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Pre-hospital critical care by anaesthesiologist-staffed pre-hospital services in Scandinavia: a prospective population-based study

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Background: All Scandinavian countries provide anaesthesiologist-staffed pre-hospital services. Little is known of the incidence of critical illness or injury attended by these services. We aimed to investigate anaesthesiologist-staffed pre-hospital services in Scandinavia with special emphasis on incidence and severity.
Methods: This population-based, prospective study recorded activity in 16 anaesthesiologist-staffed pre-hospital services in Denmark, Finland, Norway and Sweden serving half of the Scandinavian population. We calculated population incidence of medical conditions, and the proportion of patients with severely deranged vital signs and/or receiving advanced therapy.
Results: Four thousand two hundred thirty-six alarm calls were recorded during 4 weeks. Two thousand two hundred fity-six alarms resulted in a patient encounter. The population incidence varied from 74.9 missions per 10,000 person-years (Denmark), followed by Finland with 14.6, Norway with 11, and Sweden with 5. Medical aetiology was most frequent (14.9 missions per 10,000 person-years, 95% CI: 14.2–15.8). Trauma was second (5.6 missions per 10,000 person-years, 95%CI: 5.12–6.09). Twenty-three per cent of patients had severely deranged vital functions, and advanced emergency medical procedures were performed in every four to twelve encounters (Denmark 8%, Sweden 15%, Norway 23%, and Finland 25%). The probability that the patient was physiologically deranged, received advanced medication, or procedure was 35%. Critical illness or injury occured at a rate of 25–30 per 10,000 person-years.
Conclusions: The incidence of pre-hospital anaesthesiologist patient encounters in Scandinavia varies. Medical aetiology is most frequent. Almost one-quarter of patients presents with deranged vital functions requiring emergency measures. The Scandinavian pre-hospital population incidence of critical illness and injury is 25–30 per 10,000 person-years.

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In Scandinavia, the backbone of the pre-hospital emergency medical service (EMS) is paramedic- and/or nurse-staffed ground ambulance services and general practitioners on call at local emergency clinics. This service is supplemented by rapid response cars and helicopters with specially trained physicians (usually experienced anaesthesiologists).[1,2] Although the structure of these services is reasonably similar, there are some inter- and intranational differences regarding mission profile and systems for dispatch. There is a common understanding in Scandinavia that equal and free access to health care – including the EMS – is a fundamental right for all. The physician staffed pre-hospital units are belived to contribute to this.

Anaesthesiologist-staffed pre-hospital services are integrated into EMS in Europe and Australasia.[2–8] Although different operational concepts have been established, one common element is a dedicated, specially trained physician who participates in the pre-hospital management of critically ill or injured patients. These services are expected to improve clinical decision making, diagnostic accuracy, and competence in emergency medical procedures compared to the alternative – most often a paramedic-staffed service.[9–11]

Rational planning and deployment of such units requires knowledge about the actual incidence of critical illness and trauma. Few data are available regarding the gross incidence of physician-provided pre-hospital critical care.

The aim of this study is to provide a population-based description of anaesthesiologist-staffed pre-hospital services with focus on the incidence of critical illness, severity of disease, and the number of advanced medical interventions performed.

Methods

Participant identification and recruitment

In this population-based prospective observational study we included anaesthesiologist-staffed air ambulance services, rescue helicopter services, and rapid response car services located in several urban and rural areas in Denmark, Finland, Norway, and Sweden. Participating services were identified using information from the ScanDoc 1a study[1] and via the professional network of the members of the ScanDoc consortium, a group of clinicians and researchers devoted to pre-hospital emergency care. Services were included based on the following inclusion criteria:

- Operational area in Scandinavia.
- Dedicated to pre-hospital critical care on a 24/7/365 basis.
- Ability to travel to the patient.
- Staffed by a physician trained in emergency care.

The respective medical directors were contacted by e-mail or phone and agreed or declined to participate in the study. No financial support was provided for participation. The study was funded by the Norwegian Air Ambulance Foundation.

Based on a desired observational time of 1 million person-years, data were prospectively collected during two 14-day periods: one during the summer of 2009, and one during the following winter (2010). The study period was seasonally divided to control for seasonal variations (e.g., trauma is more common during summer, and certain infectious diseases are more common in the winter).

