Development of a Mass-Gathering Medical Resource Matrix for a Developing World Scenario

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Keywords: developing world; FIFA; mass-casualty incident; mass gathering; medical resource matrix; soccer; World Cup

Abbreviations:
FIFA = Federation International de Football Association
HSG = *A Guide to Health, Safety and Welfare at Music and Similar Events*

Received: 26 January 2010
Accepted: 01 March 2010
Revised: 16 March 2010

Web publication: 18 November 2010

Abstract

Mass gatherings have a higher patient presentation rate than is found within the general population. Despite this fact, many mass gatherings are occurring without suitable medical coverage. South Africa has had no standard approach or model to determine the number of medical personnel needed to deploy to an event. The awarding of the FIFA (Federation International de Football Association) 2010 World Cup to South Africa has provided the impetus for the development of such a model. The model presented in this paper is based on existing recommendations that originate from the United Kingdom.

This paper outlines the modifications that have been made to this model to ensure that adequate medical resources still are provided, albeit in a developing country where medical resources may not be as plentiful.

Smith WP, Wessels V, Naicker D, Leuenberger E, Fuhri P, Wallis LA: Development of a mass-gathering medical resource matrix for a developing world scenario. *Prehosp Disaster Med* 2010;25(6):547–552.

Introduction

When South Africa made its transition to democracy in 1994, it became a favored destination for international events. In 1995, South Africa hosted the Rugby World Cup, which was followed in 2003 by the hosting of the International Cricket Counsel Cricket World Cup. Despite a failed bid for the 2004 Olympics, South Africa was awarded the hosting rights to the 2010 Federation International de Football Association (FIFA) Soccer World Cup, one of the largest sporting events in the world.

There is little agreement on the definition of a *mass gathering*, although few would argue that the FIFA Soccer World Cup does not constitute one. But, however they are defined, mass gatherings have a higher rate of illness and injuries compared to the general population and have, at times, resulted in major incidents (mass-casualty incidents).[1,2] In this regard, Sub-Saharan Africa has not been spared.[3,4] Wherever a large number of people gather in one defined area, there is an increased risk for a major incident.

South Africa, like many other countries, does not make use of uniform standards or guidelines to establish the level of medical coverage needed at large events.[3] More often than not, the medical coverage at an event is based on precedents, tradition, and/or financial constraints on the part of the event organizer.

The risk associated with mass gatherings is not purely a function of the number of persons attending the event, although the density of people is an important consideration. Milsten *et al* described the multiple variables whose interactions were noted to contribute to the number of patients.[5] Important variables include: (1) weather; (2) nature of the event; (3) age profile of the spectators; (4) crowd mood; (5) crowd density; and (6) the presence of alcohol and/or drugs at the event.

As part of the preparations for the 2010 FIFA Soccer World Cup, the South African National Department of Health commissioned a medical staffing resource model for mass gatherings. A mass-gathering medical resource model was developed that was appropriate for a developing world setting in which there are limited medical personnel.

Category	Risk Factor	Score
(A) Nature of Event	Classical performance	2
	Public exhibition	3
	Pop/rock concert	5
	Dance event (rave/disco)	8
	Agricultural/country show	2
	Marine	3
	Motorcycle display	3
	Aviation	3
	Motor sport	4
	State occasions	2
	VIP visits/summit	3
	Music festival	3
	International event	3
	Bonfire/pyrotechnic display	4
	New Year celebrations	7
	Demonstrations/marches	5
	Sport event with low risk of disorder	2
	Sport event with medium risk of disorder	5
	Sport event with high risk of disorder	7
	Opposing factions involved	9
(B) Nature of venue	Indoor	1
	Stadium	2
	Outdoor in confined location, e.g., park	2
	Other outdoor, e.g., festival	3
	Widespread public location in streets	4
	Temporary structures	4
	Includes overnight camping	5
(C) Seated or unseated	Seated	1
	Mixed	2
	Standing	3
(D) Spectator profile	Full mix, in family groups	2
	Full mix, not in family groups	3
	Predominately young adults	3
	Predominately children and teenagers	4
	Predominately elderly	4
(E) Past history	Good data, low casualty rate previously (<0.05%)	-1
	Good data, medium casualty rate previously (0.05%–0.2%)	1
	Good data, high casualty rate previously (>0.2%)	2
	First event, no data	2
(F) Expected numbers	<1,000	1
	<3,000	2
	<5,000	4
	<10,000	8
	<20,000	16
	<30,000	20
	<40,000	24
	<50,000	28
	<60,000	32
	<70,000	36
	<80,000	42
	<90,000	46
	<100,000	50
	<200,000	60
	<300,000	70

