

# HEMS in Slovenia: One Country, Four Models, Different Quality Outcomes

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## Abstract

**Objective:** The objective of this study was to determine the quality of patient care using quality indicators in 4 different Slovenian helicopter emergency medical service (HEMS) models.

**Methods:** This was a cross-sectional study of all 4 HEMS in Slovenia. We collected data on quality for the period from July 2003 to August 2008, in a sample of all eligible patients that were managed by HEMS during the study period (N = 833). We obtained the following data on emergency operations: the time and organizational features of the operation; the description of the patients' condition; and the on-site diagnostic and treatment procedures. We used the following as quality indicators: the number of resuscitated patients that were intubated; the number of patients with a Glasgow Coma Scale (GCS) score of  $\leq 8$  that were intubated; the number of patients with acute coronary syndrome that received treatment with morphine, oxygen, nitroglycerine, and aspirin (MONA); the number of patients with a National Advisory Committee on Aeronautics (NACA) scale score of  $\geq 4$  with an intravenous line; the number of patients with a NACA score of  $\geq 5$  that were given oxygen; and the number of patients with a NACA score of  $\geq 4$  that were given appropriate analgesic treatment.

**Results:** Across all HEMS bases, 36 (87.8%) resuscitated patients were intubated; 122 (81.9%) patients with GCS  $\leq 8$  were intubated; 149 (89.2%) patients with ACS were given MONA treatment; 52 (92.9%) patients with a NACA score of  $\geq 4$  were given an intra-

venous line; 254 (92.7%) patients with a NACA score of  $\geq 5$  were given oxygen; and 18 (32.7%) trauma patients with a NACA score of  $\geq 4$  were given intravenous analgesics. The quality of patient management in HEMS in Slovenia is affected by the callout procedure, the presence or absence of a fixed rope, the type of helicopter operator, and the provider of the doctor in the helicopter team.

**Conclusions:** The data from our study indicates that the quality of patient management in HEMS in Slovenia is high. It also seems that organizational factors play a role in the quality management of patients in HEMS as well, but their effect remains unclear and needs further evaluation.

## Introduction

Quality helicopter emergency medical services (HEMS) play a significant part in modern Emergency Medical Systems (EMS) in many countries. This is especially true for Alpine and other mountainous countries (including Slovenia), because of the challenging geographical conditions, the often long response times, and other limitations of ground-based EMS units.

HEMS refers to an organization that provides helicopter rescue activity in a particular country. Usually it consists of 1 or more operational units called HEMS bases. HEMS need to be integrated into the existing EMS system and can then work effectively, following international standards; they can provide cover for the entire country.<sup>1</sup> Providing quality HEMS, adapted to the needs of patients while effectively managing financial and other resources in a particular country, is a very complex project from the organizational, technical, financial, and professional points of view.<sup>2</sup> It can be difficult to manage patients in accordance with the guidelines and recommendations for best practice, or even in accordance with evidence-based medicine, when the HEMS and EMS operate in a hilly or mountainous environment.<sup>3</sup>

Common problems in collecting data on the functioning of EMS and other emergency systems include diversity and lack of data, as well as different methods of collecting information. These facts make a comparison between services, systems, research, and standardization of EMS even more difficult.<sup>4</sup> Nevertheless, some of the key organizational and professional quality indicators in EMS and HEMS are well defined; the organizational ones include the activation of HEMS instead of an EMS team in clinically justified cases,<sup>5</sup> the anticipated shorter callout and response time,<sup>6</sup> and the higher speed, sensitivity, and safety of the transport.<sup>1,7</sup> The clinical ones are the

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**Table 1. Basic Features of Slovenian HEMS Bases\***

Base	Helicopter Operator	Type of Helicopter	Winch	Fixed Rope	Provider of Doctor	Activation by	Decision by	Average Number of Operations Per Year	Age of the Database (Years)
<b>HEMS SL</b>	Slovenian police AB-412	AB-109 AB-212	Often	No	Public	EMS and dispatcher	Doctor	250	2
<b>HEMS Brnik</b>	Flycom <sup>†</sup>	EC 135	Always	No	Public	EMS and dispatcher	Doctor	5	0 <sup>§</sup>
<b>PILOT HEMS</b>	Slovenian army	B 412	Sometimes	No	Public	EMS and dispatcher	Doctor	165	3
<b>HEMS SMR</b>	Slovenian army	B 412	Always	Yes	SMR	SMR and dispatcher	SMR	80	14

HEMS, helicopter emergency medical service.

