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STREET: Swedish Tool for Risk/Resource Estimation at EvenTs. Part one, risk assessment - face validity and inter-rater reliability

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ABSTRACT

Objective: To develop a validated and generalized high reliability organizations collaborative tool in order to conduct common assessments and information sharing of potential risks during mass-gatherings.

Methods: The Swedish resource and risk estimation guide was used as foundation for the development of the generalized collaborative tool, by three different expert groups, and then analyzed. Analysis of inter-rater reliability was conducted through simulated cases that showed weighted and unweight κ-statistics.

Results: The results revealed a mean of unweight κ-value from the three cases of 0.37 and a mean accuracy of 62% of the tool.

Conclusions: The collaboration tool, "STREET", showed acceptable reliability and validity to be used as a foundation for high reliability organization collaboration in a simulated environment. However, the lack of reliability in one of the cases highlights the challenges of creating measurable values from simulated cases. A study on real events can provide higher reliability but need, on the other hand, an already developed tool.

1. Introduction

Large scale events are an important part of a vivid society. Meetings, mass-gatherings (MGs), sport activities, festivals and musical events not only contribute to pleasant experiences, but may also create security and/or healthcare challenges due to crowding and its unpredictable consequences. Such events maybe planned or unplanned. The latter are often private and small. However, the number of people involved can still exceed the ability of high reliability organizations (HROs) *i.e.* emergency medical services (EMS), rescue teams (RT *e.g.* firefighters) and police department (PD) and may result in major incidents/disasters such as the disco fire in Gothenburg 1998 with 63 deaths and over 200 injured[1-3]. These events should be managed based on available disaster's plans. On the other hand, planned activities such as sport events and concerts should be evaluated with regard to security and healthcare challenges prior to the event, due to the possibility of violence and disastrous outcome (Heizel stadium, England 1985)[4], to optimize all available resources. This calls for improving seamless actions, capacity integration and information sharing between HROs as well as event's organizers[5].

MGs are defined as crowds from 1 000 to 25 000 persons[6,7]. Arbon suggests that MGs are events in which HROs activities are delayed due to difficulties in passing into and out of the area[8]. Furthermore, Arbon emphasizes the need for careful strategies to limit unnecessary delays and guarantee sufficient resources. Such a definition covers not only common events, but also all situations where large groups

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of people gather and are exposed to common risks such as collapsing buildings, fire, trampling, high temperature, storm, aggressions and terrorism[8]. The variation of risks, type of arena (indoor or outdoor), the environment (urban or rural) and the distance to emergency hospitals all contribute to challenges, which should be overcome by adjusting HRO resources to severity of the incident and the needs.

Since MGs could be exposed to man-made events such as traumas and threats[4], there is a need for intra-organizational integration and mutual strategies between HROs. In Sweden, PD and RT together with EMS are three major key players in the management of an incident. Each organization analyzes and estimates the needs of resources for its own organization, respectively. Information about the type of event, expected amount of visitors and other parameters such as weather are used as a foundation for analyzing the possible consequences of an event in order to take proper preparative measures, to estimates the need for security measures (PD), risk of fire and use of pyrotechnics (RT) and the needs for prehospital care and ambulance transportations of injured victims (EMS). Although information sharing and integrative planning have proven to be important factors to improve security[9], there is no collaborative instrument to use in assessing the needs for resources each organization and in total prior to the event. Such instrument may convert the facts to touchable and understandable parameters.

At the time of emergencies, organizers as well as HROs need to define the type and potential risks of the event, degree of collaboration, organizational settings and assembling areas. Since this should happen quickly, the readiness should be trained and needs common tools and plans. Making plans is the first necessary step in a chain of activities to establish sufficient preparation[10]. A reasonable estimation of risks and needed resources during an event is prerequisite for creating common staff pools, common unit leadership areas, inter-organizational incident management groups, common register and triage areas. Such organizational model is especially important in Sweden since the PD, RT and EMS are legally equal *i.e.* each organization is vertically independent (*e.g.* a police officer cannot give orders to staff from other organization) and horizontally collaborative. This collaborative approach not only challenges organizations in Sweden[11], but also stresses the need for evident collaborative tools that can be used prior and during different types of events[12]. The aim of such a tool is to enhance the collaboration between PD, RT and EMS before and during an event. In this way all partners get an understanding of all risks from various perspectives and can utilize all available resources to play under non-emergency conditions, avoiding depression of their ability of disaster management as described in each organization's disaster plan.

