Developing a decision support system for geriatric patients in prehospital care
Veronica Vicente, Fredrik Sjöstrand, Birgitta W. Sundström, Leif Svensson and Maaret Castren

Objectives To develop a feasible and safe prehospital decision support system (DSS) for the emergency medical services (EMS), facilitating safe steering of geriatric patients to an optimal level of healthcare.

Methods The development process involves four consecutive steps. The first step was gathering data from patients transported by EMS, with the electronic patient care record, to retrospectively identify appropriate patient categories for steering. The second step was to allow a group of medical experts to give advice and suggestions for further development of the DSS. The third step was validation of the decision support tool and the fourth step was validation of the entire prehospital DSS in a pilot study.

Results The patient categories relevant to steering were those medical conditions that the geriatric clinicians felt confident in receiving from the EMS. A prehospital DSS was then developed for these 11 medical conditions. The validation and evaluation of the DSS showed a high degree of compliance with the patients’ final level of healthcare. The pilot study included 110 randomized patients; 33.9% were triaged to an alternative level of healthcare, that is geriatric care or primary care. No medical inaccuracies or secondary transports from alternative care to the hospital emergency department were identified.

Conclusion Using this prehospital DSS – developed for 11 medical conditions – the Swedish prehospital nurse can safely decide on the level of healthcare to which an elderly patient can be steered. European Journal of Emergency Medicine 00:000–000 © 2012 Wolters Kluwer Health | Lippincott Williams & Wilkins.

Keywords: ambulance, assessment, emergency medical service, geriatrics, prehospital nurse, triage

Introduction The need for healthcare increases with age. As in many other countries, Sweden faces a large increase in the number of elderly individuals and, subsequently, an increase in the need and cost of healthcare services [1,2]. In the future, there will be a political issue of resources [3,4] as well as patient safety [5]. Emergency department (ED) crowding has been a significant problem that has been well documented [6–11], and has even been shown to correlate to increased mortality [5]. The ED is not always the right place for all patients with varying severities of illness. International studies have shown that 12–24% of the patients treated in the ED are 65 years of age or older [2,12,13] and they arrive more frequently by ambulance than younger patients [3,13]. Today, in Stockholm (Sweden) 98% of all patients met by the emergency medical services (EMS) are transported to the ED, even those who are not in need of emergency room facilities [14]. Against this background, our assumption is that by practicing comprehensive geriatric assessments, should such a patient have an acute episode of a minor medical condition [15]. Preferably, these patients should be admitted directly to such a unit without having to spend time in a crowded ED. This can be made possible by a prehospital nurse (PHN) assessing and steering geriatric patients directly from their homes to such a geriatric unit.

This study was designed to develop a prehospital decision support system (DSS) for the EMS to aid the PHN to assess and steer geriatric patients to an optimal level of healthcare. The aim was to be able to steer 20% (measure of effect, primary outcome) of these geriatric patients to an alternative level of care. Furthermore, secondary transports (patient is moved to another level of healthcare within 24 h) should not exceed 5% (measure of safety, secondary outcome).

Methods Study setting In 2010, Sweden had approximately nine million inhabitants, of whom two million lived in Stockholm. A total of 14.8% of the individuals who lived in Stockholm were 65 years of age or older [1]. In the year 2010, the EMS in the Stockholm area had almost 150,000 assignments. The geographical suburban area of Stockholm that was studied...
had ~86,000 inhabitants and 5444 EMS assignments. Of these assignments, 54% involved patients 65 years of age or older. The study was carried out in 2008 at two private ambulance companies with 11 ambulances.

PHN in Sweden are registered nurses with advanced knowledge in prehospital emergency care. The criterion for entering this programme is a Bachelor of Science with a major in Caring Science/Nursing [16]. All EMS personnel follow national medical guidelines [17] that contain protocols for procedures and treatments for specific symptoms and groups of diagnoses, which are categorized in a specific list of predetermined conditions.

This list of conditions, which does not follow the ICD-10 code system, is of mandatory use by the EMS staff. Another task required is to grade the severity of the medical condition of each patient, which is done using the National Advisory Committee for Aeronautics (NACA) score (Table 1) [18–20]. The level of priority for each transport is communicated according to the score shown in Table 2 [21,22].

### The alternative levels of healthcare

1. **Primary care**: District healthcare centres with facilities such as laboratory, radiology and medical staff. This level includes community healthcare.
2. **Secondary care**: Local hospitals with facilities such as laboratory, radiology and medical staff. This level includes geriatric care.
3. **Tertiary care**: University hospitals. This level includes an ED.