\*Each base covers the same working area: 20,270 km<sup>2</sup>

<sup>†</sup>Private helicopter operator.

<sup>§</sup>This base operated only for 1.5 months.

number of intubated patients in appropriate cases<sup>8</sup>: the use of treatment with morphine, oxygen, nitroglycerine, and aspirin (MONA) in patients with acute coronary syndrome (ACS),<sup>9</sup> the placement of an intravenous line in appropriate cases; the application of oxygen in appropriate cases,<sup>10</sup> and proper analgesic treatment in appropriate cases.<sup>11</sup>

EMS systems (including HEMS) vary considerably between different countries. Most studies have focused on specific problems in specific environments (ie, 1 country, or even a particular region in a country),<sup>12</sup> or have described state-of-the-art HEMS in different countries.<sup>13-16</sup> A small number of studies have dealt with quality indicators<sup>17,18</sup> and with those measures that have led to their improvement.<sup>18-20</sup>

Slovenia is geographically a very diverse country, with 4 main geographical areas, the Alps, the Pannonian Plain, the Dinaric Mountains, and the Mediterranean. The majority of the land area of Slovenia is hilly or mountainous, with around 90% of the surface lying at 200 meters or more above sea level. In Slovenia there are 2 different HEMS services, the Slovenian HEMS (HEMS SL) and the Slovenian Mountain Rescue Service HEMS (HEMS SMR). Both are based in adjacent buildings in Slovenia's main airport, Brnik. Nominally they cover the same geographical area (the whole of Slovenia), but in fact HEMS SL covers incidents mostly away from mountainous terrain (in areas where it is possible for a helicopter to land) and the majority of inter-hospital (secondary) transports. HEMS SMR primarily covers the hilly and mountainous areas, or terrain where it is often not possible to land and so special skills and equipment like a winch are required. Another 2 HEMS services operated for short periods of time in the past: Brnik HEMS (HEMS Brnik) was in operation from December 1, 2006, to January 12, 2007, and a pilot HEMS Brnik (PILOT HEMS), a precursor of HEMS SL, operated from July 7, 2003, to November 30, 2006.

Since there are only limited data available on the quality of HEMS in Slovenia, we decided to survey these 4 services. The aim was to determine the quality of patient care using quality indicators in the 4 different Slovenian HEMS models.

## Methods

### Study Design

This was a cross-sectional study of all 4 HEMS in Slovenia. We collected and analyzed data on the quality of the services during the period from July 2003 to August 2008. The National Medical Ethics Committee approved the study.

### Participants

All 4 Slovenian HEMS participated in the study (Table 1). All patients that were managed by HEMS during the study period were included. Only data from primary emergency operations (those which took place at the site of the emergency) were considered; secondary operations (hospital transportations) were excluded because they are usually not as urgent (and therefore have longer callout and response times) and patients are usually managed and stabilized by hospital doctors. We also excluded non-medical operations (rescue of healthy people and search operations).<sup>7</sup>

### Data Collection

We obtained data from the incident reports of emergency operations in each HEMS. Their standardized reports include information about time, the organizational features of the operation, a description of the patients' condition, and the onsite diagnostic and treatment procedures (Tables 2 and 3). They do not include personal data on patients which would allow their identification.

We used the following as quality indicators: the number of resuscitated patients that were intubated, the number of



patients with a Glasgow Coma Scale (GCS) score of  $\leq 8$  that were intubated, the number of patients with ACS that received MONA treatment, the number of patients with a National Advisory Committee on Aeronautics scale (NACA scale) score of  $\geq 4$  with an intravenous line, the number of patients with a NACA score of  $\geq 5$  that were given oxygen, and the number of trauma patients with a NACA score of  $\geq 4$  that were given appropriate analgesic treatment. The term *resuscitated* in this study means resuscitation for any reason (primary cardiac arrest, trauma, etc).