Data quality assurance, presentation, and ethics

During the study period, all activity in the service was documented and reported. As 'activity' does not always include on-scene patient contact (e.g., supervision by radio communication and requests were also included), we labelled the episode of use as an 'event' rather than a 'mission'. To ensure the comparability of the collected variables, each variable was precisely defined, and the definition of 'event' was emphasised.

The variables included event operational data (e.g., time variables, vehicle used), patient characteristics and vital data, diagnostic and therapeutic interventions, and outcome. The patients' medical emergency was documented according to aetiology (medical, trauma, other surgical, psychiatric, gynaecological/obstetrical, or other); the medical condition according to the First Hour Quintet (FHQ)[12] (cardiac arrest, severe breathing difficulties, severe trauma, chest pain, and stroke); and finally according to the ICD-10 chapter most likely to pertain to the patient's emergency. Vital data were reported according to the Mainz Emergency Evaluation Score (MEES),[13] which is frequently used for benchmarking in many anaesthesiologist-staffed pre-hospital services in Central Europe. The MEES includes the Glasgow Coma Scale, heart rate, respiratory rate, systolic blood pressure, arterial oxygen saturation, heart rhythm, and pain; essentially MEES quantifies the difference between a score measured at first patient contact with the score at the end of care. Missing data were requested for completion from the participating services' databases.

Data analysis

Some services, e.g., the rapid response car service of Copenhagen, Denmark, dispose several units within their service area, while other services include both ground- and air-based units. Some areas might overlap with neighbouring services. We defined the population (i.e. number of inhabitants covered by each service) as reported by the medical directors of that service to be the denominator. The actual observation period was 28 days (4 weeks) for all services. The resulting incidence rates were reported as the number of events per 10,000 person-years,[14] with 95% confidence intervals.

In this study, we employed a 'three-dimensional' definition of a severely ill or injured patient (details in Table 1):

1. The patient had severely deranged physiology on arrival of the physician.
2. One or more advanced medical procedures were performed by the attending physician.
3. Advanced medication was provided by the attending physician.

The results are presented according to the STROBE guidelines for observational studies.[15] Descriptive statistics were given for country- and service-

specific data. SPSS® Statistics (version 20.0, IBM Corp, Armonk, NY, USA), Microsoft Excel (version 10.0 Microsoft Corp., Redmond, WA, USA) and the statistical software R version 2.15 (R: A language and environment for statistical computing, URL: http://www.R-project.org/) were used for the statistical analyses and graphical presentation.

The study was approved by the Regional Committee for Medical and Health Research Ethics of Central Norway (reference number: 2009/125-2) and the Norwegian Social Sciences Data Services (reference number: 21951/2/JE). The collected data were required to not contain patient identifiable information; thus no times, places, or reference numbers were reported. Approval was obtained from the respective authorities in each participating country.

Table 1

Study definition of the severely ill or injured patient.

Deranged physiology
Glasgow Coma Scale 7, or less
Heart rate 39 per minute or less, or 161per minute or more
Respiratory rate 4 per minute or less, or 31 per minute or more
Heart rhythm VT, VF, asystole or pulseless electrical activity
Systolic blood pressure 79 mmHg or less, or 230 mmHg, or more
Oxygen saturation 85% or less
Advanced medications
General anaesthesia
Antibiotics
Sedation
Vasopressor
Diuretics
Thrombolytic/anticoagulation
Vasodilator
Advanced procedures
Endotracheal intubation or insertion of supraglottic airway device
Invasive blood pressure measurement
Defibrillation
Fracture reduction
Non-invasive ventilation
Thoracocentesis
Initiation of therapeutic hypothermia
Central iv-line placement
Incubator
Transfusion
Intra-aortic balloon pump/ECMO
Other advanced treatment

ECMO, extracorporeal membrane oxygenation.

Results

Participants

The participating services covered a total of more than 12 million people, corresponding to almost half the combined population of Denmark, Sweden, Finland, and Norway (URL: http://www.norden.org/en/the-nordic-region/population, accessed 4 June 2013). The population in each area varied between 75,000 and 2,100,000 inhabitants (Table 2).

We recorded a total of 4236 events during the study period. Of these events, 986 (23%) represented supervision and/or consultation from other parts of the EMS, while 3247 (77%) resulted in a mission. Of the 3247 missions, 128 (4%) were inter-hospital transfers, and 93 times (3%) the unit was diverted en-route to a more urgent mission. In 627 (19%) of the missions, the first responding unit (typically an ambulance) cancelled the mission before arrival

Table 2

Participating services. Demographic and structural characteristics.

