

Original Research

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Norwegian Emergency Medicine Systems' Training and Equipment for Penetrating Injuries: A National Survey-Based Study

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Abstract

Objective: Recent terror attacks led the Norwegian government to develop a procedure for emergency and law enforcement services cooperation during Active Violent Incidents (AVI, abbreviated PLIVO in Norwegian). To address further national initiatives to improve preparedness for mass casualty events and penetrating injuries among emergency medical services (EMS) in Norway, training and equipment status were mapped.

Methods: All EMS regions in Norway were invited to participate in an electronic nation-wide survey about practical medical training in PLIVO scenario training and specific training in hemorrhage control and penetrating injuries.

Results: Ninety percent (842/938) had attended at least 1 PLIVO training scenario. Of these, 76% (642/938) reported only evacuation training during the exercise, while only 20% (168/938) had practiced hemorrhage control. Eighty-one percent (760/938) respondents reported that they were equipped with tourniquets and 91% (853/938) were equipped with gauze to pack wounds. However, only 52% (487/938) and 48% (450/938) reported practical training in tourniquet application and wound packing, respectively, while 30% (280/938) reported that they had no training or only theoretical education in tourniquet application. Supervised practical training on penetrating thoracic injuries was reported by <20%, and <50% reported practical training in needle decompression of a tension pneumothorax.

Conclusions: Enhanced focus on training in hemorrhage control and penetrating injuries is needed. This supports the recent decision from the Norwegian government to strengthen the training for EMS in AVI (PLIVO) exercises, by focusing on medical procedures in addition to evacuation training. Although the estimated response rate is 17%, we believe the large number of respondents still make the results valuable.

On July 22, 2011, Norway experienced the worst terrorist attack since World War II. The first strike was a large car bomb placed in central Oslo, killing 8 and wounding 90 people. The terrorist then drove to a political youth camp located on an island only accessible by boat and, disguised as a police officer, shot and killed 69 people and wounded 60.¹

Based on this experience from July 22 and other terror attacks in Europe, a national procedure for cooperation between emergency and law enforcement services during Active Violent Incidents (AVI, PLIVO in Norwegian) was made in cooperation with the Norwegian Directorate of Health, the National Police Directorate, and the National Directorate for Civil Protection. PLIVO is defined as an ongoing situation wherein 1 or more assailants are exercising lethal violence against multiple innocents.² The procedure was implemented through mandatory cooperation exercises among the ambulance services, fire and rescue departments, and local law enforcement. The initial focus of these exercises was the logistics of evacuating patients by creating temporary safe zones for emergency medical services and fire and rescue. Patient examination and wound treatment were not compulsory parts of the training, and many ambulance services did not practice this thoroughly during the joint exercises. Norway is divided into 4 geographic health regions, which are further divided to numerous health trusts. This study will refer to the 4 major health regions as Health Regions A-D.

The car ambulance service in Norway is 1-tiered. A regular ambulance is operated by 2 emergency medical technicians (EMTs) or paramedics (from now on grouped as ambulance personnel). Although there are 19 anesthesiologist-manned helicopter emergency medical services

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(HEMS) and a few physician-manned ambulances, the ambulance personnel can be expected to act alone in many cases with injured patients, and in the initial phase of a mass casualty event.

Equipment and training differ significantly between different emergency services and law enforcement across the country. Training in hemorrhage control and penetrating injuries is mostly local and based on the instructor's education and experience. Equipment is chosen by the emergency medicine leader in each health thrust, and there are no national guidelines regarding equipment or techniques for hemorrhage control.

To guide further national initiatives toward preparedness for penetrating injuries and extremity exsanguination in both single- and multi-casualty scenarios for the emergency medical services (EMS) in Norway, we assessed the current status of training and equipment.

Methods

All ambulance personnel in Norway are trained as advanced providers, compared with tiered EMT training in other countries. The education was initially based on short courses and "on the job" training, but in 2006, it was upgraded to 2 y of high school followed by 2 y of apprenticeship training before authorization. In later years, a college-level education as a paramedic was introduced, but implementation of this has varied greatly across the country. Several universities and colleges in Norway are now offering a bachelor's degree in prehospital medical service (paramedic), which may eventually replace the current educational requirements. In the current curriculum for the EMT training, examination and treatment of penetrating wounds is not specified, and we found it lacking in a previous study.³

All EMS regions in Norway were invited to participate in an electronic survey concerning practical medical training within PLIVO scenario training as well as specific training in hemorrhage control and penetrating injuries. Demographic data such as geographic region, level of education, experience, age, and job description, were also registered to allow to adjust for confounders in the final data analysis.