Table 1—Risk scores *(continued on page 549)*

https://doi.org/10.1017/S1049023X0000875X Published online by Cambridge University Press

Category	Risk Factor	Score
(G) Expected event duration (including queuing from gate open time)	<4 hours	1
	4 hours but <12 hours	2
	12 hours	3
(H) Seasons (outdoor events)	Summer	2
	Autumn	1
	Winter	1
	Spring	1
(I) Proximity to hospitals (nearest suitable emergency center)	<30 minutes by road	0
	>30 minutes by road	2
(J) Profile of hospitals	Choice of emergency center	1
	Large emergency center	2
	Small emergency center	3
(K) Additional hazards	Carnival	1
	Helicopters	1
	Parachute display	1
	Street theatre	1
	Water hazard	1
	Onsite alcohol use	1
(L) Additonal on-site facilities	Suturing and/or plastering	2
	Vending machine for over-the-counter medication	2
	Public access automatic external defibrillator	1
	Existing full-time operational medical facilities on-site	2

Table 1—*(continued from page 548)* Risk scores

Medical Resource Models for Mass Gatherings

In 1993, the United Kingdom Health and Safety Executive, in conjunction with the British Home Office and the Scottish Office, published *A Guide to Health, Safety and Welfare at Music and Similar Events* (HSG).[6] This Guide, with a second edition published in 1999, was adopted as the standard for the planning of mass gatherings in the United Kingdom. Inclusive in this Guide was a medical staffing model that looks at the risk profile of the event in determining the medical resources required. All authors (except LW) formed part of the core group that reviewed and, when necessary, modified the staffing model. Variables were adjusted to reflect local mass-gathering profiles, as well as experiences of such events by members of the core group, through repeated rounds of consensus gathering until unanimity was achieved. The resourcing numbers were amended to those that a developing country could realistically deliver. This article describes the model.

The Proposed Model

The model retains the same broad risk categories as contained in the United Kingdom model (the HSG), and as supported by the literature.[6] These categories include:

A. Nature of the event;
B. Nature of the venue;
C. Seated or unseated;
D. Spectator profile;
E. Past history of similar events;
F. Expected number of spectators;
G. Event duration;
H. Seasonal considerations;
I. Proximity to hospitals;
J. Profile of hospitals;
K. Additional hazards; and
L. Additional on-site facilities.

Within each of the categories, particular risk factors are identified and allocated a score. Only one score is allocated per category, and this will be the highest possible score within that particular category. For example, a New Year celebration event also may include a pyrotechnics display: both of these risks are listed under category (A) Nature of event. A single score of 7 will be awarded, as a New Year celebration scores 7, and this is higher than the score (4) allocated to a pyrotechnic display.

To determine the medical resources required, scores in all categories are summed and the resulting total score number determines a recommended number of medical resources, divided into various qualification levels.

Event Risk Categories

There are 12 categories in the model (Table 1).

(A) Nature of the Event

The nature of the event being hosted has been noted to be an important risk factor as regards the number of spectators that may require medical intervention.[7] Changes made by the workgroup included the addition of a score for sport

https://doi.org/10.1017/S1049023X0000875X Published online by Cambridge University Press

events specifically (since the model was used for medical event planning for the 2010 FIFA Soccer World Cup).

(B) Nature of the Venue
Table 1 contains the risk profile categories and relevant scores regarding the venue in which the mass gathering is to be held. This category was adopted as initially described in the HSG. Much descriptive research has been done on outdoor events and reports a higher usage of medical resources as when compared to similar events held indoors.[8,9]

(C) Seated or Unseated
This category was adopted without any changes from that initially recommended in the HSG.