Site	Country	Population	Area (km^2)	Concept	Funding
Aarhus city	DK	650,000	2,000	RRC	G
Aarhus rural	DK	200,000	2,500	RRC	G
Copenhagen	DK	1,500,000	2,000	RRC	G
Odense	DK	400,000	6,000	RRC	G
Kuopio	FIN	811,000	85,000	RW, RRC	G,C
Oulu	FIN	500,000	60,000	RW, RRC	G,C
Helsinki*	FIN	850,000	7,000	RW, RRC	G,C
Banak	N	75,000	300,000	SAR, RRC	G,C
Bergen	N	465,800	15,440	RW, RRC	G,C
Dombås	N	75,000	33,400	RW, RRC	G,C
Trondheim	N	660,000	32,983	RW, RRC	G,C
Ørland	N	600,000	56,381	SAR, RRC	G,C
Oslo	N	2,150,000	31,240	RW, RRC	G,C
Lycksele	S	260,000	55,397	RW	G
Gothenburg	S	1,600,000	75,000	RW	G
Stockholm	S	1,900,000	6,519	RRC	G

*Vantaa region.
RW, rotor wing (helicopter); RRC, rapid response car; SAR, search and rescue helicopter; G, governmental; C, charity.

on-scene, and in 143 missions (4%), there was no patient at the scene. Ultimately, 2256 events resulted in on-scene patient encounter, and were analysed further (Fig. 1).

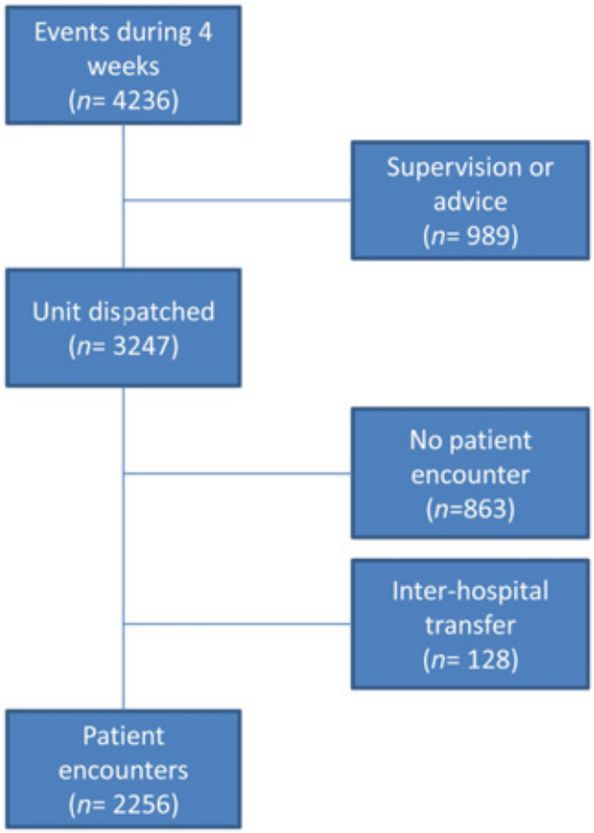

Fig. 1. Flowchart study population.

The incidence of missions per 10,000 inhabitants varied markedly; the Danish services had the highest rate, with 74.9 missions, followed by Finland with 14.6, Norway with 11, and Sweden with 5 (Table 3). A rural search-and-rescue helicopter service in Norway had the lowest overall incidence of missions with patient encounters, while a rural rapid response car-based service in Denmark had the highest incidence (3.3 and 143.4 per 10,000 person-years, respectively).

The incidence of missions involving a severely ill or injured patient (see below) did in general increase with the incidence of missions with patient encounters, but plateaued at approximately 25–30 missions per 10,000 person-years (Fig. 2). The same pattern was observed in all participating countries. Denmark generally had a higher incidence of missions but also a higher number of missions involving a severely ill or injured patient. Larger diversities were observed in the Finnish and Norwegian services (Table 4).

Time variables and mission outcome

The frequencies of patient encounters were slightly more common during the summer for Finland, Norway, and Sweden, but showed no seasonal difference in Denmark (Table 3). All experienced most encounters between 8–16 h; in Denmark almost half of all missions occurred during this period, while Finland saw a more uniform distribution.