The intubation/resuscitation ratio gives the ratio between the number of patients intubated (for any reason) and those resuscitated (for any reason). It is a common ratio, regularly used as a quality indicator in emergency medicine, and should be as high as possible, at least 1.3.<sup>21, 22</sup>

The NACA scale is used to assess the severity of patients' clinical state in most HEMS in Alpine countries. A higher score indicates a greater severity of injury, demanding more medical care, and corresponds to a higher mortality rate.<sup>23</sup> Usually, out-of-hospital patients with serious clinical states which demand medical procedures (such as the use of par-enteral drugs, the application of oxygen, monitoring, etc.) score 4 or more on the NACA scale; we therefore used a score of 4 or more or 5 or more in our study. A GCS score of 8 or less indicates severe brain injury, usually demanding intubation, which is why we used this score here.

### Statistical Analysis

For the purpose of statistical analysis, we created the following dependent variables: the number of resuscitated patients with intubation; the number of intubated patients with GCS  $\leq 8$ ; the number of patients with ACS given MONA; the number of patients with NACA  $\geq 4$  with an intravenous line; the number of patients with NACA  $\geq 5$  given oxygen; and the number of trauma patients with NACA  $\geq 4$  given intravenous analgesics. These variables were considered as quality indicators. For the purpose of univariate analysis, we dichotomised categorical variables

and created new variables: HEMS SL (yes + HEMS SL base/no + other bases), HEMS Brnik (yes + HEMS Brnik base/no + other bases), PILOT HEMS (yes + PILOT HEMS base/no + other bases), and HEMS SMR (yes + HEMS SMR base/no + other bases).

Both descriptive and univariate analyses were carried out. For categorical variables, we used the  $\chi^2$ -test, and for continuous variables, we used the Mann-Whitney test. The limit for statistical significance was set at  $P < 0.05$ .

### Results

We included all 4 HEMSs, which engaged in a total of 833 operations. Of these, HEMS SL carried out 274 operations, HEMS Brnik 13, PILOT HEMS 454, and HEMS SMR 92 (Table 2). A winch was available (but not necessarily used) in 736 (88.4%) operations.

Across all the HEMS bases, 42 (4.9%) patients were resuscitated. Of them, 36 (87.8%) were intubated. Of 149 (17.9%) patients with GCS  $\leq 8$ , 122 (81.9%) were intubated, and of 167 (20.1%) patients with ACS, 149 (89.2%) were given MONA treatment. Of 56 (6.7%) patients with NACA  $\geq 4$ , 52 (92.9%) were given an intravenous line; of 274 (32.9%) patients with NACA  $\geq 5$ , 254 (92.7%) were given oxygen; and of 57 (6.8%) trauma patients with NACA  $\geq 4$ , 18 (32.7%) were given intravenous analgesics (Table 2).

The numbers of resuscitated patients that were intubated were not significantly different across the 4 HEMS bases. Similarly, the numbers of patients with ACS that received MONA treatment were not significantly different in the 4 HEMS bases. However, significantly more patients with GCS  $\leq 8$  managed by the medical team from the HEMS SL base were intubated, when compared to patients managed by the other bases (91.5% vs 75.6%,  $P = 0.016$ ). On the other hand, significantly fewer patients with GCS  $\leq 8$  managed by the medical team from the HEMS SMR base were intubated when compared to patients managed by the other bases (0% vs 85.9%,  $P < 0.001$ ). Significantly more patients with NACA  $\geq 4$  managed by the medical team from the HEMS SL base

Table 2. Quality Indicators of HEMS Operations

Base	No of Operations Resuscitated Patients	No of Resuscitated Patients and Intubated Patients	Intubation/Resuscitation Ratio	No of Patients With GCS $\leq 8$	No of Intubated Patients With GCS $\leq 8$	No of Patients With ACS Given MONA	No of Patients With NACA $\geq 4$	No of Patients With NACA $\geq 5$	No of Patients With NACA $\geq 5$ Given Oxygen	No of Trauma Patients With NACA $\geq 4$	No (%) of Trauma Patients With NACA $\geq 4$ Given IV Analgesics			
HEMS SL	274	25	21 (84.0)	5.9	59	54 (91.5)	58	50 (86.2)	29	29 (100)	102	100 (98.0)	32	14 (46.7)
HEMS Brnik	13	0	0	/	1	0	3	2 (66.7)	0	0	4	4 (100)	0	0
PILOT HEMS	454	16	15 (93.8)	3.2	82	68 (82.9)	105	96 (91.4)	20	18 (90.0)	159	147 (92.5)	19	4 (21.1)
HEMS SMR	92	0	0	/	7	0	1	1 (100)	7	5 (71.4)	9	3 (33.3)	6	0 (0)
ALL	833	41	36 (87.8)	4.4	149	122 (81.9)	167	149 (89.2)	56	52 (92.9)	274	254 (92.7)	57	18 (32.7)