(D) Spectator Profile
The only change made by the group was to remove a risk listed in the original model that concerned the presence of rival factions as this already has been considered in Category A. Zeitz *et al* identified that predominately young crowds (<35 years of age) are a significant determinant of medical work load as are more elderly crowds (as well described in the planning for Papal visits by Felderman *et al*).[10,11]

(E) Past History of Similar Events
The history of previous events of a similar nature, with particular reference to the type of incidents that occurred and the medical problems that arose, is an important piece of information to be considered when planning the medical coverage for an event. Despite the fact that South Africa has little data relating to previous events, the table referring to previous events was deemed important enough to be included unchanged in the modified model.

(F) Expected Number of Spectators
The number of spectators that is expected to attend an event usually is one of the parameters that is known prior to the event taking place. The capacity of the venue as well as the number of pre-event tickets sold will inform planners in this regard.

Changes made to this category involved the addition of three further groupings of expected attendance numbers which were not addressed in the original HSG document. The additions made were to cater for <50,000, <70,000, and <90,000 persons attending.

(G) Expected Event Duration
The duration of the event is an important determinant of the number of medical personnel needed at the event.[10] Longer events will require a shift system so as to ensure the medical teams have time to rest and that the hours worked are not in conflict with legislative frameworks that govern the working hours of staff. It also is expected that the number of patients presenting for medical attention is likely to increase the longer the event continues. Event duration includes expected queuing time while spectators await the opening of the gates.

(H) Seasonal Considerations
Much of the literature lists weather as an important factor to consider when planning the medical coverage for a mass gathering.[12,13] In particular, hot and humid conditions have been associated with a higher patient presentation rate.[14]

The HSG document lists the time of the year as a defining risk category. This is divided into the seasons and each is given a risk score. This seasonal variation of risk is likely to be geographically specific (e.g., summer in Africa tends to have higher ambient temperature than summer in Northern Europe). For this reason, it was decided to change the risk score from that originally suggested in the HSG to represent the South African weather profile. Only summer was deemed to represent a higher risk and the risk score has been changed accordingly. This score is only of relevance when the event is held outdoors.

(I) Proximity to Hospitals
The distance from the event location to the closest appropriate hospital will impact on medical staffing at the event. A longer distance to a hospital relates to longer transport times, and thus, the longer the period of time that the resource is not available for the event standby. Also, the longer the distance to definitive care, the higher the risk to the patient. This risk may necessitate that the medical staff doing duty at the event have the appropriate medical qualifications to ensure stabilization of the patient and treatment en route as required.

(J) Profile of Hospitals
The level of care that can be provided by the receiving hospitals also is of importance. Having a choice of emergency centers to which patients can be referred is the ideal, and thus translates to the lowest risk score. The size of the emergency center also is relevant, particularly when dealing with mass-casualty scenarios.

(K) Presence of Additional Hazards
Consideration also must be given for any other potential hazards that may be present or associated with the event. This will be based on event intelligence and therefore, it is vital that a complete profile of the event is obtained from the event organizers prior to deciding on the medical resources to be deployed. Table 1 lists some of the potential hazards that may be present. The sale and/or presence of alcohol has been added to the original list as published by the HSG. Events at which alcohol is on sale or is readily available is associated with an increased number of patients presenting for medical care.[2,15]

(L) Additional On-Site Facilities
The capability of onsite medical facilities is a determinant as regards to the number and qualification of medical personnel required. The presence of automatic external defibrillators within public areas has become popular over the last couple of years. This can be seen at most international airports and other public areas where many people gather. As such, it provides the public with rapid access to a life-saving procedure without requiring large numbers of qualified medical persons.

