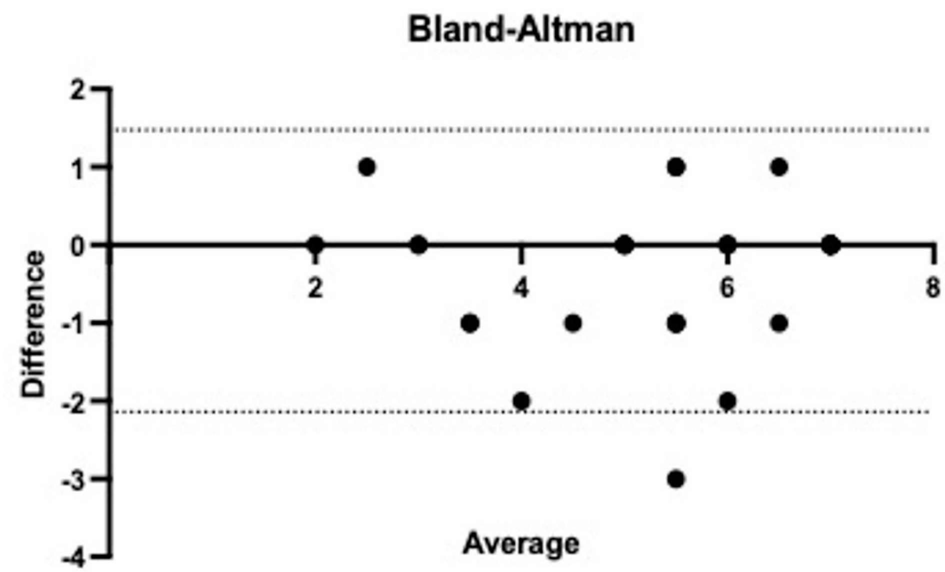

Fig. 2 Bland-Altman plot for Ottawa GRS inter-rater variability

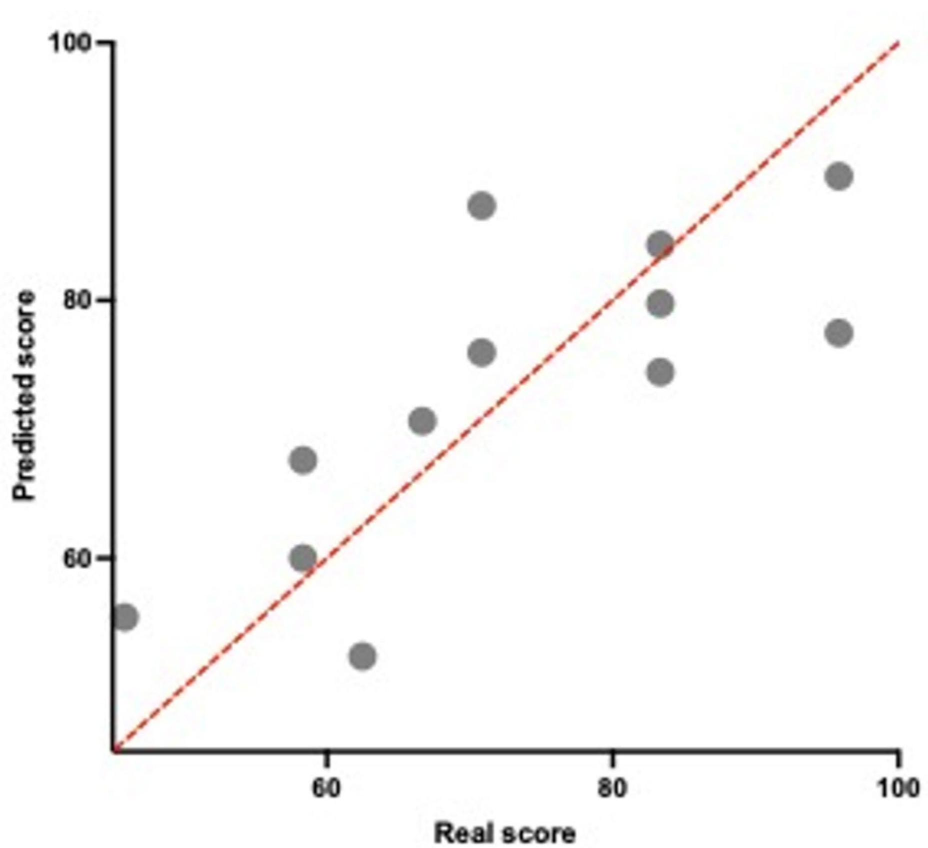

Fig. 3 Scatter plot with regression line showing the relationship between KPI and Ottawa GRS

