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ENHANCED SURVEILLANCE AT MASS GATHERINGS

WZMOŻONY NADZÓR EPIDEMIOLOGICZNY PODCZAS ZGROMADZEŃ MASOWYCH

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STRESZCZENIE

W czasie masowych zgromadzeń może pojawiać się wiele różnych zagrożeń dla zdrowia: urazy, porażenia słoneczne, również choroby zakaźne. Dlatego w przygotowaniach do masowych zgromadzeń, zarówno dostęp do usług medycznych, jak i system nadzoru epidemiologicznego odgrywają istotną rolę. Prócz naturalnie występujących zagrożeń, należy się liczyć z możliwością wykorzystania zgromadzeń do ataków bioterrorystycznych.

W analizie systemów wzmożonego nadzoru epidemiologicznego należy się liczyć z dodatkowymi kosztami wdrożenia określonego systemu oraz jego prowadzenia. Systemy oparte na funkcjonującym nadzorze rutynowym wymagają mniej nakładów na ich usprawnienie niż wtedy, gdy system wprowadzony jest od nowa. Nowe systemy wymagają też merytorycznego przygotowania personelu, który styka się z nimi po raz pierwszy. Szczególną czułością odznaczają się systemy polegające na zgłoszeniu objawów. Jednak weryfikacja rozpoznań wymaga współpracy ze sprawnymi laboratoriami, co również poważnie wpływa na wzrost kosztów.

Kluczowe znaczenie dla sprawnie funkcjonującego nadzoru epidemiologicznego jest przygotowanie odpowiednio wyszkolonego personelu. Szkolenie powinno być dostosowane do charakteru i rozmiarów zgromadzenia oraz do struktury planowanego systemu nadzoru. Szkolenie powinno obejmować nie tylko podstawowy trening metodyczny, ale również przygotowanie motywacyjne.

Słowa kluczowe*: masowe zgromadzenia, choroby zakaźne, nadzór epidemiologiczny, zespoły objawowe*

ABSTRACT

Mass gatherings may be associated with particular health hazards including injuries, sun burns and thermal shocks and also infectious diseases. For that reason preparations for mass gatherings should include easy access to health facilities and enhanced epidemiological surveillance. Potential threat of bioterrorist attack should always be considered at mass gatherings.

In the preparation of the enhanced surveillance system increased cost of implementation and operation should always be considered. System based on functioning routine surveillance require less investment then newly implemented ones. New systems require also more training and usually more operational effort from the personnel who encounters it for the first time. Syndromic systems are noted for high sensitivity, but they require cooperation with laboratories for confirmation of diagnoses.

Of particular importance for effectively functioning enhanced surveillance is proper training of personnel which will operate it. Training should be tailored to the character and size of the gathering as well as to the structure of the implemented system. Besides technical training it should include also motivational aspect.

Key words: *mass gatherings, infectious diseases, epidemiological surveillance, syndromes*

INTRODUCTION

Defining mass gatherings by the number of participants causes serious methodological difficulties. The same number of people gathered in different areas may bring different problems depending on type of event, infrastructure, preparedness, and background density of the population on which mass gathering is superimposed. WHO document “Communicable disease alert and response for mass gatherings” defines threshold of mass gatherings as low as 1000, but recommends as generally acceptable numbers >25 000 people gathered at a specific location for a specific purpose and for defined period of time (1).

The basic distinction regarding mass gatherings is whether they are planned or not. The impact of mass gatherings is profoundly influenced by their purpose, number of participants, their demographic structure, local development of infrastructure, resources and preparedness of services if the event was planed (2).

Mass gatherings, which occur at planned sport and other social events, bring for organizers the whole spectrum of problems and challenges related to the logistics of the event, but also to security and safety of participants and nonparticipating permanent dwellers of the place or region where those events occur (1- 4).