Likewise, any medical facility at the event that may be able to provide a procedure otherwise only performed at a

SCORE	Ambulance	BLS	ILS	ALS	Ambulance Crew	Doctor	Nurse	Medical Coordinator
<20	0	2	0	0	0	0	0	0
21–25	0	4	0	0	0	0	0	0
26–30	1	4	1	0	2	0	0	0
31–35	1	6	1	1	2	0	0	0
36–40	1	8	1	1	2	0	0	0
41–45	2	12	1	1	4	1	0	1
46–50	2	16	2	2	4	1	1	1
51–55	3	20	3	3	6	2	1	1
56–60	3	24	3	3	6	2	2	1
61–65	4	32	4	4	8	2	2	1
66–70	5	40	5	5	10	3	3	1
71–75	6	48	6	6	12	3	3	1
76–80	8	64	8	8	16	4	4	1
81–85	10	80	10	10	20	5	5	2
86+	15	120	15	15	30	6	6	2

Table 2—Medical staff resource matrix (ALS = advanced life support; BLS = basic life support; ILS = intermediate life support)

Medical Resource	Modified Medical Model	HSG Model
Ambulance	2	4
Ambulance Personnel	4	8
BLS/First Aiders	12	40
ILS	1	Included in Ambulance Personnel
ALS	1	
Doctor	1	3
Medical Coordinator	1	2
Total Medical Staff	22	57

Table 3—Comparison between medical resources predicted by the modified model against that of the HSG model (ALS = advanced life support; BLS = basic life support; ILS = intermediate life support)

hospital potentially will decrease the number of resources that may have been required to transfer the patients to hospitals. Resources relevant in the South African context are included in Table 1.

Calculation of the Event's Risk Score

The following calculation was used to determine the risk score for an event:

Event Risk Score =
(Sum of scores of sections A to K)) - (score of section L)

The resultant Risk Score obtained is then referenced against the medical resource matrix as shown in Table 2.

For example, an event that scores 43 on the risk profile will require the following medical resources to be deployed at the event: (1) two ambulances; (2) four crew members to staff the ambulances; (3) 12 Basic Life Support providers; (4) one Intermediate Life Support provider; (5) one Advanced Life Support provider; (6) one doctor; and (7) one medical coordinator.

A comparison as to how this prediction of medical resources required compares to the HSG model of an event scoring 43 on the risk profiling is shown in Table 3.

Discussion

Internationally, mass gatherings continue to pose many challenges to medical planners and event organizers alike. While some debate may occur as to the definition of a mass gathering, it is apparent that mass gatherings require the presence of medical services on site.[16,17] Recent work identifies a classification system for events that is based on weather, the number of persons in attendance, the presence of alcohol, and crowd mood.[18] This classification again estimate the risk profile as a predictor for medical requirements.

In many developing countries, no standard exists against which medical resources are allocated to any particular

https://doi.org/10.1017/S1049023X0000875X Published online by Cambridge University Press

event. To achieve a balance between medical resources allocated to an event and the resources that, in fact, are required often is difficult. Countries with well-resourced EMS services often are in the enviable position of being able to over-resource a mass gathering with the appropriate personnel.

In a developing country, the EMS services may be under-resourced to such an extent that often they are not in a position to address the daily demands placed on it by the citizens they serve. For this reason, it is imperative that the medical coverage provided by such EMS services is done as efficiently as possible while paying due respect to the event's risk profile.

The Medical Staff Resource Matrix has been modified from the originally proposed 1993 and 1999 versions. The modifications are an attempt to address the problem of a resource-poor country being able to provide suitable medical coverage to a mass gathering. For this reason, some downscaling of the number of medical resources required, has been factored into the matrix. Despite this downscaling, it is still expected that those medical resources that in fact are proposed for any mass gathering by the matrix, does provide enough medical coverage so as to meet appropriate standards and response times. To test this expectation, a validation study is in progress.

Conclusions

The medical resources as proposed by this model serve to provide medical response and appropriate medical care to persons who may be injured or become ill during an event. In the event of a major incident, these resources will be in a position to commence a medical response while additional resources are being deployed to the incident site. The model as proposed is an appropriate and achievable model for use at mass gatherings in a developing world setting.