There were no differences in on-scene time intervals between the countries, while the time from alarm to arrival at the patient location was signifi-

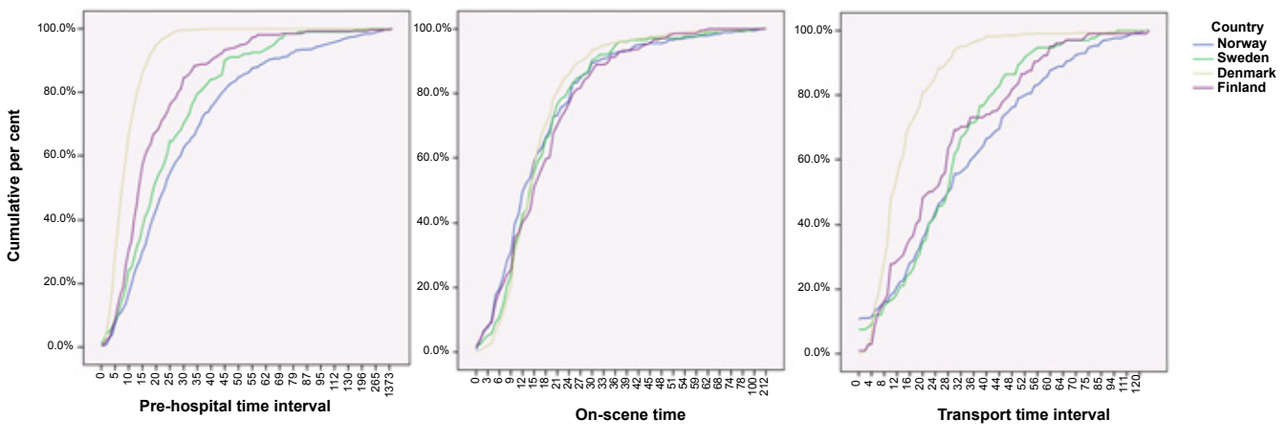

Fig. 2. Cumulative percentage of missions and time intervals during missions according to service country.
Pre-hospital time interval: Time from alarm to physician-staffed service to hands on patient (minutes).
On-scene time: Time from hands on patient to departure with patient or leaving patient (minutes).
Transport time interval: Time from departure with patient to patient handover at destination (minutes).

Table 3

Operational and medical characteristics in 2,256 missions with patient encounter during four weeks according to country.

Missions with patient encounter, $n = 2256$	Country	Denmark	Finland	Norway	Sweden	Total
No. of missions	Counts (range)	1,580 (220–798)	242 (70–95)	290 (10–119)	144 (9–68)	2,256 (9–798)
	Per. 10,000 inhabitants per year	74.9	14.6	11	5	
Season	% summer vs. winter	51/49	58/42	61/39	56/44	53/47
Time of day (%)	0800–1559	48	39	43	50	46
	1600–2159	28	32	34	34	30
	2200-0759	24	29	23	16	24
Patient age (pts > 2 years)	Median (range)	60 (2–100)	56 (2–90)	45 (2–90)	48 (2–93)	57 (2–100)
	Number of patients 0–2 years	54	6	14	11	85
	Number of neonates	1	1	2	2	6
Gender	% male	56	47.1	60	52.8	55
	not reported (%)	0	16.1	4.8	11.8	3.1
Co-morbidity	Pre-event ASA* (mean, SD)	1.8/0.88	1.92/0.95	1.70/0.79	1.77/1.03	1.82/0.89
	n missing	410	53	35	32	530
Medical indication, count (%)	Medical	1,025 (64.9)	137 (56.6)	147 (50.7)	81 (56.3)	1,360 (61.6)
	Trauma	311 (19.7)	50 (20.7)	112 (38.6)	46 (31.9)	519 (23)
	Other surgical	22 (1.4)	4 (1.7)	7 (2.4)	4 (2.8)	37 (1.6)
	Psychiatry	31 (2)	7 (2.9)	4 (1.4)	4 (2.8)	46 (2)
	Gynaecological/obstetrical	7 (0.4)	14 (5.8)	6 (2.1)	2 (1.4)	29 (1.3)
	Other	36 (2.3)	5 (2.1)	5 (1.7)	4 (2.8)	50 (2.2)
	Not reported	148 (9.4)	25 (10.3)	9 (3.1)	3 (2.1)	185 (8.2)
Patients with severely deranged vital signs	% of all	20.7	31.4	26.9	26.4	23
	Excluding cardiac arrest ($n = 2,029$)	16.1	21.5	17.3	16.1	16.8
Patients with severely deranged vital signs and/or receipt of advanced medication or procedure	% of all	33.2	43.8	40	31.9	35.1
	Excluding cardiac arrest ($n = 2,029$)	28.7	35.4	31.8	22.6	29.4
Mission outcome	Patient to medical facility (%)	1,215 (77)	179 (74)	215 (74)	112 (78)	1,721 (76)
	Death of patient (%)	154 (10)	44 (18)	32 (11)	13 (9)	243 (11)
	Treat and leave (%)	211 (13)	19 (8)	43 (15)	19 (13)	292 (13)