Infectious diseases are not the only health hazards which may happen at mass gatherings, but they are among important threats. Potential sources of infections may be related to close proximity of participants at the events, creating conditions which may enhance spread of airborne infections. Large numbers of people using restaurants or food vendors increase possibility of food borne outbreaks. Some of mass gatherings may also facilitate social encounters, and bring possibility of STI or infections related to IVDU. Deliberate release of infectious agents also has to be taken under consideration as a potential treat of unestimated probability and unpredictable severity (5, 6).

Historically mass gatherings are probably as old as organized state. But for centuries they were a subject of care (or a headache) of political or religious leaders, but rarely of health or sanitary services. Although, with a dose of good will, testimonies from Middle Ages about prohibitions of entering markets at the time of plague may be interpreted as preliminary public health measures regarding human gatherings.

Modern public health approach to mass gatherings is relatively new. Medical interest in mass gatherings started most probably in early 70-ties in connection with potential substance abuse and injuries at music festivals (7, 8). Later more emphasis was put on other threats and on preparation and organization of medical services at those festivals (9-11).

Expectations of increased incidence of health problems in the other types of mass gatherings came later. Paper of *J. Franaszek*: "Medical care at mass gatherings", published in 1986, expressed supposition that at mass gatherings numbers of health problems among participants should be higher, then as it could be expected in the same populations not gathered at the events (12). In oncoming years more evidence was collected on incidence in the different categories of health problems and on the potential types of exposures which may be associated with disease incidence at mass gatherings. Extensive review of medical literature reporting health problems at mass gathering events prior to the year 2001 provides paper of *A.M. Milsten* at al. (13). Most of the studies collected in *Milsten* review had rather descriptive or postulative character and lacked deeper epidemiological analysis. In some of those events information on health problems was based on anecdotal case reports, in other on retrospective chart reviews. But since Olympic Games in 1984 in Los Angeles enhanced surveillance was gradually introduced and upgraded in increasing fraction of major international sport events (14).

PRACTICE AND RATIONALE BEHIND ENHANCED SURVEILLANCE AT MASS GATHERINGS

As it was mentioned above, in the last decades enhanced surveillance of infectious diseases was implemented in some of the mass gatherings at sport or religious events. Despite wide recognition of the importance of early and highly sensitive detection of health events at mass gatherings, specially implemented syndromic surveillance systems (SSS) are relatively rarely applied, although fraction of mass gatherings with such systems increases.

In their comprehensive assessment Sniegoski et al. compared systems of enhanced surveillance applied at different sport events: Summer Olympics, Winter Olympics, and World Cup (soccer) since 1984 up to 2007. Out of six Summer Olympics syndromic surveillance was applied in 1984 Games in Los Angeles (California) and in Athens in 2004. In Winter Olympics syndromic surveillance was used in Salt Lake City (Utah) and in Torino (Italy). Regarding World Cup (soccer), syndromic surveillance was implemented in 2002 in Korea and Japan (14-22).

Enhanced reporting of diseases and syndromes by phone three times per week was the essence of the system employed at Los Angeles (1984) Olympic Games (23). In 1992 Summer Olympics in Barcelona routine reporting was upgraded by adding diseases and increase of frequency of reporting (24). In 1996 in Atlanta lab reporting was augmented. Additional surveillance system for Olympic clinics was also created (14). In the 1998 World Cup in France "activated" reporting of modifiable diseases was used. Computer system to analyze data and produce reports was also created (18). In 2000 Summer Olympics and Para-Olympic Games in Sydney, augmented reporting was introduced. It was supplemented by sentinel surveillance organized by Epidemiology Department for Olympic clinics, cruise vessels, food safety, environmental health and global epidemiological news (25). For 2002 Winter Olympics in Salt Lake City system ALERT was created and also drop-in RODS, real time public health surveillance system was installed. During World Cup in Japan for syndromic surveillance was used web-based national