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Editorial Comments—Development of a Mass-Gathering Medical Resource Matrix for a Developing World Scenario

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Web publication: 18 November 2010

The paper titled "Development of a Mass-Gathering Medical Resource Matrix for a Developing World Scenario" provides us with a consensus or expert opinion-based model for determining the resources (both human and material) required to support expected demand for healthcare services at a mass gathering in South Africa. The authors developed and refined their model on the basis of local data (evidence) and experience. The model takes as its starting point an established and well utilized United Kingdom model that also is based on experience and expert opinion.

The scientific literature in this field provides good support for the key features of mass gatherings that are used in the proposed model and considered by the authors to be drivers of resource demand. As a result, the paper provides a comprehensive framework with high face validity and good support in terms of the key factors identified in the scientific literature as having an impact on the demand for health services arising from these events.

The model appears to have good external validity and is generic enough for application in the context of different cultures and expectations for the appropriate level of health services at major public events. However, it should be remembered that health providers must determine whether the event health service is limited to the provision of emergency care and urgent evacuation of patients or incorporates extended care including primary health care. This decision usually is made after a thorough assessment of factors such as the distance and time required for evacuation of casualties from the event, the expected level and type of casualties, and the expectations for level of service of event organizers and the public.

We have relatively strong scientific evidence concerning the principal factors that affect healthcare service demand at mass gatherings. We have little scientific evidence concerning the relationship between each factor and the level of effect of these factors on demand.

Therefore, we still are stuck in an in between space—where we know what influences demand but do not have good evidence on the relative effect of health service strategies, including the use of resourcing frameworks such as the one presented here, on either managing the resulting workload of an event or in reducing demand on the health services. For example, we have a poor understanding of the relationship between different health professional qualification sets, response strategies, preventive measures and health promotion activities, the geographic spread of health services within venues or the equipment, and evacuation strategies utilized on the demand for health services. We require more scientific evidence to assist us in re-shaping frameworks, such as the resource matrix discussed here to suit our local needs and to mitigate the impact of mass gatherings on health services within the event itself and in the surrounding community.

The challenge is to review outcomes and workload demand and to compare these to items in the resource matrix to help us understand how this might be working.

The paper also refers to one of the more difficult issues in mass-gathering health services provision. How do we determine appropriate standards for health services at international events such as the World Cup? How do we bal-

ance our decision-making between local standards and expectations for the level of care provided and those of international visitors, which may be higher or lower, and in any case, frequently differ from the local expectations. Added into the mix in considering these issues are the requirements and standards set by the event owner—in this case, FIFA. What responsibility should the owner of an event assume when they award an international event? What standards should they set and how do we agree on them? Should they be based on a level of resource provision—given that across the world we have different standards for healthcare professionals' qualifications such as paramedics and nurses—and different response frameworks? Is it even possible to define a common resource matrix or standard for resources for an event if we are not talking about the same resources with the same skill set or response strategy?

Perhaps the answer is to focus more on the outcomes. Perhaps response and service delivery times provide only a part of the answer. What should the benchmark timeframe within a major event be for the arrival of a basic life support-trained provider to the side of a collapsed patient? With an outcome-based strategy, free health service providers must try innovative strategies and provide an opportunity for the strategy to be tested against consensus-based benchmarks. For example, if we wanted to provide an emergency health response in the venue and acceptable time limits for access to basic life support, advanced life support including early defibrillation, evacuation from the site, and arrival at advanced tertiary care, what would we do? The existing resource matrices provide a typical and consensus-based interpretation of what would be required, and we would allocate ambulances, health centers, first aid posts, and health professionals to provide cover. But—if we create a strategy in which police, security, ushers, or others can provide basic life support (are first-aid trained and expected to play a role in response), in which we have a joined up communication system across the event to ensure a coordinated response to a health emergency by event management, security, health services and others, we find ourselves with the opportunity to respond differently with resources not traditionally incorporated into our matrix. To take this argument a step further, consider what roles event marketing and ticketing services can play in health promotion and in reducing demand on event health services; consider the role of real time environmental scanning including collection of data on weather, crowd density and movement, and the like. Establishment of such systems should assist health services to be more responsive and may impact on resource requirements. So how do we manage and research this complexity? A more outcome-focused strategy based on agreed upon service standards may be part of the answer.