Although Sweden is a small country, events have become an important part of the society and some of the yearly events have taken international proportions. This is especially true in the western part of Sweden with the annual events such as The Göteborgs Varvet (the world's largest half marathon race), the "Around the Tjörn Island" sailing competition (one of the largest sailing competitions in the world) and "Gothia Cup" (the largest youth football tournament in the world), all subjected to a large number of participants and crowds of spectators. In 2013, 91 events were planned in Western Sweden. Not less than 30 of these events were considered to have high risk factors by HRO seniors.

While collaboration between HROs has proven to increase the quality and pace of crises or disasters management[13-15], traditions, conservative behaviors and internal routines, the lack of integration, diverse organizational agendas, path-dependency and delimitations between various partners during response time have been reported as a hinder[16]. Such integration, collaboration and the non-hierarchical organizational structure between HROs stressed a need for a collaborative tool in order to assess risks, predict actions and needed resources and harmonize the inter-organizational collaboration[12]. The shifting nature of MGs demands a generalized tool to cover the needs in different types of events. A close collaboration between organizers, EMS, RT and PD in Western Sweden has resulted in utilization of a predictive instrument[12,17]. This study introduces this collaborative tool to be used for conducting a mutual assessment of the same event and estimate the need of HRO reinforcement.

2. Materials and Methods

A multidisciplinary project group was established and researchers from the Prehospital and Disaster Medicine Center in Western Sweden were recruited. The project participants proposed the development of a tool based on the modified version of British "Purple Guide" (a British guide for health, safety and welfare at music and other events) adjusted to Swedish context[12] into a collaborative, predictive, generalized and easily manageable tool, which could improve the quality of event's planning in 2014. Therefore, in the first step, the old estimation tool was completed by including the most important items related to the Swedish context.

A predictive tool "STREET" - Swedish (Swedish Tool for Risk/Resource Estimation at EvenTs) was designed and consisted of 35 items grouped into six dimensions (Table 1) to fit different types of events and to suite HROs as well

as organizers. The response option range was presented as actual factors, *e.g.* temperature or distance to a hospital, on a three degree scale of none, moderate and high[18]. STREET has two different parts, one overview of the event and one adapted to the HROs. The overview part, which is the focus of this study, is filled in by the organizer and HROs. It is divided into three dimensions: character, population and risks. The dimensions of character and risk are divided into five items each and population is divided into three items. Character and population are based on actual information from the organizers and provides information about the planned event. Risk is a prediction based on the information of character, population and other information provided by organizers and HROs (*e.g.* intelligent services). Examples

Table 1
General factors of risk assessment.

C1: Type of events (choose 1–2 factors)		P1: Expected number of spectators (Choose 1 factor)		R1: Disturbances/conflicts (Choose 1 factor)	
Consert	4	<1000	1	Low risk	0
Exhibitions	3	<3000	2	Medium risk	4
Watter sports/events	3	<5000	8	High risk	8
Motor sports	4	<10000	12	Rival groups	10
City festivals	6	<20000	16		
Conference/Conventions	1	<30000	20	R1: Mark your choice	
Political (VIP) meetings	4	<40000	24		
Music festivals	3	<60000	28	R2: Alcohol and drugs (Choose 1 factor)	
Demonstrations/Riots	7	<80000	34	None	0
stadium sports	4	100000 or more	42	Low	3
Marathons, cyke tournements	6			Medium	7
		P1: Mark your choice		High	10
C1: Mark your choice					
		P2: Density of mass gathering (Choose 1 factor)		R2: Mark your choice	
C2: Area involved (Choose 1 factor)		Low density	0		
Localized to one limited area	0	Medium	4	R3: Threats such as terror	
Localized to couple of areas	2	High density	8	(max 1 year assessment, Choose 1–2 factors)	
Spread out in many areas	3			None	0
		P2: Mark your choice		Internationally	2
C2: Mark your choice				Nationally	6
		P3: Predominating age group (Choose 1 factor)		Both International and National	6
C3: Place/Local (Choose 1–2 factors)		31–50	1	Distinct threat for this event	25
Indoor	1	>50	4		
Stadium	2	15–30	4	R3: Mark your choice	
Outdoor intersperce	2	Mixed public	1		
Outdoor others	3			R4: Pre-requisite for quick evacuation	
Street events	4	P3: Mark your choice		(Choose 1 factor)	
Temporary buildings outdoor	4			Good	0
Included camping for night stay	5			Medium	5
				Low, not enough	10
C3: Mark your choice					
				R4: Mark your choice	
C4: standing/sitting rooms (Choose 1 factor)					
Sitting room	1			R5: Accesibility for vehicles (Choose 1 factor)	
Mixed	2			Low	8
Standing	3			Medium	4
No room, moving around	4			High	0
C4: Mark your choice				R5: Mark your choice	
C5: Event coincides with (Choose 1–2 factors)					
New year and Midsummer	6				
End of month, sallary payment	5				
Christmass and Easter	3				
Vaccations, summer time	3				
None of above	0				
C5: Mark your choice					
				Add upp CPR to your organizational (PO, RT, EMS) sum from part B of the tool	
Sum of Cs		Sum of Ps		Sum of Rs	
				Sum of CPR	