Emergency Medical Info System (26). In 2004 Summer Olympics and Para-Olympic Games in Athens cases of infectious diseases were reported daily. Syndromic surveillance of hospital outpatients, athletic venues and cruise ships was also implemented. This system required high operational effort since most of the work was done manually (14, 16). At Winter Olympics in Torino was implemented augmented system for selected diseases and labs and also toxic exposures, which were reported with increased frequency. Syndromic surveillance was also introduced and coded manually (14, 19). During 2006 World Cup in Germany augmented reporting was performed by means of SurvNet web system with increased frequency. Daily summary reports were obtained from local physicians. An additional free text reporting system was also introduced for relevant public health events, as it were defined by local state health departments. In parallel it was continuous monitoring of domestic and international media for epidemiological events. German system was remarkable for domestic and international spread of publicly available data and information (27, 28, 29). During Euro 2004 in Northern Health Region of Portugal following adverse health events were reported on daily basis by phone or e-mail by physicians: foodborne outbreaks, legionnaire's disease, meningococcal disease, acute flaccid paralysis, diphtheria, measles, and unexpected adverse health events. Zero reporting was required (30). Enhanced surveillance during Euro 2008 in Austria did not include syndromic surveillance. It was based on enhanced surveillance by health authorities and food safety sector. The reports on outbreaks and special events were send daily. In addition the reference laboratories reported daily on potential clusters of confirmed cases (31, 32).

Terrorist attack on World Trade Center in New York, was a turning point for security measures in sport events, especially in the USA. In 2001 enhanced surveillance was implemented in Super Bowl (American football league semifinals and final). All seven annual Super Bowls between 2001 and 2007 had enhanced surveillance, but syndromic surveillance was implemented in three of them: Tampa (Florida) 2001, Jacksonville (Florida) 2005 and Miami (Florida) 2007. For Super Bowl in Tampa special computerized surveillance system STARS was created, for Jacksonville system BioDefend and in Miami system ESSENCE. Novel solution in 2007 Super Bowl was inclusion of zip codes into data so territorial and age grouping was done automatically (14).

More profound insight into interdependencies between circumstances and health outcomes may lead to models better prioritizing environmental and behavioral factors functioning in mass gathering setting. This would allow for the more effective interventions. Important attempt in this direction was done in a series of papers by *P. Arbon*, who tried to develop conceptual models for mass gathering health (6, 33-37). In order to obtain comparability of different studies, he started from defining basic measures of reported incidence - patient presentation rates (PPR), transport to hospital rate (TTHR). Then he attempted to classify key characteristics with potential effect on PPR, such as: size of the event, the weather, duration of the event, exposure of participants (indoor vs. outdoor events), mobility of the crowd, type of the event, emotions of the crowd, type of terrain, demography (distribution of age and gender), availability of booze and drugs. His preliminary model divides the key characteristics of mass gathering events into three inter-related domains: biomedical, psychosocial and environmental. He believed that his models may help to understand epidemiology of mass gatherings and encourage further research and "to facilitate the development of knowledge base, that we apply into practice". A question remains how realistic is such a program. Number of different factors and variability within each of them and between different mass gatherings is such, that even the most meticulous analyses of past events may offer only crude estimations of variables to be measured in future ones. On the other hand past experience, even imperfect as it is, provides kind of confidence interval for rational predictions which may help in planning events and formulate guidelines and checklists as a frame for preparation to the oncoming event. Also postulate of some standardization of registered variables in order to make studies more comparable is worth consideration.

Implementation of enhanced surveillance during mass gatherings brings several theoretical questions regarding its purpose, need, and extend needed. There are also technical questions of big importance. They concern size of the event, place where it occurs, locally existing infrastructure with special reference to medical and epidemiological services including surveillance system, its technical organization staffing and technical armament. Climate, season, and weather are important variables (6).

If enhanced surveillance is being considered, cost of its implementation and operational effort should be also analyzed (38).

