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an efficacy study

Skjøt-Arkil, Helene; Pontoppidan, Louise L; Laursen, Jens O; Giebner, Matthias; Andersen, Jesper D; Mogensen, Christian B

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Titlepage

Full title: DO PREHOSPITAL PROVIDERS AND EMERGENCY NURSES AGREE ON TRIAGE ASSIGNMENT? – an efficacy study
Short title: Uniform triage

Helene SKJØT-ARKIL, Louise Lerche PONTOPPIDAN, Jens Ole LAURSEN, Matthias GIEBNER, Jesper Damm ANDERSEN, Christian Backer MOGENSEN

1 The Emergency Department, Hospital of Southern Jutland, Kresten Philipsensvej 15, 6200 Aabenraa, Denmark
2 Danish Institute of Regional Health Research, University of Southern Denmark, J.B.Winsløws Vej 19, 5000 Odense C, Denmark
3 Surgical Department, Hospital of Southern Jutland, Kresten Philipsensvej 15, 6200 Aabenraa, Denmark
4 Medical Office, Falck Danmark A/S, Caspar Müllers Gade 2-4, 6000 Kolding, Denmark

Corresponding author: Helene Skjøt-Arkil, The Emergency Department, Hospital of Southern Jutland, Kresten Philipsensvej 15, 6200 Aabenraa, Denmark. Helene.Skjoet-Arkil@rsyd.dk

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Abstract
Objectives: The aim of the study was to investigate the agreement on triage level between prehospital providers and ED nurses in clinical practice when using the same triage system. The objectives were: 1) What is the agreement of triage between prehospital providers and ED nurses, when using DEPT correctly, 2) Which part of the triage process yields the highest agreement regarding the final triage?

Methods: The study was an prospective and observational efficacy study. Patients transported to the ED by ambulances were included. They were triaged by prehospital providers while being transported by ambulance to the ED, and by ED nurses upon arrival. Triage was done using the Danish Emergency Process Triage (DEPT) - a 5-level triage system based on vital signs and a presenting complaint algorithm. An agreement analysis was performed.

Results: DEPT was used correctly by both professions in 292 patients. In 182 patients (62%) the prehospital providers and the ED nurses agreed on the same triage level. This equals to kappa = 0.47 (95% CI: 0.41-0.56). When considering the triage based on vital signs the agreement was 72% (kappa=0.46 (CI: 0.41-0.47) and based on presenting complaint the agreement was 46% (kappa=0.41(CI: 0.37-0.44)

Conclusions: There was a moderate interrater agreement on triage assignment between ED nurses and prehospital providers. They agreed on final triage more often if they agreed on triage based on vital signs rather than presenting complaint.

Keywords: Triage, prehospital providers, emergency nurse, agreement, presenting complaint, vital sign
Introduction
Triage systems are widely used in the Emergency Departments (ED) and in the prehospital service, but most emergency triage systems are designed for and validated in either the ED or the prehospital setting[1-5]. Using a uniform triage system letting the prehospital providers triage the patients just before or up on arrival by ambulance to the ED, may allow the hospital personnel to prioritize the patient more rapidly and break down boundaries between pre and in hospital acute care improving the handover. It could be assumed, that this will minimize time to examinations and treatments resulting in a decrease of the patients’ throughput time and resource utilization.

Very little research has been made about implementing the same triage system in the prehospital setting as in the ED and moving the first triage of patients to the ambulance before arrival to the ED. A systematic review from 2013 found a lack of scientific documentation evaluating whether or not it is effective to use the same triage system in two or more settings of the acute chain[2]. Another review concluded that a number of barriers to effective handover exist and there are gaps in evidence based knowledge[6]. A qualitative study identified, that one of the barriers to effective handover was the lack of common language[7]. Hence further research is needed regarding whether this result can be transferred to clinical practice.

The aim of the study was to investigate the agreement on triage level between prehospital providers and ED nurses in clinical practice when using the same triage system – in this study the Danish Emergency Process Triage (DEPT), which is based on vital signs and a presenting complaint algorithm. The objectives were: 1) What is the agreement of triage between prehospital providers and ED nurses when using the DEPT correctly, 2) Which part of the triage process yields the highest agreement regarding the final triage?