HEMS, helicopter emergency medical service; GCS, Glasgow Coma Scale; ACS, acute coronary syndrome; MONA, morphine, oxygen, nitroglycerine and aspirin; NACA, National Advisory Committee on Aeronautics scale; IV, intravenous.

had an intravenous line, compared to patients managed by the other bases (100% vs 85.2%,  $P = 0.048$ ). Significantly more patients with NACA  $\geq 5$  managed by the medical team from HEMS SL received oxygen than patients managed by the other bases (98.0% vs 89.5%,  $P = 0.008$ ). On the other hand, significantly fewer patients with NACA  $\geq 5$  managed by the medical team from HEMS SMR received oxygen, when compared to patients managed by the other bases (33.3% vs 94.7%,  $P < 0.001$ ).

The quality of patient management in HEMS in Slovenia is affected by the callout procedure, the presence or absence of a fixed rope, the type of helicopter operator, and whether or not there is doctor in the helicopter team (Table 3).

## Discussion

According to the quality indicators studied, the quality of HEMS in Slovenia considering patient care, is high. The highest indicators were observed at the HEMS SL base and the lowest at the HEMS SMR base.

According to the literature, the individual quality indicators of the Slovenian HEMS are the same as or higher than those found in other studies. For example, the intubation/resuscitation ratio, which is one of the most important indirect indicators of the quality of an EMS, should be at least 1.3,<sup>22</sup> and was much higher in our study. Few studies have so far dealt with intubation rate. Helm and coworkers<sup>24</sup> reported 100% intubation success, but other studies have reported a rate of between 40% and 100%.<sup>24-27</sup> A high intubation/resuscitation ratio (or a high successful rate of intubations) is 1 of the indicators that for HEMS units is usually at least the same as, but is more often higher than, the level of care in ground EMS units.<sup>22</sup> Two possible reasons that account for the high number of resuscitated and intubated patients in our study are the presence of a doctor at all operations, and the fact that the majority of HEMS doctors (in HEMS SMR, only half) are trained to perform rapid sequence intubation, thus providing a higher intubation rate.<sup>28</sup>

Another established quality indicator is the percentage of patients with a GCS score of eight or less who are intubated.<sup>29</sup> In our study, 81.9% such patients were intubated, which is rather a high rate, but since we could not find any studies providing similar data from HEMS in other mountainous countries, we cannot compare our data with anywhere else.

The next quality indicator is the number of patients with ACS that receive MONA treatment. This treatment is the gold standard for managing such patients in out-of-hospital settings, although according to new guidelines oxygen application has limited indications in comparison with previous ERC guidelines.<sup>8,9</sup> At the time of the study, the new guidelines did not yet exist, so we adhered to the existing ones. In our study, most patients with ACS received MONA treatment, which is an indicator of good quality.

An intravenous line should be established for each seriously injured patient,<sup>30</sup> such as patients with NACA  $\geq 4$ .

**Table 3. Effect of HEMS Organizational Factors on Quality Indicators**

		% of Intubated Patients With GCS ≤ 8	% of Patients With NACA ≥ 4 With Intravenous Line	% of Patients With NACA ≥ 5 Given Oxygen	% of Trauma Patients With NACA ≥ 4 Given Intravenous Analgesics
<b>Winch during intervention</b>	Yes	86.4	95.9	94.3	35.4
	No	100	100	100	100
	P value	1.000	1.000	1.000	0.367
<b>Activation by</b>	EMS and dispatcher	85.9	95.9	94.7	36.7
	SMR and dispatcher	0	71.4	33.3	0
	P value	< 0.001	0.072	< 0.001	0.162
<b>Decision by</b>	Doctor	85.9	95.9	94.7	36.7
	SMR	0	71.4	33.3	0
	P value	< 0.001	0.072	< 0.001	0.162
<b>Fixed rope/short haul</b>	Yes	85.9	95.9	94.7	36.7
	No	0	71.4	33.3	0
	P value	< 0.001	0.072	< 0.001	0.162
<b>Helicopter operator: police</b>	Yes	91.8	100	98.1	46.7
	No	75.0	85.2	89.3	16.0
	P value	0.009	0.048	0.007	0.022
<b>Helicopter operator: army</b>	Yes	73.9	85.2	89.1	16.0
	No	90.3	100	98.2	46.7
	P value	0.030	0.048	0.004	0.022
<b>Provider of doctor</b>	Public	85.9	95.9	94.7	36.7
	SMR	0	71.4	33.3	0
	P value	< 0.001	0.072	< 0.001	0.162

HEMS, helicopter emergency medical service; GCS, Glasgow Coma Scale; NACA, National Advisory Committee on Aeronautics scale; EMS, emergency medical service; SMRS, Slovenian Mountain Rescue Service.