THE PURPOSE OF ENHANCED SURVEILLANCE AT MASS GATHERINGS

Early publications indicating increase of adverse health events during mass gatherings are in accord with intuitive insight into the circumstances, which are known as potential risk factors of infections, injuries, cardiovascular incidents and other adverse health reac-

tions (12). Learned assessment of those risks is essential for focusing attention on certain groups of participants or permanent dwellers and also for planning extra services, mobilization and training of personnel as well as for estimation of the extra costs. Expectations are that enhanced surveillance may provide more accurate data on the disease burden related to mass gatherings (39-45).

Another rationale for enhanced surveillance is direct finding of cases which may need medical assistance and discovering of outbreaks, which require full work up including administrative decisions (9, 46-48).

One of the most important tasks in planning enhanced surveillance at mass gathering is preparation for bioterrorist attack. It requires preparation of special measures, which would assure early detection and could minimize potential effects of deliberate release of infectious agents, which may have unusual characteristics for the place and population, may have unpredictable properties in terms of virulence and drug resistance, and may be released in a way different from well known patterns of diseases spread. (49-50)

THE RELIABILITY

Regarding enhanced surveillance at mass gatherings question remains how reliable is obtained information, which indicates increased incidence observed at those events. In another words: what fraction of reported cases depends on increased incidence and what is related to increased sensitivity of surveillance resulted from increased commitment of people reporting or by introduction of new reporting tools, like sentinel posts of syndromic surveillance systems. In assessment of detecting algorithms is also important quality of the basic surveillance system in a particular place. With an efficient local systems some enhanced surveillance algorithms may not provide any additional value for outbreak detection (51)

Reliable comparison of the background of local epidemiological conditions as reported in routine surveillance with results of enhanced surveillance would require implementation of enhanced surveillance in the same place at another time when there would be no mass gathering. Seasonal or annual fluctuation should be taken under consideration as potential effect modifying factors. So far, such an assessment of epidemiological background which would be based on enhanced surveillance out of the event, was rarely done (52).

Another problem may be related to the fact that age and gender distribution of cases may differ between pre gathering background and during the event. It may reflect differences between local demography and demography of the participants.

EVALUATION OF PREVIOUS EFFORTS OF ENHANCED SURVEILLANCE

Good example of structured evaluation of enhanced surveillance at mass gatherings was prepared by *Lombardo* and al (53). In the part focused on the risk of infectious diseases those authors first analyzed primary aspects of mass event i.e. increase of the population and population density and population movement. As factors related to the risk of infections connected to the size of the population they listed increase of absolute number of initial cases, then frequency of interpersonal contacts and increased proximity of those contacts. It would be advisable to estimate relative importance of those factors in the process of hierarchization of the analyzed events.

Another important aspect depends on population movement and on contacts between population groups: exposure of locals to visitors, exposure of visitors to locals and spread of infection to domestic population of visitors. As secondary aspects Lombardo et al. lists behaviors and customs of participants as well as new services, then breakdowns in infrastructure and finally potential for terrorist attack.

When reviewing enhanced surveillance practices those authors suggest to start with evaluation of the effort required for setup and then for maintenance of the surveillance system. Setup effort depends on projected expectations regarding coverage, sensitivity, timelines and quality of the data as well as on the existing surveillance system on which enhancement was superimposed.

Operational effort depends mostly on information structure of the system, extend of automatic procedures its elasticity and simplicity and obviously on the professional skills of the personnel. Electronic system generally require less operational efforts then paper and pencil ones, but on the other hand they put higher requirements to the personnel operating the system. Implementation of any new, not operating before the event, additional surveillance system (sentinel, syndromic) increases both setup and operational effort.

The next important aspect in evaluation concerns sharing results. What is shared: data or information or both? Is it raw or structured? With whom it is shared? How wide is the sharing: within local jurisdiction or inter-jurisdictionally? Is information available publicly, or is it shared within administrative authorities? (54)

Within any structure, quality of surveillance depends on proper choice of variables to be reported. Clear and well documented methodology for prioritization was provided by a group of authors from Robert Koch Institute, who introduced specially designed three tiered scoring system. With use of weights representing local

specificity and characteristics of the event those criteria may be well applicable to choose priorities for enhanced surveillance in mass gatherings (55).