Methods

Study design and setting
We did this prospective and observational efficacy study between April 1st and July 1st 2015. The study involved 80 ED nurses at the Hospital of Southern Denmark and 160 prehospital providers working in the hospital’s coverage area. The hospital is a 24-hour emergency care hospital offering emergency, level-2 trauma, medical, surgical and intensive care services. It provides medical care for 228,000 citizens. The ambulance service was covered by a private company, and the prehospital providers were emergency medical technicians and paramedics.

The study was run through the research unit in Emergency Medicine at the University of Southern Denmark, Institute of Regional Research, Southern Center.

Study instrument
Danish Emergency Process Triage (DEPT) is a 5-level triage system based on a combination of vital signs and a presenting complaint algorithm. DEPT categorizes the condition of the patient into five degrees: red (life threatening), orange (critical), yellow (stable, but potentially unstable), green (stable) and blue (unaffected). The color determines the urgency of medical attention required: red requires immediate action while blue demands reevaluation every 4th hour.[8]

The procedure for triage assignment is: First the triage level based on the measured vital signs is determined. Secondly the triage based on presenting complaint is determined. The presenting complaint algorithm consists of 50 main presenting complaints. They are based on both subjective information as expressed by the patient and objective data, and are divided into 5 levels equivalent to the triage categories. Based on the presenting complaints a triage category is assigned.
The triage level based on vital signs and based on presenting complaint are then combined, and the final triage level is determined by the variable that indicates the highest degree of urgency. If the nurse/prehospital provider does not agree with the assigned category, the system can be overruled and the triage level elevated.[8]

The equipment used by prehospital providers for measuring respiration rate (RR), arterial oxygen saturation (SAT), blood pressure (BP) and pulse was LIFEPAK®15 monitor/defibrillator, Medtronic Physio-Control, Redmond, WA, USA. The equipment used by ED nurses for RR, SAT, BP and pulse was patient monitor IntelliVue X2, Philips, Amsterdam, The Nederlands. The prehospital providers and ED nurses both used the ear thermometer Braun Termoscan PRO 6000, Welch Allyn, Skaneateles, NY, USA.

DEPT has been used at the ED of Southern Jutland Hospital for several years and was completely implemented. To ensure equal level of DEPT-training, the prehospital providers and ED nurses completed a short e-learning program on triage. Before recruitment, the educated prehospital providers had a pilot period of a month to implement the triage procedure.

**Study population and procedures**

All patients brought to the ED by ambulance, were triaged by prehospital providers and ED. The prehospital providers triaged the patient en-route to the hospital an again upon arrival (within 5 minutes limit). The last triage assignment was written in a data chart and handed in a locked letterbox at the ED secretary on arrival. The prehospital providers were instructed not to pass their triage assignment to the ED nurses at handover. Since the nurses were not informed of the prehospital provider’s use of DEPT, and it was not normal procedure to discuss triage at handover, it was no problem in practice to make sure, that they did not compare their triage results.

The ED nurses triaged the patients on arrival to the department within 5-10 minutes after the prehospital triage. The triage assignment were written in a data chart and handed to the ED secretary. The ED secretary subsequently transfers these data to the clinical record. This process was the normal procedure at the ED.

The examined population included orthopedic, internal medicine, surgical, gynecology and cardiology patients. Major trauma patients were received by a trauma team and are only triaged by a trauma score. They were therefore not recruited in this study. Pediatric patients were admitted directly to pediatric department and were not recruited in this study.

The data charts were collected from both the prehospital providers and the ED nurses. Since we only wished to measure the triage agreement between prehospital providers and nurses if DEPT was used correctly as intended, the a priori inclusions criteria were that the triage should have been followed according to the DEPT instruction, reflected in a notice on vital values, presenting complaints and final triage level. Only patients where both the prehospital providers and the ED nurses had registered this information were included.

A database was established by the ED secretary pairing the data charts from the prehospital providers and the triage from the ED nurses. Patients’ age and gender, vital signs, triage based on presenting complaints and final triage levels were recorded. The data were registered in the surveying tool SurveyXact, Rambøll, Aarhus, Denmark.

The ethics committee waived the need for approval as the study was considered a quality improvement project. All data was anonymously recorded and after request no registration to the Data Protection Agency was required.
Statistical analysis
We expected a non-serious triage in 70% of the patients. Expecting an interrater agreement of 0.6 ±0.1 with 95% confidence interval would require at least 295 pairs of observations.