*American Society of Anesthesiologists Physical Status (ASA-PS) co-morbidity index.

Table 4

Medical problem, incidences and probability of deranged physiology, provision of advanced procedures or medication related to country.

		Probability of having severely deranged vital signs	Probability of provision of advanced medication	Probability of provision of advanced procedure	Probability of severely deranged vital signs and/or provision of advanced medication or procedure	Yearly incidence in study population (*n*/28/365)	Incidence per 10,000 persons per year (95% CI)
Medical problem event (*n*)	Medical (1,390)	0.29	0.24	0.12	0.42	18,119	14.98 (14.20–15.79)
	Trauma (519)	0.15	0.13	0.16	0.25	6,756	5.59 (5.12–6.09)
	Other surgical (37)	0.16	0.14	0.11	0.24	482	0.4 (0.28–0.55)
	Psychiatric (46)	0.11	0.09	0.04	0.17	600	0.5 (0.36–0.66)
	Gynaecological/obstetrical (29)	0.03	0	0.03	0.03	378	0.31 (0.21–0.45)
	Other (50)	0.16	0.04	0.08	0.22	652	0.54 (0.40–0.71)
	Not reported (185)	0.14	0.11	0.04	0.23	2,412	1.99 (1.72–2.30)
	Total (2,256)	**0.23 (0.21–0.25)**	**0.19 (0.17–0.21)**	**0.12 (0.11–0.13)**	**0.35 (0.33–0.37)**		
First Hour Quintet diagnoses (n)							
Denmark	Cardiac arrest (139)	0.68	0.37	0.42	0.79	1,812	6.59 (5.54–7.78)
	Severe respiratory difficulties (130)	0.42	0.21	0.12	0.52	1,695	6.16 (5.15–7.32)
	Severe trauma (RTS < 11) (63)	0.19	0.13	0.14	0.37	821	2.99 (2.29–3.82)
	Chest pain (227)	0.09	0.4	0.01	0.45	2,959	10.76 (9.36–12.16)
	Stroke (55)	0.24	0.15	0.06	0.29	717	2.61 (1.96–3.39)
	Other (916)	0.14	0.06	0.04	0.2	11,941	43.42 (40.65–46.33)
Finland	Cardiac arrest (33)	0.94	0.61	0.67	0.97	430	1.99 (1.37–2.79)
	Severe respiratory difficulties (9)	0.78	0.67	0.56	0.89	117	0.54 (0.25–1.03)
	Severe trauma (RTS < 11) (8)	0.88	0.63	0.75	1	104	0.48 (0.21–0.95)
	Chest pain (17)	0.12	0.59	0.18	0.65	222	1.03 (0.6–1.64)
	Stroke (6)	0.5	0.33	0.17	0.5	78	0.36 (0.13–0.79)
	Other (169)	0.15	0.15	0.14	0.26	2,203	10.19 (8.71–11.85)
Norway	Cardiac arrest (35)	0.97	0.71	0.8	1	456	1.33 (0.93–1.85)
	Severe respiratory difficulties (21)	0.67	0.43	0.19	0.86	274	0.8 (0.49–1.85)
	Severe trauma (RTS < 11) (25)	0.64	0.52	0.76	0.88	326	0.95 (0.62–1.40)
	Chest pain (22)	0.09	0.32	0.05	0.36	287	0.84 (0.52–1.27)
	Stroke (18)	0	0.17	0.06	0.17	235	0.68 (0.41–1.08)
	Other (169)	0.07	0.11	0.08	0.18	2,203	6.43 (5.50–7,48)
Sweden	Cardiac arrest (20)	0.9	0.6	0.65	0.9	261	0.69 (0.42–1.07)
	Severe respiratory difficulties (3)	0.33	0.33	0.33	0.33	39	0.1 (0.02–0.30)
	Severe trauma (RTS < 11) (5)	0.6	0.6	0.4	1	65	0.17 (0.05–0.4)
	Chest pain (7)	0.14	0.14	0	0.27	91	0.24 (0.10–0.5)
	Stroke (1)	0	0	0	0	13	0.03 (0.00–0.19)
	Other (108)	0.14	0.07	0.05	0.19	1,408	3.74 (3.07–4.52)

