Use of checklists improves the quality and safety of prehospital emergency care

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Objectives **High-level emergency medical care requires transfer of evidence-based knowledge into practice. Our study is the first to investigate the feasibility of checklists in improving prehospital emergency care.**

Materials and methods **Three checklists based on standard operating procedures were introduced: General principles of prehospital care, acute coronary syndrome and acute asthma/acutely exacerbated chronic obstructive pulmonary disease. Subsequent to prehospital care and immediately before transport, information on medical history, diagnostic and therapeutic procedures was obtained. Data of 740 emergency missions were recorded prospectively before (control group) and after implementation of checklists and compared using the χ^2-test (significance level $P < 0.05$).**

Results **Documentation on patients' history (pre-existing diseases: 69.1 vs. 74.3%; medication: 55.8 vs. 68.0%; allergies: 6.2 vs. 27.7%) and diagnostic measures (oxygen saturation: 93.2 vs. 98.1%; auscultation: 11.1 vs. 19.9%) as well as basic treatment procedures (application of oxygen: 73.2 vs. 85.3%; intravenous access: 84.6 vs. 92.2%) increased significantly. Subanalysis of acute coronary syndrome cases showed a significant increase of 12-lead ECG use (74.3 vs. 92.4%), administration of oxygen (84.2 vs. 98.6%), ASA (71.7 vs. 81.9%), heparin (71.1 vs. 84.0%), β blockers (39.5 vs. 57.1%) and morphine (26.8 vs. 44.6%). In the chronic obstructive pulmonary disease subgroup, oxygen supply (78.8 vs. 98.5%) and application of inhalative and intravenous β2-mimetics (42.4 vs. 66.7% and 12.1 vs. 37.9%) increased significantly.**

Conclusion **Introduction of checklists for prehospital emergency care may help to improve adherence to treatment guidelines. Additional efforts (e.g. team trainings) have to be made to increase quality of care.** ***European Journal of Emergency Medicine*** **24:114–119**

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Introduction

Treatment of patients in accordance with current guidelines and recommendations plays a key role in modern emergency medical care. Adequate technical and pharmaceutical equipment of rescue vehicles is a prerequisite for transfer of guidelines into practice [1]. A growing number of emergency medical systems (EMS) use standard operating procedures (SOP) for the treatment of various diseases. In terms of a continuous improvement process following implementation of SOPs, integration into daily practice should be monitored.

EN ISO 9000:2008 defines quality as 'a degree to which a set of inherent features meets requirements'. Relating to everyday prehospital emergency care, this means that diagnosis and treatment of diseases and injuries have to be carried out in accordance with predefined and revisable criteria. Immediate and reliable transfer of current recommendations into daily practice is a major challenge for EMS management as well as crews. Therefore, it seems paramount to identify ways of measuring the degree of implementation. Use of SOPs adjusted to local conditions is an important first step, but major deficits were found in terms of implementation in the field of prehospital emergency care [2].

In operative medicine, checklists that aim at guaranteeing correct and complete procedures on an individual case level are being used widely. Haynes *et al.* [3] showed that using a preoperative surgical checklist, mortality was reduced by up to 40%.

This study investigates the effects of routine use of checklists as an additional quality assurance tool in guideline-adherent prehospital emergency care where standards have been successfully implemented. In

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addition, acceptance by emergency medical staff was analysed.

Materials and methods

After approval by the local ethics committee, the study was initiated following a prospective and monocentric design. We analysed data from a German mobile response unit that is staffed 24/7 by an emergency team consisting of an emergency physician and a paramedic. Most of the emergency physicians are board-certified anaesthesiologists; only a few are internists. This unit always operates in cooperation with an ambulance team run by two paramedics and is dispatched to 3500 calls every year as part of the metropolitan EMS of the city of Berlin. After prehospital stabilization and initial treatment, emergency physicians decide whether to accompany the patient during ambulance transport to a hospital or to hand the patient over to the ambulance team.

To review SOPs that had been introduced the previous year, three checklists were developed.

For all patients:

(1) General principles of prehospital care checklist.

For patients with specific diagnoses:

(1) Acute coronary syndrome (ACS) checklist.
(2) Asthma and chronic obstructive pulmonary disease (COPD) checklist.

These two diagnoses were chosen as both ranked first among the most common reasons for prehospital missions.

Checklists were divided into three subcategories (past medical history, diagnostics and therapeutic procedures) and were geared to SOPs that had been developed from current guidelines and recommendations for the treatment of those diseases.