The interrater agreement was determined using the Kappa statistic[9] with 0.5 weights. The vital signs were categorized into triage levels according to the triage model.

A two-sided probability of p<0.05 was considered statistically significant. The statistical analyses were performed in STATA v.14.0, StataCorp LLC, College Station, Texas, USA. This study has been presented according to the Strengthening the Reporting of Observational Studies in Epidemiology statement[10].

Results
For 724 patients data charts were collected from both the prehospital providers and the ED nurses. In the study we only want to measure the triage agreement if DEPT was used correctly as intended. For 385 patients the presenting complaint was not completed and for 47 patients the vital sign triage not completed. Therefore, of the 724 paired data charts, 292 (40%) paired data charts were used correctly by both professionals. These were further analysed. The median age was 70 years and 48% were females.

In 182 patients (62%) the prehospital providers and the ED nurses agreed on the same final triage level (table 1). This equals kappa = 0.47 (CI: 0.41-0.56) (table 2). In 50 patients (17%) the ED nurses triaged a lower level than the prehospital providers and in 60 patients (20%) they triaged a higher level. Overall nursing triage category was a little higher than that given by the prehospital providers.

When considering the triage based on vital signs the prehospital providers and the ED nurses agreed in 211 patients (72%) and kappa = 0.46 (0.36-0.52) (table 2). For 130 (45%) patients the prehospital providers and the ED nurses assigned the same triage level based on presenting complaints (table 2). This equals kappa = 0.42 (CI: 0.41-0.44).

Discussion
This efficacy study of 292-patient sample shows that prehospital providers and ED nurses agreed on final triage in 62% of the situations (kappa 0.47 (95% CI: 0.41-0.56)) which equals to a moderate interrater agreement [11]. They agreed more often on triage based on vital signs (72%) rather than presenting complaint (45%).

The distribution of the triage categories includes more critical and less stable patients compared with a recently published article on DEPT [12]. However in our study only patient brought to the ED by ambulances were included and not the patients who themselves were able to transport to the ED. This will displace the distribution in favor of more critical patients. Calculation of sample size was based on the less stable patients attending our ED. However since the percentage of the less stable patients in the study population was expected to be lower, the actual sample size needed will be lower than the one described in our power calculation.

A review of the literature revealed that there are few published studies that shed light on the agreement of triage between ED nurses and prehospital providers. Buschhorn et al[13] has evaluated the interrater
reliability between Emergency Severity Index assignments designated by emergency medical service and emergency triage nurses. The interrater agreement was moderate \((kappa 0.41 \ (95\% CI: 0.26-0.56))\) when evaluating 75 patients. A study by Dallaire et al [14] also investigated triage scoring during ambulance transportation. This study of 94-patient sample found a moderate agreement \((kappa 0.50 - calculated with quadratic weights)\) when comparing Canadian Emergency Department Triage and Acuity Scale (CTAS) assigned by ED nurses and base hospitals nurses. The base hospital nurses did however not see the patients but relied on communication with paramedics and their measurements. Kahveci et al found similar results when comparing paramedics and prior year’s ED physician assistants \((kappa 0.45)[15]\). Our data are consistent with these studies. Practice can however be differing and depends on the country’s health system or the hospitals themselves within the same system.

The moderate agreement on triage between ED nurses and prehospital providers has to be correlated with the reliability of the triage system. No studies of the reliability of DEPT have been reported but other studies have assessed the interrater reliability of triage scoring in clinical practice. Dallaire et al showed a moderate agreement \((kappa 0.44 – calculated with quadratic weights)\) between experienced nurses[16]. Dong et al showed moderate to good agreement \((kappa 0.55-0.65)\) between study nurses and duty triage nurses trained by web-based triage tool[17]. Hence, our interrater agreement is not inferior to the interrater reliabilities between ED nurses.

The ED nurses and prehospital providers agreed on triage based vital sign in 72% of the patients which equals a moderate agreement. Disagreement might originate from dynamic changes during time, as vital signs often can change even over short time period. A risk of an oversight therefore exist, if the ED nurses fully rely on previously obtained scores that, at the time, may have been entirely correct. This issue therefore needs further research to state, whether ED nurses can rely on the vital signs measurement performed by the prehospital providers and bypass the ED triage process.