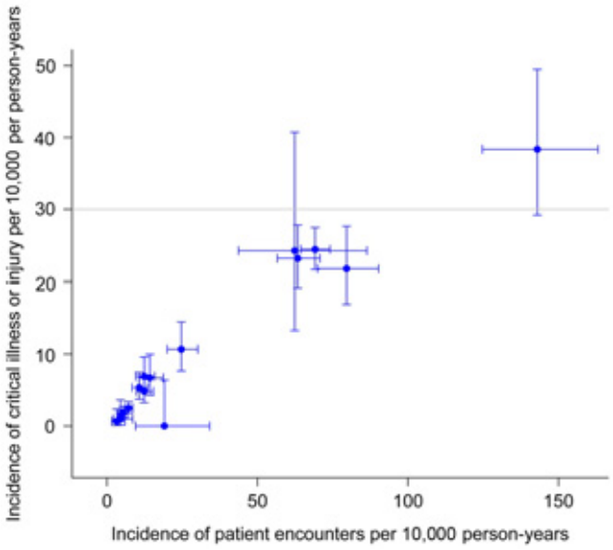

Fig. 3. Incidence of critical illness or injury per 10,000 person-years versus incidence of patient encounters in 16 physician-staffed pre-hospital emergency medical services in Scandinavia.
Dots represent services number of patient encounters, incidence of critical illness or injury, and error bars 95% confidence intervals.

cantly lower for the Danish services than for the other countries ($P = 0.027$, one-way ANOVA). The time from the departure from the scene to arrival at a medical facility was reported to be shorter in Sweden and Denmark compared to Finland and Norway ($P < 0.005$) (Fig. 3).

Approximately three-quarters of all patient encounters resulted in hospital admission (Denmark 77%, Finland 74%, Norway 74%, and Sweden 78%); the patient died on-scene in 11% of all encounters (Table 3). The patient was left on-scene after the physician assessment and treatment in 13% of the patient encounters (Denmark 13%, Finland 8%, Norway 15%, and Sweden 13%).

Medical categories and patient complaints

Events with medical aetiology were the most frequent, with an incidence of 14.9 missions per 10,000 person-years. Trauma was the second most frequent event, with 5.6 missions per 10,000 person-years. Events with a surgical (excluding trauma), obstetric, psychiatric, or otherwise non-classified aetiology had an incidence of less than 1 per 10,000 person-years (Table 4).

The incidence of FHQ (cardiac arrest, severe breathing difficulties, severe trauma, chest pain, and stroke) aggregated for all services was 9.6 per 10,000 person-years.

Including all events from all participating services, the incidence was 24.3 patient encounters per 10,000 person-years.

The Danish services reported both the highest frequency and the highest incidence of the five FHQ complaints combined. For the other countries, the incidence was lower: Finland, 4.4 per 10,000 person-years; Norway, 4.6 per 10,000 person-years; and Sweden, 1.2 per 10,000 person-years (Table 4). At the same time, the probability for the patient to be physiologically deranged or receiving advanced medication or procedures remained comparable in Danish patients and Swedish patients (Denmark 0.33 vs. Sweden 0.32) but was lower than the numbers for Finland and Norway (0.44 and 0.40, respectively).

A total of 1362 patients had complaints other than the those contained in the FHQ. Among these, 261 (19%) fulfilled the study definition of being severely ill or injured, and 169 (12%) met the study definition of physiological derangement (68 with trauma, 35 suffering circulatory compromise, and 19 with neurological disease).