### Definition of geriatric care

Geriatric specialists provide healthcare to individuals 65 years of age or older who have been afflicted by an acute illness or whose chronic condition has deteriorated with the consequent need for medical investigation, treatment or rehabilitation. Furthermore, inpatient or outpatient memory assessments are performed by the geriatric specialists [23].

### Developing the prehospital decision support system

The generation of the prehospital DSS was divided into two major steps: a decision support tool (DST) was designed, followed by an implementation process. These two steps can be further divided into four consecutive steps (Fig. 1). Each step generates significant results that the following step is dependent on.

**Step 1: Description of the study population and the generation of a preliminary decision support tool**

The goal of the first step was to retrospectively identify geriatric patients in the EMS electronic patient care record system with medical conditions that were hypothetically possible to triage to primary or secondary care. Data from the year 2006 were used. Furthermore, a preliminary DST was generated on the basis of these analyses, which were carried out by the researchers VV and FS.

The inclusion criteria for this study population were as follows:

1. at least 65 years of age or older;
2. resident in the specified geographical area;
3. transported to tertiary care;
4. priority levels 2 and 3; and
5. transported during the period 08:00 a.m.–10:00 p.m. (enabling access to laboratory, radiology and medical staff).

There were 1006 patient medical records (Fig. 2) that fulfilled the criteria for inclusion.

Furthermore, we performed a subanalysis of these medical records by adjusting for the following exclusion criteria:

1. acute conditions requiring an assessment by a nongeriatric specialist, such as neurology, cardiology, surgery or orthopaedics, for example stroke, cardiac infarction, fractures, etc.;
2. vital parameters outside a set of references;
3. NACA score more than 4 (Table 1); and
4. conditions not in concordance with the definition of geriatric care.

The subanalysis yielded 11 medical conditions possible for steering, because these were the most common ones and fulfilled the following criteria for admission to geriatric care:

1. urinary and/or with catheter disorders;
2. dizziness;

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<table>
<thead>
<tr>
<th>Table 1</th>
<th>The National Advisory Committee for Aeronautics score, which has levels 0–7, grades the severity of illness and injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No damage or disease</td>
</tr>
<tr>
<td>1</td>
<td>Mild injury or illness not requiring medical treatment</td>
</tr>
<tr>
<td>2</td>
<td>Minor injury or illness requiring medical treatment but no need for hospitalization</td>
</tr>
<tr>
<td>3</td>
<td>Injury or illness that requires hospitalization, but not life threatening</td>
</tr>
<tr>
<td>4</td>
<td>Injury or illness that is potentially fatal</td>
</tr>
<tr>
<td>5</td>
<td>Life-threatening injury or illness where immediate treatment is needed</td>
</tr>
<tr>
<td>6</td>
<td>Serious injury or illness manifesting failure of vital functions</td>
</tr>
<tr>
<td>7</td>
<td>Died on scene</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>The priority levels 1–4 for emergency medical services transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 1</td>
<td>Acute life-threatening symptoms or severe accident. Assignment with the highest priority, blue lights and sirens.</td>
</tr>
<tr>
<td>Priority 2</td>
<td>Acute but not life-threatening symptoms. Assignment of high priority, blue lights and sirens if needed.</td>
</tr>
<tr>
<td>Priority 3</td>
<td>Other ambulance assignment. Tasks for which supervision and care may be needed by medically trained personnel and where a reasonable waiting period is not deemed to affect the patient’s condition.</td>
</tr>
<tr>
<td>Priority 4</td>
<td>Only transportation. Tasks not requiring supervision or care by trained medical personnel during transport.</td>
</tr>
</tbody>
</table>
(3) respiratory disorders/chronic obstructive pulmonary disease;
(4) respiratory disorders/pneumonia;
(5) diabetes (except for hypoglycaemia, because of the need for extended investigation);
(6) fever;
(7) hypotension;
(8) frailty;
(9) back pain/back contusion;
(10) fall/injury and accident; and
(11) hip trauma (without suspicion of a femur fracture).

Step 2: Peer review of the preliminary decision support tool
The goal of the second step was to engage a group of external experts for peer review. This group was selected by a written and oral request forwarded to the directors of the clinics at the tertiary care hospital. Each director chose a specialist who had good clinical and research experience from the respective areas of expertise. The selected specialists provided advice and suggestions for changes in the content and structure of the preliminary DST and also suggestions on specific implementation requirements. After the revision of the DST, the expert group confirmed the final product.