Our analysis indicated that agreement on triage based on presenting complaint is important to obtain final triage agreement. The presenting complaints are based on the patient’s statements and therefore it depends on the patients’ opinion of degree of symptoms and equal reporting by the patient to both the nurse and the prehospital provider.

A qualitative study evaluating the implementation of Hillerod Acute Process Triage (HAPT), which is the prior model of DEPT, concluded that the nurses experienced difficulties in finding a presenting complaint algorithm relevant to the patients’ presenting problem[18]. This indicates that the inter-observer reliability of the presenting complaint might be low, and explain the lack of agreement in our study.

Both professions used the DEPT correctly in only 40% of the paired data charts. This issue will need focus in a subsequent efficacy study.

Demonstrating prehospital providers’ ability to use the DEPT and the new knowledge of triage association are valuable information for the design of future triage systems, triage education and communication between prehospital providers and ED nurses. It will also set the stage for further studies investigating whether this knowledge will have an impact on the handover of patients, the flow in ED’s or patient’s throughput time.

**Strength and limitation**

The strength of this study is that it is the first study investigating which part of the triage process that yields the highest agreement regarding the final triage. It is also the first study with a large sample size investigating the agreement of triage between prehospital providers and ED nurses.

There are some limitations of the study. We only examined one center and the extent of external validity needs further investigation. In our study no evaluation of inter-observer agreement among nurses or
among prehospital providers was done. The prehospital providers had only one month to implement the triage procedure, and therefore not much experience with DEPT. The data did not include trauma patients for trauma team or highly specialized patients as these latter patients preferentially are admitted to highly specialized departments in other hospitals and are underrepresented in this study.

Unfortunately there exists no reliable number to quantify how many patients were presented to the ED by ambulances in the study period.

Conclusion
There was a moderate interrater agreement on triage assignment between ED nurses and prehospital providers. They agreed on final triage more often if they agreed on triage based on vital signs rather than presenting complaint. However before considering implement uniform triage, further research is needed in other sites and on handover effectivenss, and the patients’ throughput time needs to be studies in additional research before considering implement.

List of abbreviations: ED: Emergency Department; DEPT: Danish Emergency Process Triage; CI: Confidence interval; BP: Blood pressure; RR: respiration rate; SAT: arterial oxygen saturation; GSC: Glasgow Coma Score; TP: temperature; OR: odds ratio.

Authors’ contributions: HS, CBM, JOL and MG conceptualised the trial and design. HS, LLP and JDA participated in data collection. HS, LLP and CBM performed the statistical analyses and contributed to manuscript development. All authors participated in the critical scrutiny and revision of the manuscript, and approved the final version.

Acknowledgements: Not applicable

References
Tables

Table 1 Agreement in final triage color between prehospital providers and ED nurses

<table>
<thead>
<tr>
<th>Prehospital providers</th>
<th>Blue</th>
<th>Green</th>
<th>Yellow</th>
<th>Orange</th>
<th>Red</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Green</td>
<td>1</td>
<td>21</td>
<td>14</td>
<td>7</td>
<td>1</td>
<td>44</td>
</tr>
<tr>
<td>Yellow</td>
<td>0</td>
<td>18</td>
<td>52</td>
<td>22</td>
<td>3</td>
<td>95</td>
</tr>
<tr>
<td>Orange</td>
<td>0</td>
<td>8</td>
<td>21</td>
<td>104</td>
<td>5</td>
<td>138</td>
</tr>
<tr>
<td>Red</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>52</td>
<td>89</td>
<td>136</td>
<td>12</td>
<td>292</td>
</tr>
</tbody>
</table>

>1 category difference 1 category difference Agreement
Table 2 Agreement statistic

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of patients with agreement</th>
<th>Kappa (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage based on vital signs</td>
<td>211 (72%)</td>
<td>0.46 (0.37-0.54)</td>
</tr>
<tr>
<td>Triage based on presenting complaints</td>
<td>130 (45%)</td>
<td>0.42 (0.41-0.44)</td>
</tr>
<tr>
<td>Final triage</td>
<td>182 (62%)</td>
<td>0.47 (0.41-0.56)</td>
</tr>
</tbody>
</table>

The table shows number of paired charts