Incidence of advanced procedures performed

Advanced medical procedures as defined by the study protocol (Table 1) were performed in every four to twelve encounters (Denmark 7.8%, Sweden 14.8%, Norway 23.1%, and Finland 24.8%). Overall, 173 advanced airway manoeuvres (including insertion of supraglottic airway devices) were performed, yielding 77 such procedures per 1000 patient encounters. Arterial lines, initiation of non-invasive ventilation, thoracocentesis, fracture reductions, central venous access, therapeutic hypothermia, and blood transfusion were performed less than once per 100 patient encounters (Table 4). Among the 1362 patients outside the FHQ complex, 104 (8 per 100 patient encounters) received advanced medication (42 trauma, 28 circulatory disease, 21 neurological disease, and 13 other), and 73 (5 per 100 patient encounters) received advanced procedures (44 trauma, 8 circulatory disease, 8 neurological disease, and 13 other).

Clinical condition and probability of deranged vital status and therapy

In the entire study population, the patient had signs of severely deranged vital functions upon physician arrival in 23% of cases. The service provided advanced procedures or medication in 12% and 19% of cases, respectively. As these criteria overlap to some degree, the total probability that the patient

was either physiologically deranged, and/or received advanced medication, and/or needed to undergo a procedure was 35%.

Discussion

Although the aim and structure of Scandinavian pre-hospital EMSs staffed by anaesthesiologists are comparable,[1] the incidence of patient encounters varies from nearly 75 per 10,000 inhabitants per year in Denmark to 5 per 10,000 inhabitants per year in Sweden. Despite this significant difference, the percentage of patient encounters that involve severely ill or injured patients and/or in which the physician provides advanced medication and/or therapy only varies between 44% and 32%. We interpret this finding as representing liberal dispatch policy in Denmark, and probably too strict dispatch policy in Sweden. When considering these possibilities, the incidence of severely ill or injured patient encounters increases with increasing mission frequency, to an incidence level of approximately 25–30 per 10,000 person-years. As for procedures performed, airway management represents the majority of the advanced procedures; others are rather infrequent.

The Danish services attend to two to three times more patients per inhabitant for all medical conditions recorded. The most likely explanation for this finding is probably related to differences in transportation means and mission duration. The car-based Danish services operate in urban areas with short distances, making early attendance possible and allowing more patient encounters per unit time, suggesting a more liberal dispatch policy than the other Scandinavian countries. This suggests a higher lifesaving potential compared to the helicopter-based services in Sweden, Finland, and Norway. Moreover, it is likely that the Danish services perform many missions which would be covered by the regular ambulance service in more rural parts of Scandinavia. Given that severely ill or injured patients should be offered the highest level of care as early as possible, the large difference in incidence between Denmark and the rest of Scandinavia could be interpreted as an underutilisation of this service in Sweden, Finland, and Norway. However, for some diagnoses, such as stroke and acute myocardial infarction, it is clear that a short time to hospital-based definitive care is paramount. For these patients, a physician on-scene might only yield a diagnostic and therapeutic benefit if it is followed by efficient triage; while for patients with breathing difficulties, trauma, or cardiac arrest, a specially trained physician on-scene may lead to better patient management and better outcomes.[16,17] Moreover, the time from the presentation of symptoms to first treatment can be significantly reduced by the availability of rural air services.[18–20]

Scandinavian anaesthesiologist-staffed services attend to a variety of acute conditions outside the hospital. Although most patient encounters were classified as belonging to one of our predefined medical conditions, a significant proportion remained unclassified by the attending physician. Moreover, patients with any of the five medical conditions defined in the FHQ were those who most frequently had deranged vital signs and received advanced therapy. Nevertheless, as many as 26% of the patient encounters in Finland outside the FHQ classification were clinically deranged or received advanced therapy. Thus, the patient population attended to by the specially trained pre-hospital physician can only in part be identified by the FHQ in the dispatch phase. It may therefore not be a realistic goal to identify all patients who require urgent medical assistance up front; some degree of 'over-triage' is unavoidable.

Deliberate over-triage might enable these services to reach more severely ill or injured patients.[21] We found a positive relationship between the incidence of severely ill or injured patients and the total mission incidence, which in our study seemed to level off at an incidence of pre-hospital critical illness or injury at 25–30 per 10,000 person-years. Beyond this level, and under the current dispatch policy, further over-triage may not pay off in terms of identifying more critically ill or injured patients. While such figures should be confirmed independently, we speculate that this level may represent a useful reference for 'tuning' the emergency dispatch sensitivity of anaesthesiologist-staffed pre-hospital services.