Again, the number of patients with an intravenous line was very high in our study. One probable reason for that is the fact that paramedics are usually part of the helicopter medical team (except in HEMS SMR) and they are well trained at establishing an intravenous line.

The treatment of pain is one of the basic procedures in any emergency medical care situation. There are no objective indications for analgesic treatment in out-of-hospital settings.<sup>31</sup> One useful criterion is a NACA score 4 or more, which usually indicates serious injuries which require appropriate analgesic treatment. In our study, appropriate analgesic treatment was administered to approximately one third of patients with a NACA score of ≥ 4. Not all patients managed in EMS should routinely receive oxygen.<sup>32</sup> In our study, almost two thirds of the patients with a NACA score of ≥ 5 received oxygen. It is difficult to judge whether these 2 quality indicators really indicate a high or poor quality of care in our study, since no objective data on the patients' level of pain were collected, and also no studies that deal with this problem could be found.

Regarding the possible effect of various variables on quality indicators, our data indicates that each variable studied in

this study had some effect, but this is very difficult to evaluate due to the small sample. Other studies have demonstrated the effect of the type of helicopter operator (private or public),<sup>14</sup> and activation procedure (dispatcher and triage system)<sup>7,33</sup> on callout and response times. In our study, we did not evaluate the effect of the type of helicopter on quality, because in the majority of the operations Bell 412s and AB 212s were used and these have very similar characteristics.

Our data indicated that HEMS SL had the highest quality of patient management among Slovenian HEMS, and HEMS SMR had the lowest quality. The probable reasons for the high quality of HEMS SL include: the fact that this base covers operations mostly away from mountainous terrain (in areas where it is possible for a helicopter to land), the helicopter team has a very skilled doctor and an emergency paramedic on board, and that patients are usually at least partly managed by a ground EMS at the scene. On the other hand, the reasons for the poorer quality which was found in HEMS SMR could be a consequence of the fact that HEMS SMR's operations are usually in difficult mountainous terrain, and that there is no emergency paramedic on board; besides the doctor, there are usually only mountain rescuers with first aid



knowledge present. Also, the average skills and experience of doctors working in HEMS SMR are lower in comparison to other Slovenian HEMS. We should also stress that the HEMS SMR team is usually the first and only medical and rescue team at the scene. This does not hold true for the other 3 Slovenian HEMS, which are usually activated by a ground EMS doctor who arrives at the scene of emergency as part of the EMS team, and provides at least partial emergency medical treatment to the patient.

Nevertheless, we should be careful with the interpretation of our data on the effect of variables on the quality indicators. Specifically, we do not know for sure whether some independent variables in our study really affect quality. Because of the small sample that the univariate analysis was based on, these findings could also be a result of chance. However, since there are a very small number of appropriate studies in this field, most of them report some effects of organizational variable.<sup>34-37</sup> The important thing is that such data are studied, documented, and considered in further research.

Callout and response times are also considered as quality indicators, but they do not indicate the quality of medical care, but rather the quality of the HEMS' organization.<sup>2</sup> For this reason we did not study the variables' effect on these times. Nevertheless, some factors that can affect these 2 times are organizational and technical, such as the features of the alert system, type of helicopter providers, configuration of the helicopter crew, location of the base, and others.<sup>20</sup> This gives us some confidence that the quality indicators of HEMS's medical care could be affected by these factors.

## Conclusion

The data from our study indicates that the quality of patient management in HEMS in Slovenia is as high as or even higher than that reported in other studies.<sup>22,24-26,34,37,38</sup> It seems that organizational factors also play a role in quality management of patients in HEMS, but their effect remains unclear. Further surveys should study quality indicators at an international level and on larger patient samples. Multivariate analyses of

these factors are crucial for determining which have an independent effect on the quality of HEMS care.

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