Study design

In phase I (control phase), before introduction of checklists, all emergency calls that lead to patient treatment were documented in detail for a 3-month period.

Within a 3-month implementation phase (phase II), checklists were introduced by a series of seminars, at the end of which implementation was considered complete. The seminars consisted of two parts. In a first step, paramedics and emergency physicians were confronted with the current situation of guideline-directed prehospital treatment by presenting the study results of phase I. The aim of this first step was to sensitize all team members to the fact that there was room for improvement in their own guideline-directed prehospital treatment. Step 2 included principles and the use of the newly developed checklists.

Checklists were used in a laminated pocket format. Intended time of use was after initial stabilization immediately before initiation of transport. Checklists were supposed to be read aloud by the unit's paramedic and to be checked by the complete emergency team. During preparation of the study, time needed for this check was measured repeatedly under different conditions. Time never exceeded the limit of 1 min.

The 'General principles of prehospital care' checklist was supposed to be used during every mission, and ACS and asthma/COPD checklists only where applicable.

Diagnostic or therapeutic procedures that were not fulfilled at that time were supposed to be performed at this point to gain full compliance with the SOP.

Detailed documentation and analysis of all missions were carried out in the intervention phase (phase III) until the exact number of missions from phase I was reached.

Subjective judgement

After implementation of checklists, emergency physicians and technicians anonymously assessed the following statements on their attitudes towards those tools:

(1) Checklists do not restrict my emergency medical practice.
(2) Implementation of checklists is reasonable.
(3) Checklists improve patient safety.
(4) I benefit from the introduction of checklists.
(5) Checklists lead to considerable additional effort.

Answers were freely marked using a metric analogue scale with endpoints 'not applicable at all' (representing '0' value) and 'fully applicable' (representing '100'). For documentation of all missions, a standardized emergency protocol (NADOK; DATAPEC Ltd, Pliezhausen, Germany) was used.

Data analysis

Written data were entered into an MS Access database (Microsoft, Redmond, Washington, USA). Procedures that were not documented were considered as not performed.

All data sets were analysed with respect to the 'General principles of prehospital care' checklist. In addition, patients who were marked with the diagnoses ACS or asthma/COPD by the prehospital emergency physicians were assigned to one of the other two SOPs.

All cases were screened for general data such as medical history including allergies, past diseases, medication and name of the GP, physical findings, for example Glasgow Coma Scale, respiratory rate, heart rate, ECG rhythm,

blood pressure, oxygen saturation and auscultation findings as well as two basic procedures (application of oxygen and intravenous access). The frequency of these procedures was determined comparing all cases from the control and intervention phase.

The ACS subgroup was screened for special procedures such as use of a 12-lead ECG, upright patient position, sublingual application of glycerolnitrate and intravenous application of acetylsalicylic acid, heparin, morphine and β blocking agents with contraindications such as blood pressure below 100 mmHg (glycerolnitrate, β-blockers) and a heart rate of less than $60\,min^{-1}$ (morphine, β-blockers) being taken into consideration.

The asthma/COPD subgroup was screened for use of 12-lead ECG, upright patient position, inhalative as well as intravenous application of β_2-mimetic agents and intravenous use of corticosteroids and theophylline.

Statistical analysis

Descriptive analysis comparing data from the control phase before and from the intervention phase after implementation of checklists was carried out using the χ^2-test (SPSS, Chicago, Illinois, USA). Significance level was defined as P less than 0.05.

Results

During the study period, data from 740 missions from the control and intervention phase were included, respectively. Tables 1 and 2 show the characteristic patterns of cases and diagnoses by emergency physicians. There were no significant differences between phases I and III with respect to patient age, sex, time of dispatch and medical qualification of emergency physician. ACS and COPD cases did not differ noticeably.

Figure 1 shows the results on the subjective judgement of the use of checklists. Overall acceptance was good, although the use of checklists required a certain amount of extra time (as mentioned above usually < 1 min). The lowest degree of consensus was obtained on the potential individual benefit of checklist use.