The calculated incidence of acute medical conditions in Denmark is similar to population-based figures published elsewhere.[22,23] This suggests that the Danish condition-specific incidences in our study closely approximates the true incidences of critical emergency medical conditions in Denmark. It may seem that critically ill or injured Danish patient has the highest likelihood of receiving treatment from a specially trained pre-hospital physician on-scene.

According to our findings, a population of 10,000 inhabitants will need at least 25–30 emergency physician primary missions per year. Some over-triage will be necessary to ensure acceptable sensitivity.[24]

Are any patients missing?

A study in Northern Norway identified neonates and parturients as two of the most important patient groups to benefit from an anaesthesiologist-staffed helicopter EMS.[25] Current Norwegian figures suggest that approximately 0.5% of newborns are delivered unplanned at home, or during transportation to hospital (http://mfr-nesstar.uib.no/mfr/, accessed 30 July 2013). Assuming an annual birth cohort of approximately 1,440,000 in the study population (12 million), there should be approximately 110,000 births during the 4-week study period, suggesting several hundred unplanned pre-hospital deliveries. We were surprised that the services responded to almost no neonatal or obstetrical emergencies, and we suggest that this issue be studied more closely.

Strengths and limitations of the study

The major strengths of our study are its prospective, population-based design combined with a detailed dataset of patient-specific variables. Moreover, we employed a three-dimensional indicator of severity that incorporated physiology, advanced medication, and advanced procedures, which should capture the concept of 'severity' better than traditionally used single indicators. A patient can be critically ill or injured without being physiologically deranged or receive advanced medication or procedures, and vice versa.

We do not state that all patients in the current study required a physician-level pre-hospital response. Rather, we believe that patients outside the hospital who are judged by a physician to be in need of such treatment could be sick enough to justify the presence of a physician on-scene, if available. Finally, it is very hard to determine whether certain patient groups were missed; this would require a prospective surveillance of all Emergency Medical Communication Centres as well as similar dispatch channels.

Our study was not designed to assess the time gain to definitive treatment. In rural areas, the reduction of time to definitive treatment often relies on air transportation in patients with, e.g., ST-elevation, myocardial infarction, or stroke. The reduction of time from occlusion to open vessel is the most important predictor of good functional outcome.[26,27] As such, our study likely underestimates the proportion of missions that can be classified as beneficial.

Our analysis is limited to missions that resulted in a patient encounter on-scene. These missions constitute approximately half of the total activity of the participating services. As such, the incidence of activity for the participating services was higher, due to missions that were refused or cancelled en route or additional workload, such as advisory tasks for ordinary EMSs. Moreover, inter-hospital transfer missions represent a substantial task for EMS services, especially in Norway.[1] Typically, these missions concern very sick patients receiving intensive care.

Implication for clinical practice

Severely ill or injured patients are primarily defined as patients suffering from cardiac arrest, severe trauma, severe breathing difficulties, chest pain, or stroke. Identifying these patients in the early phase seems to be important in applying the correct level of emergency medical response. Pre-hospital acute critical illness or injury in Scandinavia seems to occur at a rate of approximately 25–30 per 10,000 person-years. Emergency medical systems in Scandinavia should be designed to respond to such events in all areas.

Unanswered questions and future research

To optimise the value of anaesthesiologist-staffed pre-hospital services, the service should ideally respond only to severely ill or injured patients. In our study, an incidence of patient encounter in the order of 60–80 per 10,000 person-years seemed to be required to address all critically ill or injured patients identified by the emergency medical system. For services covering large populations, this translates to a high number of missions and a significant resource expenditure. A main challenge in the future will be to develop dispatch criteria that are able to predict the need for advanced pre-hospital emergency response to avoid excessive overuse.[28]

As medical science evolves and new treatment opportunities arise, target populations might change. A continuous evaluation of current practice is needed for all health services, pre-hospital care being no exception. What seems to be a target population today will not necessarily be a target population tomorrow, and some patients might safely be allocated to other EMSs, while currently unidentified patient groups may require the highest level of care response.[29]

Conclusions

The total incidence of patient encounters varied from nearly 75 per 10,000 inhabitants per year in Denmark to 5 per 10,000 inhabitants per year in

Sweden. This heterogeneity arises presumably because of different transportation concepts and different mission times. The pre-hospital population incidence of critical illness or injury seemed to be 25–30 per 10,000 person-years.

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