MEASUREMENT OF THE LOCAL PREPAREDNESS TO THE EVENT

Enhanced surveillance is one of many aspects of local preparedness to the event. Other aspects are related to existing material resources and infrastructure, availability of human personnel, and its professional education, training targeted for the purpose and if possible experience in participating in the previous events of similar type. Numerous sources provide extensive description of elements needed for the effective preparation to mass gatherings with all possible areas of importance: legal base, safety and security, transportation and traffic regulation, accommodation, food supply, media, communication, and many areas of public health including infrastructure and preparation of health services including surveillance of infectious diseases and of other adverse health events (1,2,13,53,56,57).

The simplest way to evaluate preparedness to the event would be by using one of numerous ready checklists, and to try it point after point. Problem is, that such an approach would be highly insufficient, because the most difficult task in assessment of the preparation to the event is in adaptation of general rules to the particular case with estimated size, expected demography, duration of the event, crowd density and mobility, local health and hygienic problems, hygienic customs of the visitors, epidemiology of infectious diseases in the country (and county) of event, and in the domestic countries of visitors.

Special attention is required to indicate which points of the chosen checklist have universal character, and which should be adjusted to the event and hosting country (or countries), and which in certain particular events could be omitted. It would be also very useful to introduce criteria for grading importance of points to be checked as well as of obtained responses.

With limited resources prioritization of problems related to the preparation of the events on local and national levels, is crucial for the rational planning of the budget (2,58).

SYNDROMIC SURVEILLANCE – SOLUTION AND A PROBLEM

Identification of the agent is of crucial value in routine surveillance of infectious diseases. It finally confirms clinical diagnosis and provides basis for treatment, narrows possibilities of transmission and points to potential sources. But identification of the agent requires involvement of laboratory and, what in some circumstances may be particularly important, requires more time then direct reporting of signs and symptoms. Meaning of the term "syndrome" in syndromic surveillance differs from clinical use of the same term. It may be based on few positions or even a single one from the short list of signs or symptoms, which are characteristic for the disease or group of diseases of particular interests. Such "particular interest" may emerge from outbreak potential (for example diarrhea with vomiting) or seriousness of the disease (eg. meningitis or encephalitis). In any case public fears and media interests should be taken under consideration, but never as a sole criterion (36,54).

In a broad meaning syndromic surveillance may include surrogate indicators of illness such as medicines purchases, which may reflect appearance of prodromes of diseases before full blown symptoms may occur. It is important to note that different indicators have different timing of development regarding stage of infection and may have independent sensitivities. In general the earliest reporting may come from school or work absenteeism, then over counter drug sales, those which are based on seeking ambulatory help, emergency transportation or emergency room notification. Systems which use multiple sources of reporting should rather analyze them separately to avoid messy data and duplicate records (59,60).

In evaluation of existing syndromic surveillance systems most of the authors point to problems with poor timeliness and low level of acceptance especially at the reporting stage in contrast to good timelines of further processing. Level of acceptance and timeliness happen to be particularly poor when reporting is done by people out of public health professions.

Most of the systems used for syndromic surveillance, including those which were designed for mass gatherings, focus on signs and symptoms of diseases actually reported in routine surveillance like flu like symptoms or on diseases with bioterrorist potential. They were tested in special simulation exercises and in real mass gatherings, but extremely rarely, if ever, on actually occurring terrorist attacks. Some of them include quite sophisticated statistical packages with algorithms aimed at detecting outbreaks with adjustment for seasonal variations in incidence. *Stoto* et al. performed modeling exercise to assess conditions under which syndromic surveillance is effective for the purpose of grading effectiveness of different algorithms. They compared four different schemes of syndromic surveillance for detection of flu like symptoms. First was daily reporting of cases, second was based on moving average with increased weight for recent cases, third used cumulative deviation from the constant expected

value and the fourth used cumulative deviation from the constant expected value, which was adjusted for seasonal variation. According to *Soto* et al. those more elaborate algorithms are needed to secure sufficient sensitivity for detection of small outbreaks or early detection of bigger ones. Large outbreaks can be quite easily detected by almost any of the systems (61).