Table 1 Case characteristics

Variables	Control phase (before implementation of checklists)	Intervention phase (after implementation of checklists)	*P*
Age (years)	60.3 ± 23.3	60.1 ± 21.5	0.89
Sex			0.14
Female	322 (43.5)	350 (47.3)	
Male	418 (56.5)	390 (52.7)	
Time of dispatch			0.28
Day time	454 (61.4)	474 (64.1)	
Night time	286 (38.6)	266 (35.9)	
Medical specialty of responding physician			0.28
Anaesthesia	575 (77.7)	577 (78.0)	
Internal medicine	79 (10.7)	75 (10.1)	
Other	86 (11.6)	88 (11.9)	

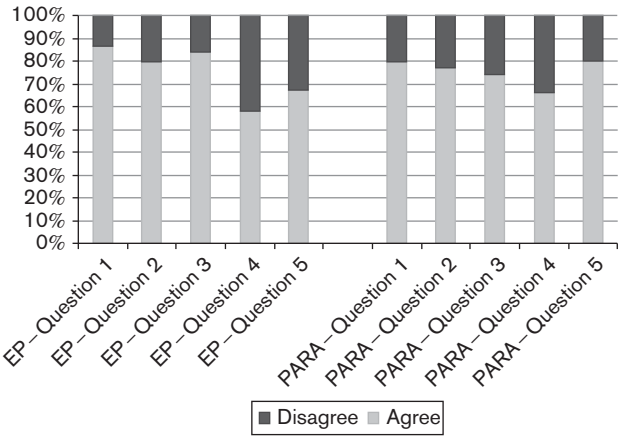
Data represent mean ± SD or *n* (%).
Significance level $P < 0.05$.

Table 2 Frequencies of diagnoses (diagnostic groups and individual diagnoses)

Diagnose	Control phase	Intervention phase	*P*
Cardiovascular	296	315	0.32
Acute coronary syndrome	152	144	0.60
Respiratory	119	128	0.53
COPD	34	46	0.16
Asthma	32	20	0.09
Neurological	160	110	0.001
Trauma	67	76	0.428
Gastroenterology	25	26	0.89
Various other	73	82	0.45
None	0	3	0.08
Total amount	740	740	

Data represent numbers.
Significance level $P < 0.05$.

Fig. 1



Subjective judgement. Data represent mean. EP, emergency physicians ($n = 11$), PARA, paramedics ($n = 9$). Question 1: Checklists do not restrict my emergency medical practise. Question 2: Implementation of checklists is reasonable. Question 3: Checklists improve patient safety. Question 4: I benefit from the introduction of checklists. Question 5: Checklists lead to considerable additional effort.

Table 3 Medical history, basic examination and life support data

Variables	Control phase	Intervention phase	*P*
Past medical history	511 (69.1)	550 (74.3)	0.024
Medication	413 (55.8)	503 (68.0)	< 0.001
Allergies	46 (6.2)	205 (27.7)	< 0.001
Name of family doctor	33 (4.5)	133 (18.0)	< 0.001
ECG monitor	419 (56.6)	530 (71.6)	< 0.001
Oxygen saturation	690 (93.2)	726 (98.1)	< 0.001
Cardiac auscultation	82 (11.1)	147 (19.9)	< 0.001
Respiratory rate	543 (73.4)	573 (77.4)	0.07
Heart rate	722 (97.6)	731 (98.8)	0.08
Blood pressure	689 (93.1)	702 (94.9)	0.16
Pulmonary auscultation	256 (34.6)	278 (37.6)	0.23
Glasgow Coma Scale	678 (91.6)	688 (93.0)	0.33
Oxygen supply	542 (73.2)	631 (85.3)	< 0.001
Peripheral intravenous access	626 (84.6)	682 (92.2)	< 0.001

Total numbers (%) are shown with significance level defined as $P < 0.05$.

Table 3 shows data on medical history from the general prehospital care checklist. Information on medication, allergies or the family doctor was available more often when checklists had been used. Monitoring of ECG and oxygen saturation was also documented in more patients.

Acute coronary syndrome subgroup analysis

A total of 296 patients with ACS were included, with 152 cases in phase I and 144 cases in phase III. When contraindications were found for a certain substance, the individual aspect was precluded from analysis (see Table 4 for details). Greater adherence to guideline recommendations is documented by the increase in 12-lead ECG from 74.3 to 92.4% ($P < 0.001$) in this subgroup.

Asthma/chronic obstructive pulmonary disease subgroup analysis

Sixty-six cases were recorded in the control and in the intervention phase, respectively (Table 5). Increase in the use of β_2-sympathomimetic agents and decrease in theophylline utilization show an effect of checklists on adherence to the SOP implemented for this patient group.

Discussion

Our data show that the use of checklists can lead to significant changes in compliance with standards. This can augment progress in guideline adherent documentation and therefore in the standard of medical care in prehospital emergency patients.

Collection of relevant data on past medical history, medication, allergies and the name of the patient's GP is relevant for the quality of care on the scene as well as further treatment in hospital.