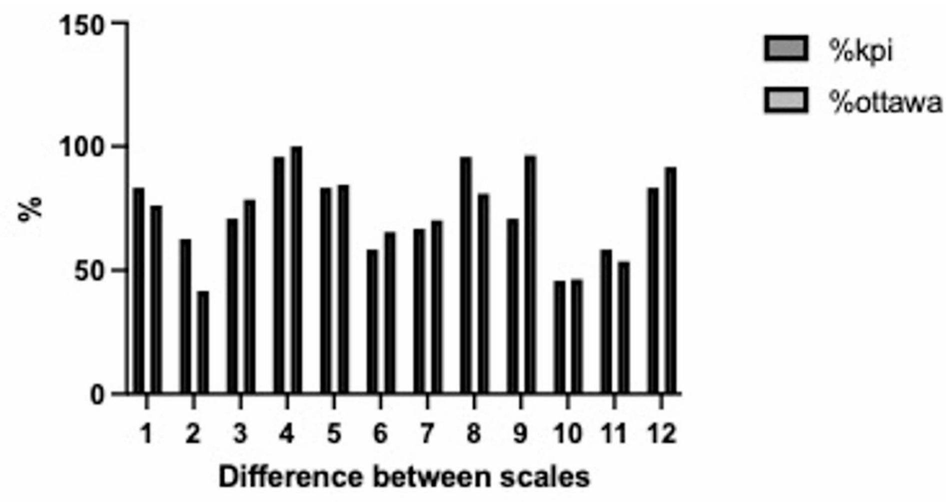

Fig. 4 Bar plot showing the comparison between KPI and Ottawa GRS in each simulation

skills appeared to importantly influence the overall performance of the EMDC.

Finally, the results of our study call for urgent training to strengthen the CRM skills of EMDC staff. Moreover, drills specifically designed to test CRM skills should be offered on a regular basis, and published KPIs should be used to evaluate EMDC performance during the management of MCIs.

Limitations

This study presents some limitations. First, the exercise design implied the lack of real resource mobilization (e.g., ambulances and ALS teams); although vehicle arrival and departure times were manually entered by instructors and accounted for a number of variables (time of day, etc.), the time needed for other actions that would have taken place on site (e.g., liaison with fire and police, casualty evacuation and treatment, etc.) was difficult to estimate and could have been unrealistic. Second, there is no consensus on a comprehensive set of KPIs for MCI management evaluation. Therefore, the ones used in this study, albeit published, could have been too generic or incomplete. Third, as the drills were unannounced, and despite the exercise rules and instructions being periodically resent by e-mail to all personnel, facilitators had to help participants occasionally with minor technical setbacks during the exercises. However, the delays caused by these rare events were minimal and could have hardly influenced staff performance. Fourth, EMDC personnel work on a rotating roster; despite all efforts to schedule the exercises so that all staff members could participate in at least one, due to last-minute roster adjustments some employees did not participate in any, while others participated in more than one. However, since performance and CRM skills were evaluated as a team and not individually, it seems reasonable to conclude that this could only have marginally influenced the final results.

Alongside these limitations, the authors believe that conducting multiple simulations across various scenarios—mostly yielding consistent results and revealing a strong correlation between KPIs and CRM skills—represents a major strength of this study.

Conclusions

To our knowledge, this is the first study that assessed the performance of an emergency medical dispatch center through a set of published KPIs and examined their correlation with the staff's crisis resource management (CRM) skills. Overall, performance across twelve different scenarios was good and showed a strong correlation with CRM skills, suggesting that further emphasis should be placed on training EMDC staff to improve and maintain non-technical abilities.

Acronyms

ALS	Advanced Life Support
AREU	Agenzia Regionale Emergenza Urgenza
AVG	Average
BLS	Basic Life Support
CBRN	Chemical, Biological, Radioactive and Nuclear
CRM	Crisis Resource Management
EMDCs	Emergency Medical Dispatch Centers
EMTs	Emergency Medical Technicians
GRS	Global Rating Scale
HEMS	Helicopter Emergency Medical Service
KPI	Key Performance Indicators
LPG	Liquid Propane Gas
MCI	Mass Casualty Incident
NTS	Non-Technical Skills
S / Sim	Simulation
SD	Standard Deviation
SOPs	Standard Operating Procedures
USAR	Urban Search And Rescue

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13049-025-01521-0.

Supplementary Material 1

Supplementary Material 2

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Author contributions
All authors participated equally in this study. ARG, GO, GDL, DA, AS, AZ, GC, FB, SL, and FZ helped conduct the simulations as follows: ARG, GO, and AZ were the evaluators for all simulations; GDL and FZ designed the first drafts of the scenarios; GDL, AS, DA, GC, FB, and SL composed the control cells and simulated most of the calls. GO and RFi helped with the statistical analysis. The paper was written mainly by ARG and GO, with the medical expertise and assistance of RS, RFi, RFu, PM, and AA. All authors read and approved the final manuscript.

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Data availability
All data generated or analyzed during this study are included in this published article and its supplementary information files.

Declarations

Ethics approval and consent to participate
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Consent for publication
Not applicable.

Competing interests
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