In systematic description of evaluation for syndromic surveillance *Chapman* et. al. point to three crucial stages: technical accuracy, case classification and outbreak detection. In technical accuracy they point to determination whether automated application performs its task and to standard reference which should be expert classification of chief complaint string, and not patient actual syndrome. Regarding case classification they stress importance of diagnostic quality of chief complaint classifier and chief complaint content. Then for outbreak detection they analyze accuracy and timelines. This task is the most difficult since outbreaks are rare so not to much material for analysis is available (62).

It is obvious that detection of small excess of cases with flu like symptoms may be crucial in case of bioterrorist attack with an agent causing infection, which starts with those symptoms. But with many seasonal viral infections such a small excess has minor public health importance. This is why one of the most important and difficult problems at mass gatherings is integration of syndromic surveillance into public health system to ensure prompt confirmation of those excessive cases and starting prophylactic and control measures. The more sensitive surveillance system would be able to detect smaller number of excessive cases over higher background of incidence. Problem is that task of indication, which of those cases are caused by deliberate release and which belong to the background, syndromic surveillance leaves to thorough outbreak investigation with involvement of the health care system. Syndromic surveillance is designed to set alarms, but what has to be done with those alarms: its confirmation or rejection, preventive and control measures, belongs to other services of the health care system in which syndromic surveillance is embedded. In any planning of implementation of syndromic surveillance, concern whether systems of medical care and public health would be able to implement obtained data, is of paramount importance, since the final value of any epidemiological information belongs to its practical application (63-65).

Complete evaluation of the enhanced surveillance at mass gatherings would include many measures, rarely mentioned in literature and even rarer proceeded in the fields. Probably the most difficult would be accountability of performance measurement (cost/benefit, efficiency and effectiveness). They should be measured against health outcomes which may occur or not. Anyway, basic cost of the surveillance activities has to be assessed despite the problems with estimation benefits (60,66,67).

In ex post assessment other features of the quality of the system and of its performance like usefulness, flexibility, ease of use, reliability, data presentation and information sharing should be also taken under consideration even if no ordinal numbers could be put behind the evaluation (54).

TRAINING FOR SURVEILLANCE AT MASS GATHERINGS

For the purpose of building enhanced surveillance capacity at local and national level properly organized training may be necessary to secure effective performance, increased acceptance and quality of leadership.

Training should be adjusted to the planed system of surveillance at all of it levels. Sophisticated computerized systems of analysis require in depth training of on the basic system functionalities, statistical methods used and data interpretation, visualization and presentation. In the last part of this training public health officials should participate to help them in interpreting the data and also to receive feedback regarding data clarity and practical usefulness.

Effective system of training should cover personnel at different stages of competence and professionalism including epidemiologists, health professionals who are not epidemiologists and lay people who may participate in collecting and supplying epidemiological data. Inclusion of people on different levels of competence requires separate courses, but for the purpose of effective coordination of surveillance activities, part of the training, especially practical exercises, should include participants at all levels of competence. Besides technical skills training should include promotion of acceptance, motivation and psychological preparation to unexpected adverse outcomes. It would be also advisable to include in the system elements of leadership training for future local leaders.

One of important issues in preparation of training scheme is proper timing. Early training, long before planed events would be effective regarding well motivated health professionals. Non professional participants would be better motivated in the atmosphere of oncoming events, but of course not in the "last minute" when they are busy with their other urgent obligations (68,69).

Regarding basic education not focused on particular mass gathering of interest, here are numerous internet commercial e-learning courses covering elements of syndromic surveillance for people interested in self education. There are also special courses, run at many schools of public health, focused on public health problems including syndromic surveillance. Although geo-

graphical distribution of those courses is not uniform, in terms of availability of such courses Europe lags behind North America, SE Asia and Australia.

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