Improvement in the quality of documentation was detectable for all of these aspects, although there is still room for further improvement, for example by continuous training efforts. Conditions such as 'no known allergies' or 'no known medication' should be documented adequately. Quality of physical examination and basic life support showed some improvement after introduction of checklists: the documented increase of a 12-lead ECG from 74.3 to 92.4% is consistent with a positive trend, and yet this is not an optimal degree.

Use of relevant pharmacological interventions, for example administration of morphine, acetylsalicyclic acid and heparin in ACS and application of inhalative as well as intravenous β_2-agents improved significantly after checklist implementation.

At the same time, use of theophylline was significantly reduced in compliance with current guidelines.

It has to be highlighted that the degree to which checklists were accepted by the emergency physicians involved was high during the entire study period. Doctors expressed no sense of diminished decision making competence, but believed that checklists were useful to them. Convincing the complete staff that newly implemented procedures are helping both patients and personnel will help to raise acceptance. A possible tool to gain higher acceptance could be confrontation with the own performance in terms of documentation. With respect to our study, presentation of current quality data (of not so optimal quality) may have contributed towards the high motivation of the staff. Independent from the general acceptance, it is noticeable that the personal benefit is considered comparably low. This fact may be attributed to a high sense of personal competence by individual staff members. Directing the focus on the individual responsibility for the quality of treatment could be an interesting new approach for future implementation strategies.

In general, adherence to guidelines improves the level of patient care beyond any doubt. In their 1993 meta-analysis, Grimshaw and Russell [4] found a significant impact on guideline adherence in 55 of the 59 studies included. In a follow-up study, they showed significant influence on guideline adherent care in 81 out of 87 studies and even a significant improvement in patient outcome in 12 out of 17 studies [5].

However, data from various medical fields indicate that publishing guidelines alone, that is without a comprehensive

Table 4 Acute coronary syndrome subgroup analysis

Variables	Control phase	Intervention phase	*P*
12-lead ECG	113/152 (74.3)	133/144 (92.4)	< 0.001
Oxygen supply	128/152 (84.2)	142/144 (98.6)	< 0.001
Sublingual glycerolnitrate	76/138 (55.1)	89/135 (65.9)	0.07
Intravenous Morphine	34/127 (26.8)	58/130 (44.6)	0.003
Intravenous acetylsalicyclic acid	109/152 (71.1)	118/144 (81.9)	0.04
Intravenous heparine	108/152 (71.1)	121/144 (84.0)	0.008
Intravenous β blockers	47/119 (39.5)	72/126 (57.1)	0.006
Upright position	66/152 (43.4)	77/144 (53.5)	0.08

Total numbers (%) of documented procedures are shown with respect to contraindications.
Significance level defined as $P < 0.05$.

Table 5 Asthma/chronic obstructive pulmonary disease subgroup analysis

Variables	Control phase	Intervention phase	*P*
Oxygen supply	52 (78.8)	65 (98.5)	< 0.001
Inhalative β_2-sympathomimetic agents	28 (42.4)	44 (66.7)	0.005
Intravenous β_2-sympathomimetics	8 (12.1)	25 (37.9)	0.001
Intravenous corticosteroids	43 (65.2)	53 (80.3)	0.05
Intravenous theophylline	24 (36.4)	4 (6.1)	< 0.001
upright position	29 (43.9)	35 (53.0)	0.30
12-lead ECG	19 (28.8)	27 (40.9)	0.14

Total numbers (%) are shown with significance level defined as $P < 0.05$.

implementation process, is not sufficient to increase the degree of guideline adherent care.

Without accompanying interventions, 30–40% of patients studied in the USA and the Netherlands did not receive care in concordance with current evidence-based guidelines [6,7]. Another study on quality of care in chronic conditions showed that guideline adherent pharmacological therapy varied between 40% in patients with depression and 79% with myocardial insufficiency [8].

Evidence from clinical anaesthesia shows that clear recommendations for the prevention of postoperative nausea and vomiting were not followed in 54% of the patients [9].

All of the data quoted above aim at the quality of elective medical procedures. The questions on the extent to which quality of prehospital emergency care is influenced by its demanding environment of stress, lack of time and information has yet to be answered. Moreover, the usefulness of quality improvement tools has to be shown [10]. Although relevant emergency medical guidelines exist on cardiopulmonary resuscitation, ACS and COPD, it is obvious that in the field of emergency medicine, implementation cannot be achieved easily.