C = Characteristic; P= Population; R= Risks.

of items mirroring character and population are type of event, expected number of visitors and presumed age of visitors. Examples of risks are presumed conflicts, presumed presence of alcohol, drugs and threats. The added items results in a total score (range 0-142) distributed in low, middle and high risk event. A high score implies a need of HRO reinforcement.

The study was conducted in three steps: face validity, data collection and statistics. The first two steps served as a preparation for testing the reliability of the tool. The preparation and the reliability test were carried out by three different expert groups. Expert Group I consisted of five academically skilled experts (one woman and four men) with extensive experience in instrument development.

Expert Group II consisted of nine senior HRO specialists (two women and seven men) who tested the tool independently and in collaboration. All of the HRO specialists were senior officers experienced in estimating recourses to planned events. Expert Groups I and II did also test the tool on written scenarios based on the literature and adjusted the data to current contexts in Western Sweden.

Expert Group III consisted of 55 experienced staff who agreed to participate in the study and use the tool in order to assess the fictive case-reports (27% women and 73% men). They were divided into organizers (n=22, 40%), PD staff (n=10, 18%), RT (firefighters) (n=10, 18%) and EMS staff (n=13, 24%). They ranged in age from 29-64 years (m=44.4, SD=9.7). The members of Expert Group III had at most 36 years of practical experience in their profession (m=17.2 SD=10.1) in planning and management of different types of events, locally, nationally and in some cases at international level.

Each participant received a letter explaining the aim of the study and their voluntary basis of participation. The completed prediction tools were sent back to the first author. One reminder note was sent out after approximately three weeks if no replies were received. The study was conducted in the spring 2014.

2.1. Cases

Three simulated case-reports of planned events, inspired by case studies from the literature were used[12,17]. The cases were selected in order to reflect different types of events and present plausible data. They were slightly adjusted based on written comments from Expert Groups I and II and reflected all dimensions of the tool. In this study, a concert, a festival and a public hockey game were included.

The fictive concert was based on experiences from the Bruce Springsteen concert in Gothenburg, summer 2012 with estimated, mainly middle-aged, spectators of 55 000. In order to hamper the assessment of the scenario an Israeli rock group was involved as pre-performers and some anonymous threats was declared. The festival was a three-day long music event visited by 10 000 to 15 000 spectators. It was located in the countryside and included a camping area. The fictive public hockey game was the final in the Swedish championship tour visited by known violent supporters. The city hockey arena was supposed to be fully booked with 12 000 spectators mainly consisting of families and supporters.

2.2. Face validity

Expert Groups I and II reviewed the tool, resulting in three new dimensions and 12 additional items. The review was an assessment of logic, relevance, understanding, readability, clarity and usefulness[18,19]. Expert Group II provided further comments after testing the tool in collaboration. According to the participants there were some items that appeared to be unclear. These items were adjusted. A total of 165 assessments were accomplished by Expert Group III (Figure 1).