All prehospital personnel are assumed to have a user account on the NAKOS (Norwegian National Advisory Unit on Prehospital Emergency Medicine) Web portal, designed to educate emergency medical personnel through e-learning courses. An email was sent to all prehospital personnel registered in the NAKOS Web portal. The email contained a link to an online survey (Questback Essentials) with an anonymous reply, securing the respondents full confidentiality. Three months after the distribution of the survey, the EMS directors were emailed by the director of the EMS service in Oslo University Hospital, with a premade attachment encouraging them to pass out a reminder of the questionnaire. We do not know how many of the NAKOS user accounts belong to active ambulance personnel. This is a weakness when trying to calculate and analyze the response rate. We received almost 1000 answers on the survey, and almost all health trusts in Norway were represented. We considered this number of feedbacks sufficient to map the current status of hemorrhage control training and equipment in Norwegian EMS.

The Norwegian National Statistics – Statistics Norway provides statistics on the Norwegian society and reports that there were 5500 operative employees in the EMS in 2017 (including employees on sick/maternal/paternal/educational leave).⁴

Data from the electronic survey were imported into IBM SPSS Statistics 24 for analysis. Descriptive analyses of proportions were

conducted to describe the current education and training situation. We also ran a logistic regression to investigate the association between different health regions and practical medical training during PLIVO scenarios. A logistic regression was also conducted to examine the associations between equipment in the ambulances and the specific training on use of this equipment.

Results

A total of 938 respondents answered the survey. The exact answer rate is not known as we do not know for sure how many potential respondents received the survey. If all EMS employees received the survey, we could report a response rate of 17%; however, we do not know that for certain. We thereby state a response rate of at least 17%. Respondents represented all 4 major health regions (Health Regions A-D) and, thereby, met the aim of a nation-wide survey. The response rate did not differ significantly between the regions.

The baseline demographics of the respondents showed an even distribution in age, experience, and education, except for the youngest and oldest ages (>60 and <24 y), least experience (0-2 y), and female gender, which were all underrepresented (Table 1).

According to national statistics (2016 numbers), 40% of employees in EMS are women, the overall median age of the Norwegian EMS is 31 y.

Our data showed no significant differences in the age distribution among respondents between health regions: Median age Health Region A, 32; B, 30; C, 37; D, 34 ($P = 0.143$). The proportion of female gender showed no significant differences between regions ($P = 0.234$).

Attending at least 1 PLIVO training scenario was reported by 842 (90%). Of these respondents, 642 (76%) reported having been solely trained on evacuation during the exercise. Only 168 of 842 (20%) had hemorrhage control training included in the scenario training.

Of the respondents, 760 (81%) reported that they are equipped with tourniquets and 853 (91%) reported that they are equipped with gauze for wound packing. However, only 487 (52%) and 450 (48%) reported having had practical training in tourniquet application and wound packing, respectively (Table 2). As many as 280 (30%) claimed that they had no training or only theoretical education in tourniquet application.

Less than 20% reported supervised practical training in penetrating thoracic injuries, and one-third reported neither theoretical nor practical training in this procedure. Less than 50% reported practical training in needle decompression of a tension pneumothorax (Table 2).

We found no significant differences in the proportion of EMS employees participating in practical procedure training under supervision among the 4 Health Regions (chi-squared test of homogeneity; $P = 0.883$) (Table 3).

Our data showed no significant associations between the different Health Regions and practical medical training during PLIVO scenarios (Table 4).

Discussion

We found that Norwegian EMTs in this survey report that they are better equipped than trained to handle penetrating injuries in both single-patient scenarios and mass casualty events.

Several security and emergency measures have been implemented in response to domestic and international terror attacks.

Table 1. Demographics

Age (y)	Years of Service in EMS		Highest Level of Education		Gender		
<24	91 (9.7)	0-2	118 (12.6)	Bachelor and/or paramedic	457 (47.9)	Male	625 (66.6)
25-35	282 (30.1)	3-6	196 (20.9)	Certified EMT	455 (48.5)	Female	313 (33.4)
36-45	285 (30.0)	7-15	348 (37.1)	Other	26 (2.7)		
46-59	255 (27.2)	>16	276 (29.4)				
>60	25 (2.7)						

Table 2. Descriptive data of reported skill training

	Tourniquet	Wound Packing	Open Thoracic Injury	Needle Decompression
Only theoretical	112 (12.0)	162 (17.3)	280 (29.9)	220 (23.5)
Demonstration of procedure	171 (18.2)	155 (16.5)	167 (17.8)	187 (19.9)
Practiced procedure with supervision	487 (51.9)	450 (48.0)	181 (19.3)	420 (44.8)
No training in the procedure	168 (17.9)	171 (18.2)	310 (33.0)	111 (11.8)

Table 3. Practical training with supervision in each Health Region (A-D)^a

	Tourniquet	Wound Packing	Open Thoracic Injury	Needle Decompression
Health Region A	84 (54.2)	71 (45.8)	29 (18.7)	81 (52.3)
Health Region B	262 (60.0)	216 (50.1)	92 (21.3)	199 (46.2)
Health Region C	121 (63.7)	108 (56.8)	36 (20.5)	94 (49.5)
Health Region D	18 (11.6)	33 (34.2)	20 (12.9)	45 (29.0)

^aPercentages of total respondents within each region in parenthesis.