Step 3: Evaluation and validation of the decision support tool
The goal of the third step was to validate the compliance and feasibility of DST. This was done by a written test consisting of a questionnaire including 22 authentic clinical cases. The test was performed in the ambulance intranet learning system, which was well known to each user. The questionnaire was sent to the entire PHN staff (n = 67). They had three weeks to complete the test. Participation was voluntary and they received no education or training in using the DST before the test.

The PHNs were asked to fulfil at least one of the 22 cases. Each case had a set of five questions. The task was to identify the relevant DST to each medical condition.
presented in the case and to use the DST as an aid to decide how to triage the case. The questions were as follows:

1. Which medical condition do you assess that the patient has?
2. What severity level is applicable for this specific patient?
3. Where would you steer the patient to: ED, community healthcare or geriatric care?
4. Was there anything in the system that was difficult to understand or to use?
5. Any other comments?

A final decision on the validity and reliability of the DST was agreed upon in consultation with the group of peer external reviews.

**Step 4 – Validation of the prehospital decision support system in a pilot study**

The goal of the fourth step was to validate the entire prehospital DSS (available as an electronic appendix) in a 3-month randomized pilot study.

The DST was used as follows:

After the PHNs had identified one of the 11 predeter-
mined conditions, they were guided by the flowchart in the DST. The process in the DST is described below for the example ‘Urinary disorder with/without catheter’ (Fig. 3).

The PHN asked the patient whether he/she had abdominal pain, complete blockage in their urinary catheter, chest pain or haematuria. If they answered ‘yes’ to any of these questions, the patient should have been transported to the ED. If they answered ‘no’ to these questions, the PHN assessed the vital parameters against the reference and followed the flow chart.

If the vital parameters of the patient violated the reference, he/she should have been transported to the ED, but if the parameters were within the reference, the PHN followed the flow chart and decided on the degree of severity level of the patient’s illness (NACA score).

If the patients were assessed to have a NACA score between 0 and 2, they should have been transported to an alternative level of healthcare, that is to primary care. If the patient’s severity levels were between 3 and 4, they should have been transported to geriatric care, that is secondary care. Finally, if the patient’s severity levels were between 5 and 7, they should have been transported to the ED, that is tertiary care.

Deceased patients with a NACA score of 7 must be transported to the ED unless the dispatch centre provides other instructions. In most cases, deceased patients are left where they are after consultation with the dispatch centre.

Before starting the pilot study, all the PHNs who were involved received both training and education. The curriculum included the following: (a) a lecture on common geriatric problems, (b) a lecture on the prehospital DSS, (c) a theoretical test and (d) a lecture on the clinical application and operation of the system.

The dispatch centre randomized the patients, during the hours of 08:00 a.m.–10:00 p.m., using sealed envelopes. The inclusion criteria were as follows:

1. at least 65 years of age or older;
2. resident in the specified geographical area; and
3. priority levels 2 and 3.

If the patient was randomized to the control group, the usual care processes were followed and the geriatric patient was transported to the ED of a tertiary care hospital.

If the patient was randomized to the intervention group, the PHN, with the help of the DST, could steer the patient to an alternative level of healthcare on the basis of the patient’s medical needs. Only patients with one of the identified 11 medical conditions could be steered.
Informed consent was obtained from the patients by the PHNs and the patients were provided with both written and oral information. Before steering the patient, the PHNs must also receive approval from the physician at the receiving unit (by telephone). Ethical approval was obtained from the Regional Ethics Committee at Karolinska Institute, Stockholm (no. 2008/1167-31).

**Statistical analysis of the pilot study**

The Mann–Whitney U-test was used to test for differences between independent samples. Additional results are expressed as risk ratios with 95% confidence intervals, and compared using $\chi^2$. All reported $P$ values are two-sided.

**Results**

**Peer review of the preliminary decision support system**

During the peer review, the consensus was reached that not only should the patients' medical requirements govern the content of the guidelines but also what competence and resources must be required by the care unit receiving the patients. One example of such a specialist competence was to insert a suprapubic catheter. As not all geriatricians have this competence in Sweden, patients with total blockage of the urinary catheter could not be steered to geriatric care. These comments led to major refinements of the system.

**Compliance to the decision support tool**

In the evaluation and validation of the DST, 37% of the PHN answered a total of 234 questionnaires. Of these responses, 23 were excluded because of missing data. A total of 211 surveys were analysed. The results of the validation showed a high degree of compliance to the DST. No patient was triaged incorrectly. The majority of the PHNs believed that the prehospital DSS was comprehensible, feasible and easy to use.