2.3. Statistics

Descriptive statistics were used to analyze the demographic characteristics of Expert Group III who were assessing the case reports. Analysis of the inter-rater reliability[20-24] showed un-weighted κ-values. According to Altman[25], a kappa value of 0.21-0.40 is regarded as fair agreement and a value of between 0.41-0.60 is regarded as moderate agreement. Good agreement is between 0.61-0.80 and >0.80 is considered as very good agreement. Accuracy was given in percentages[20].

3. Results

The mean value of all assessments of the five dimensions of assessed risk, was (62.9±13.2) on a scale from 0, *i.e.* no risk to 142, *i.e.* extremely high risk. The respondents considered the concert as more risky than the festival and the hockey game. The assessments presented a variation in mean from (51.6±13.2) in case number three, the hockey game, to (62.5±11.7) in case number one, the festival and (74.6±14.7) in case number two, the concert.

There were notable differences between the four professions. They displayed a high degree of agreement on the festival case (m=60.5-64.3). Least agreement were displayed on the hockey case (m=47.9-57.3). The ambulance services assessed the highest risk of the participating organizations (64.8±13.1) followed by organizers (63.4±14.2) and police (62.4±12.7). RT (firefighters) assessed a lower risk than the other organizations (59.9±11.3) (Table 2).

Table 2
Assessed risk of the event.

Professions	Case 1 Festival	Case 2 Concert	Case 3 Hockey	Mean of all
PD	62.1±11.8	76.2±14.3	48.9±12.1	62.4±12.7
RT	64.3±9.8	67.5±11.7	47.9±12.5	59.8±11.3
EMS	60.5±11.6	76.6±12.3	57.3±15.5	64.8±13.1
Organizers	63.2±13.0	75.8±17.2	51.1±12.4	63.4±14.2
All	62.5±11.7	74.6±14.7	51.6±13.2	62.9±13.2

Data are expressed as mean±SD. Scale 0: no risk, 142: extremely high risk.

In terms of accuracy (Table 3), the case reports showed a mean accuracy of the tool of 62%. Two of the cases (concert and hockey game) showed a substantial accuracy of 67% and 69%. The festival case displayed a low accuracy (48%). The accuracy differed between the four professions. It appeared to show higher accuracy when used by the police (63.3%) than to the other organizations (organizers, 61.3%, RT 60%). The tool displayed least accuracy when it was used by EMS (51.3%).

Table 3
Accuracy of the tool.

Professions	Case 1 Festival	Case 2 Concert	Case 3 Hockey
PD	40%	70%	80%
RT	60%	50%	70%
EMS	23%	69%	62%
Organizers	28%	64%	60%
All	48%	67%	69%

The mean κ-value of the three case reports was calculated as a linear unweight κ-value (Table 4). In total it showed an inter-rater reliability of κ=0.37, *i.e.* fair agreement. The κ-values did however vary between the participating organizations. The instrument displayed κ=0.45, moderate agreement, when it was used by the police, it was followed by RT (κ=0.40, moderate agreement) and organizers (κ=0.30, fair agreement). The lowest result (κ=0.27, fair agreement) was displayed by EMS.

Table 4
Inter-rater reliability of the tool (unweight kappa values).

Professions	Case 1-3
PD	0.45
RT	0.40
EMS	0.27
Organizers	0.30
All	0.37

4. Discussion

An increased number of national and international events in Sweden has resulted in higher risk for unexpected man-made disturbances and a need for resource prediction for HROs. In an earlier published study, we introduced a guide for estimation of healthcare resources at sport events. The guide was, however, a modified version of British "Purple Guide" adjusted to Swedish context and generalized to all sport events. Furthermore, the model only embraced the healthcare needs and the tool was not tested for validity or reliability.

The aim of this study was to develop a validated and generalized collaborative tool, based on previously presented estimation tool[12,17], to be used of all HRO partners together with organizers, in order to conduct common risk assessments prior to an event. A similar tool may be used to estimate collaborative HRO resources needed (next study). Three different expert groups were used to develop such a tool and analysis of inter-rater reliability through simulated cases showed acceptable reliability and validity of the tool to be used as a foundation for partner's collaboration in a simulated environment.