Table 4. Association between Health Region and training on practical medical procedures (other than evacuation) in the joint practical scenario training on PLIVO (AVI)

	OR Unadjusted	P-Value	OR Adjusted ^a	P-Value
Health Region A	2.50 (CI, 0.76-8.20)	0.128	2.37 (CI, 0.71-7.97)	0.161
Health Region B	1.62 (CI, 0.52-5.00)	0.401	1.57 (CI, 0.49-4.97)	0.443
Health Region C	2.46 (CI, 0.77-7.91)	0.128	2.16 (CI, 0.65-7.17)	0.205
Health Region D	2.89 (CI, 0.86-9.65)	0.844	2.37 (CI, 0.71-7.97)	0.107

^aAnalysis adjusted for respondent's experience in years, age in years, type of employment (leader, trainee, EMT, paramedic). Abbreviation: CI, confidence interval; OR, odds ratio.

One component was the procedure on joint efforts between law enforcement, fire departments, and emergency medical systems during ongoing lethal violence, the PLIVO procedure.² From its implementation in 2015 up until now, EMS have mostly focused on evacuation training during these exercises. Evacuation is very important in mass casualty events,⁵ but massive hemorrhage kills within minutes. Recent military experience has shown that rapid intervention and control of extremity hemorrhage with tourniquets improves survival rates, decreasing preventable deaths by more than 50%.⁶⁻⁹ Our respondents reported a low rate of hemorrhage control training in PLIVO exercises, and only half of the respondents had ever trained practically with supervision

on tourniquet application in their general training. The national core curriculum states that EMTs should be able to identify and treat life-threatening injuries in general, but skills in hemorrhage control are shown to be highly variable in a study from 1 Norwegian Health Region.^{3,10} If it is not within the scope of the PLIVO program to teach these skills, another program should be made. A US survey revealed that the slow incorporation of military medical techniques in civilian prehospital practice is caused by concerns of safety and effectiveness, expenses, and lack of training.¹¹ The Norwegian National Advisory Unit on Trauma is currently suggesting a national procedure for tourniquet use, which might mitigate concerns on safety and training.

The Norwegian Directorate of Health has taken the initiative to strengthen the training for ambulance personnel in the PLIVO procedure exercises by improving practical training in medical procedures in addition to the evacuation training. Our study supports the lack of training in hemorrhage control and penetrating injuries in previous exercises. Our results do not reveal any differences between the 4 major health regions, suggesting that there is a nation-wide need for more focus on training on penetrating trauma and hemorrhage control.

Recent mass casualty incidents, such as the acts of violence in Las Vegas, Nevada, and Parkland, Florida, have underlined the need for improved prehospital interventions to reduce mortality.^{12,13} Incorporation of tourniquets in civilian EMS has been mentioned as 1 of the success factors in the Boston marathon bombing.¹⁴ Equipping ambulance personnel with the necessary skills and tools is paramount to avoid preventable deaths.

During the implementation of the PLIVO procedure, the vast majority of the emergency and law enforcement services in Norway participated in both theoretical and practical training. This proves that we have the potential to educate a large number of emergency personnel over a short period of time if deemed necessary.

Limitations

Data were collected from an individual survey-based study. Individual surveys are not able to follow trends in real time or over short periods of time. We cannot tell if local initiatives are trending toward more practical training during PLIVO scenarios. In a survey-based study like this with an unknown but possible <20%

response rate from the total EMS population, we cannot adjust for selection bias and we cannot know for certain that our population is representative of the total population working in EMS in Norway. Forty-seven percent of our respondents had a bachelor's degree or were paramedics, while the national average in bachelor's degree among personnel working in the Norwegian EMS is 25%. Female gender was also underrepresented among respondents compared with total population (33% vs 40%, respectively). This suggests that our study population may not be representative for the total population.

We still believe that a survey-based study like this is a valuable precursor for planning and designing intervention studies on the implementation of enhanced training in hemorrhage control and treatment of penetrating injuries.

Conclusions

We found that the vast majority of emergency medical personnel who answered the survey had participated in joint exercises in ongoing lethal violence. The initiative from Norwegian Health Authorities on strengthening the focus on treating patients during these exercises is a much-needed element, as a minority of the participants had practical training in hemorrhage control and penetrating injuries from their local EMS education program.

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Conflict of Interest. None of the authors have conflicts of interest to declare.

Ethical Standards. Every user signed a declaration of consent that allows data collected in the NAKOS portal to be used for research and quality assurance when they generate a profile.¹⁵ Because data from the present study did not contain personal information, it was not necessary to report it to the Norwegian Center for Research data.¹⁶ Data were deleted from the user page after it was transferred to SPSS, and it is, therefore, not possible for the survey platform to trace the IP addresses. According to Norwegian regulations, approval from the Regional Committees for Medical and Health Research Ethics was not necessary because the study did not include patients or patient data.¹⁷

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