**The pilot study**

The study continued for 3 months and 110 geriatric patients were randomized into the study. After exclusion, 94 patients remained in the study; 62 (65.9%) were assigned to the intervention group and 32 (34.0%) patients received standard treatment (control group). The reasons for the exclusion were aborted assignment, that is 16 patients were not in need of the EMS.

The baseline characteristics of all the patients enrolled in the study are shown in Table 3. The two groups were similar in almost all the major characteristics, except for the mean systolic blood pressure, which was significantly higher in the control group.

There was also a difference in sex ($P = 0.015$) and in the priority level (to the hospital) ($P = 0.005$) (Table 3).
Primary outcome (effect)
In total, 21 patients (33.9%; 95% confidence intervals 23.3–46.3), in the intervention group could be steered to an alternative level of healthcare with the help of the prehospital DSS (Table 4).

Secondary outcome (safety)
No patient was transported within 24 hours from the alternative care to the ED at the tertiary hospital (Table 4). No medical inaccuracies were identified.

Table 3 Baseline characteristics of all patients included in the study (n=94)

<table>
<thead>
<tr>
<th></th>
<th>Intervention (N=62)</th>
<th>Control (N=32)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>81±8</td>
<td>80±9</td>
<td>0.016</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>35 (56.5%)</td>
<td>10 (30.3%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>27 (43.5%)</td>
<td>23 (69.7%)</td>
<td></td>
</tr>
<tr>
<td>Vital parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>37.3±1.06</td>
<td>37.3±1.04</td>
<td>0.835</td>
</tr>
<tr>
<td>Respiratory rate (RT/min)</td>
<td>19±6</td>
<td>19±5</td>
<td>0.875</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>141±24</td>
<td>152±30</td>
<td>0.051</td>
</tr>
<tr>
<td>(BP/mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturation (%)</td>
<td>94±7</td>
<td>95±3</td>
<td>0.589</td>
</tr>
<tr>
<td>Heart rate (HR/min)</td>
<td>85±21</td>
<td>83±14</td>
<td>0.413</td>
</tr>
<tr>
<td>GCS decreased level of consciousness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild (≥ 13)</td>
<td>50 (100.0%)</td>
<td>27 (100.0%)</td>
<td></td>
</tr>
<tr>
<td>Moderate (9–12)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Severe (≤ 8)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>NACA score and steering level</td>
<td></td>
<td></td>
<td>0.243</td>
</tr>
<tr>
<td>Primary care (0–2)</td>
<td>19 (30.6%)</td>
<td>6 (18.8%)</td>
<td></td>
</tr>
<tr>
<td>Secondary care (3–4)</td>
<td>41 (66.1%)</td>
<td>26 (81.2%)</td>
<td></td>
</tr>
<tr>
<td>Tertiary care (5–7)</td>
<td>2 (3.2%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Priority level out: to the patient</td>
<td></td>
<td></td>
<td>0.525</td>
</tr>
<tr>
<td>1</td>
<td>2 (3.2%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>35 (56.5%)</td>
<td>17 (53.1%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25 (40.3%)</td>
<td>15 (46.9%)</td>
<td></td>
</tr>
<tr>
<td>Priority level in: to the hospital</td>
<td></td>
<td></td>
<td>0.006</td>
</tr>
<tr>
<td>1</td>
<td>8 (12.9%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>16 (25.8%)</td>
<td>18 (56.2%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>38 (61.3%)</td>
<td>14 (43.8%)</td>
<td></td>
</tr>
</tbody>
</table>

The decision support tool for steering was used in the intervention group. The continuous variables are presented with mean±SD and tested using the Mann–Whitney U-test, whereas the categorical variables are presented with n and % and are tested using the χ²-test.

Table 4 Primary and secondary outcomes in patients steered by prehospital nurse to alternative levels of healthcare

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Control</th>
<th>Proportion (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome (effect)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of steered patients to alternative levels of healthcare</td>
<td>Steered/total</td>
<td>21/62</td>
<td>33.9% (23.3–46.3)</td>
</tr>
<tr>
<td>Secondary outcome (safety)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of secondary transports from alternative levels of healthcare</td>
<td>Secondary transport/total steered</td>
<td>0/21</td>
<td>0.0%</td>
</tr>
<tr>
<td>Intention to treat/treated population</td>
<td></td>
<td></td>
<td></td>
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</table>

*Figures are numbers.