This hypothesis is confirmed by one of our working group's previous studies: in a prospective setting, Bosse *et al.* [2] found the share of guideline adherent prehospital care to be about one-third of all cases of acutely exacerbated COPD before and after implementation of an SOP without accompanying quality assurance measures. Implementation of a SOP did not result in significant changes. Another study showed that SOPs are useful to improve the completion of patient care documentation, therefore ensuring information transfer from the prehospital field to the emergency department [11]. In a very recent trial, Rognås *et al.* [12] could show that implementation of a SOP improved the overall prevalence of automated transport ventilator use in emergency patients requiring respiratory support. These results make it necessary to look for additional tools to close the existing gap between theoretical knowledge and (prehospital) medical practice.

A 2003 analysis of 54 reviews shows that improvement can be achieved using a wide variety of interventions, for example training, conferences, group meetings, feedback, reminders, computer-assisted aids, interdisciplinary cooperation and media campaigns [13]. Of these different tools, the use of reminders seems to be most useful for prehospital emergency care. Standardized checklists have been introduced for a long time in high reliability organizations such as the aviation industry. In healthcare, there is some evidence for successful implementation of checklists: Haynes *et al.* [3] showed in their major prospective study that the introduction of the WHO Safe Surgery Checklist helped to reduce perioperative mortality by 40% (1.5% before vs. 0.8% after introduction of the checklist).

The results of our study may be considered a first hint of the significance of checklists as an instrument of quality assurance in emergency medical care. In contrast to surgical checklists, the aim was not to avoid complications, but to improve compliance with given standards. Both approaches are adequate in achieving higher levels of quality and safety in healthcare.

At the same time, it has become clear that the level of improvement is not satisfactory as yet and other options are needed to ensure a high level care in emergency medicine. There is evidence that education and training for residents, implementation of highly qualified triage physicians and emergency medical teams can improve the quality of care in emergency rooms [14–16].

Rall *et al.* [17] recommend the use of checklists as a vital part of their so-called 'Crisis Resource Management (CRM)' concept. CRM is defined as the ability to transfer medical knowledge and abilities into successful teamwork under the stressful conditions of medical emergencies. The CRM concept is based on the fact that 70% of errors in medical care are related to 'human factors'. This term encompasses individual factors (degree of education and training, vigilance) as well as groups' abilities with respect to communication and teamwork and systemic aspects such as establishment of a safety culture. All emergency medical personnel should know and exercise CRM basic principles. Acquisition of these skills should take place in patient simulators under the supervision of experienced instructors and using case studies from emergency medicine under realistic conditions. Structured feedback by instructors helps participants to manage critical situations in a safe atmosphere and to integrate the newly won abilities into daily practice [17]. Another way of improving quality and safety is the use of benchmarks as established in the German Resuscitation and Trauma Registries [18,19].

The effect of checklists was not investigated in this study. Linking process quality to outcome data in future studies is highly desirable. Nevertheless, it seems justifiable to conclude that checklists raising adherence to current evidence-based guidelines and recommendations will positively influence patient outcome, provided that they are updated and used continuously.

In accordance with current guidelines, future use of oxygen has to be more restrictive than in the study period where different recommendations were provided.

These items do not impair our general conclusion that the use of checklists leads to improvement in essential medical procedures in emergency medicine.

It remains unclear whether procedures that were not entered into EMS protocols were in fact omitted or

simply documented inadequately. In the end, this question is of minor importance as procedures that are not documented can impair patient safety as well as those not undertaken.

Putting current scientific evidence into guidelines and consequent implementation into clinical practice are paramount for improving quality and safety in prehospital emergency care. Discussions on the way in which this challenge can be met more effectively have only just begun in the scientific community and 'implementation science' is a growing field in medical research [20].

We are convinced that integration of our findings into daily emergency medical practice can be achieved if SOPs and checklists are implemented and continuously evolved using established quality improvement tools. This process has to be ensured by emergency medical directors approved by EMS agencies in each community. To make a difference in quality and safety, checklists, SOPs and other tools such as Critical Incident Reporting Systems and CRM trainings should be established as part of an evolving comprehensive safety culture in emergency medicine.

Summary

Use of checklists can raise the standard of care in prehospital emergency care. Acceptance by emergency physicians appears to be high. Although the use of the checklists leads to an increase in process quality, some results remain unsatisfactory. Future studies should investigate the use of checklists combined with other methods for quality improvement such as structured feedback or team trainings to achieve higher levels in the quality of emergency medical care.

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Conflicts of interest

There are no conflicts of interest.

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