The main reason for development of such a tool was the evident need of an instrument, which could engage all HROs and organizers in a common assessment to predict all possible risks. Another reason was to make it possible for each partner to estimate needed resources for each organization. Planned mass gatherings and large events can turn into major incidents. A failure in pre-planning process, may result in shortage of resources needed for management of disasters and major incidents. By using a common tool, risk assessments for each group are conducted, risks are identified and information is shared. The outcome will then raise the awareness and preparedness and safe-guard a better management of any incidents without any impact on available disaster plans. Thus, the main goal is to enhance collaboration between HRO and organizers.

A need for a joint risk evaluation prior to an event between PD, RT, EMS and organizers, has already been reported[26]. However, until now and to the best of our knowledge, no mutual and evaluated instrument has ever been offered for such joint evaluation. This study shows that STREET may be used as such instrument. It covers all involved organizations and engages them all in individual evaluations, as well as, a joint discussion, which results in a common understanding of the event and its consequences including the possible needs for resources for each partner and in total.

Using STREET's general part, one could anticipate that all organization had similar evaluation, since they all received the same information from the organizer; however, it is to realize that the professional belonging and the individual experience have an impact on the outcome. Different organizations face diverse risks to consider prior to an event. Thus, each organization evaluates the risk based on its own experience and background *e.g.* EMS focuses on diseases, injuries and transportations issues that may appear during such event, while PD sees the risks related to the type of

events, social disturbances related to the use of alcohol or drugs, increased criminality and riots. RT, on the other hand, foresees the probabilities for fire and collapsing buildings. Obviously, information offered by PD and RT are necessary for EMS planning, since it may also have an impact on hospital's resources and ambulance availability.

Although, all partners may have foreseen some of the risks, the extent and severity of the evaluation may differ between them and the results should be balanced to the acceptable level and without duplication of resources. To all these evaluations, organizer's perspectives should also be added. The aim of organizers is to have a spectacular and well-organized event that will attract thousands of people, give a large economic boost and also secure the participation of more spectators next coming years. Although they have no knowledge about societal and medical consequences of their event, they have very good knowledge of public types attending their event and experiences earned from the same kind of event from earlier years. This information has a striking impact on HRO's evaluation. As shown in this study, the diverse nature of each organization results in various assessment and consequently different estimation and duplication of some resources. This calls for and necessitates the collaboration between organizations to sum up a final assessment and common resource estimation. The general part of the tool makes it possible to obtain data from organizers and provide the similar information to all HRO partners to enable a base for risk evaluation and further collaboration.

Although there is a learning curve and increasing reliability by repeated use of the tool, it gears up the possibility of preventive measures, based on all risks assessment, before, during and after any event. It may also minimize the role of age and experience of evaluators for such evaluation. The low accuracy in the festival case is probably due to the learning curve as the individuals had no previous experience of using the tool. The results of subsequent cases may confirm our statement about the learning curve and also indicates that the tool should be used widely within all organizations before it can be used in collaboration with other partners to achieve the highest possible validity and reliability. Although there is a limitation and a risk for first users, our data indicates that all users may rapidly acquire enough knowledge to use the tool correctly and the results will be reliable enough for an estimation and guidance. However, further studies are needed to validate this statement.

Although using simulated cases is common[27-29], it does not offer all real facts and information that can be presented in a real environment. However, the advantage of using simulated cases is comparability, since all participants receive similar information. The use of simulated case reports is also common when instruments are being assessed, particularly when investigating accuracy and inter-rater agreement[30-34] is on target. Weighted κ-values, *i.e.* linear and quadratic κ-values were not calculated. Such values are known to be more allowing than unweight κ-values[23-24].

Sharing the results of risk assessments and information between HRO and organizers are of high importance to obtain a more similar assessment of an event.

An assessment tool (STREET) offers a common understanding of all risks prior to an event and may prevent disastrous consequences of identified risks by mutual planning and resource estimation.

A joint planning strengthens the ordinary capacity within all organizations and enables adequate use of available resources without entering any higher preparedness level.

An estimation tool should be used internally in each organization before it is used in collaboration due to an increasing learning curve.

In this study, STREET showed acceptable reliability and validity to be used as a foundation for HRO collaboration in a simulated environment. However, the lack of reliability in one of the cases highlights the challenges of creating measurable values from simulated cases. A study on real events can provide higher reliability but needs, on the other hand, an already developed tool.

Conflict of interest statement

The authors report no conflict of interest.

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