Discussion
Our finding shows that a PHN, with the help of a prehospital DSS, can steer geriatric patients to alternative levels of healthcare. This is in agreement with previously published studies [24,25].

However, several published studies [26–30] have shown that paramedics and emergency medical technicians have limited ability to make decisions on which patients require admission to the ED and which require admission to alternative healthcare. With the correct DSS, which needs to be designed on the basis of the competence level of the prehospital staff and the resources available at the receiving units, we now have reasons to believe that it is indeed possible. In fact, our study implies that a significant part (33.9%) of the nonurgent transportations of elderly patients can be steered using a well-designed DSS. Furthermore, none of the patients required a secondary transport, which indicates that the patient ended up at the right level of healthcare.

Currently, there is no clear definition of the optimal level of healthcare or, in other words, what constitutes ‘the right patient in the right place’. We challenged this question by involving several medical experts from different disciplines when developing the prehospital DSS and it generated a local Swedish consensus expressed in the DSS. We found that a specific and critical issue in the EMS triage (step 2) is the willingness of the receiving unit to accept these patients. This has not been discussed in previous published studies. This is not only based on medical, radiological and laboratory resources but also what overall assignments and financial contracts the receiving unit has. We strongly suggest that healthcare providers address these questions and collaborate between different professions and between different specialties.

In the development process (step 1), we could identify 11 possible medical conditions that were relevant to steer to an alternative level of healthcare. These conditions were similar to those described by Ross et al. [31]. They showed that the most common conditions in older patients in the ED were chest pain, dehydration, dizziness, syncope, infection, back pain and chronic pulmonary disease. The main reasons why elderly patients inappropriately seek emergency services are chronic diseases and lack of social support [6]. The conditions may be urgent or nonurgent. It is when these conditions are nonurgent that the patient is given lower priority in the ED. We suggest that more efficient and appropriate care could be provided at an alternative level of healthcare for nonurgent patients.

Various triage scales have been developed and are used in the ED [32–35]; unfortunately, there is little research on triage scales developed for the EMS organization. Triage scales improve the performance of the healthcare providers, that is decrease the time to definitive care and improve diagnostic accuracy [36]. The PHNs in this
study (on the basis of the questionnaire test) believed that the steering tool developed was easy to use and it helped them to make the decision regarding which level of healthcare was most appropriate for the patient. They also found that the prehospital DSS was safe.

Elderly patients are high consumers of healthcare and the challenge is to satisfy the patient’s rights to the best and safest possible care [13]. With fewer nonurgent geriatric patients arriving to the ED, we can expect this to have an impact on ED crowding but also in providing medical care adjusted to the patient’s medical needs. All patients who were transported to alternative levels of healthcare were each immediately taken care of by the receiving doctor after having instantly received a hospital bed.

Despite everything, there is little evidence in the literature on EMS triage systems [32]. Further studies on the guidelines, development and assessment of the EMS triage system will hopefully lead to a more proper allocation of healthcare resources and more adequate care for elderly patients. Thus, this study warrants further research at a national level to assess the use of prehospital DSS for optimal healthcare of geriatric patients.

Limitations
This study has a number of limitations. Gathering retrospective data from the electronic patient care record system is consistent with the limitation that the data may have been incorrectly filled in. By analysing previously compiled information, inherent biases may exist.

Furthermore, in the questionnaire, the response rates of the PHN cannot be considered high, although probably as high as can be expected, considering that participation was voluntary.

The pilot study was also limited in that it was carried out using only two private ambulance companies and only included one large city; consequently, the studied groups are quite different in size. Moreover, one specific issue regarding assessment and decision is that the EMS personnel have different qualifications in different regions. One specific issue is that the EMS cannot be considered high, although perhaps as high as can be expected, considering that participation was voluntary.

The pilot study was also limited in that it was carried out using only two private ambulance companies and only included one large city; consequently, the studied groups are quite different in size. Moreover, one specific issue regarding assessment and decision is that the EMS personnel have different qualifications in different countries and even within one country. We have only studied the potential for a Swedish PHN to use the prehospital DSS described in this paper.

Conclusion
With the help of this prehospital DSS – developed for 11 medical conditions – the Swedish PHN can safely decide on the level of healthcare to which an elderly patient can be steered.

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Conflicts of interest
There are no conflicts of interest.

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26 Hauswald M. Can paramedics safely decide which patients do not need ambulance transport or emergency department care? Prehosp Emerg Care 2002; 6:383–386.


