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ORIGINAL ARTICLE

Cognitive aid in telecommunication information handover – prospective field experimental open-label study

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Abstract

BACKGROUND: Health care providers are paying more and more attention to clinical handovers. Previous studies have found that poor handovers resulted in adverse effects for patients. This study aims to determine the effectiveness of the standardized pre-notification process, from emergency medical services (EMS) to in-hospital care, with specific cognitive aid based on ATMIST.

METHODS: In February 2018, a prospective field test of the effectiveness of a standardized handover tool based on the ATMIST acronym was conducted in 11 Prague hospitals. The Emergency Medical Dispatch Centre used the form to record the information from the Crews (Protocol 1). The hospital dispatch centre (Protocol 2) used the same form to record the information from the EMS Dispatching. Both protocols were then compared and monitored to determine whether the information from the field was correctly transferred to the hospital. Signature items from the ATMIST form in different groups were empirically set to find out if the level of awareness of the personnel differs between groups.

RESULTS: Two hundred and sixty-nine Protocols 1 and 2 (37.41% of all pre-notifications) were analysed. There were 7,262 possible pieces of information to be transferred in total. 82.78% (n=6012) of all information was transferred correctly. The group analyses show no differences between the clinical condition of the patient and the awareness of the health care providers.

CONCLUSION: This is first study evaluating the use of a standardized handover tool for telecommunication handover. The clinical condition of patients did not play any role in how the information was transferred.

Abbreviations & units:

ALS	- Advanced Life Support
BP	- Blood pressure
CPR	- Cardiopulmonary resuscitation
ECG	- Electrocardiogram
ED	- Emergency Department
EMD	- Emergency Medical Dispatching
EMS	- Emergency Medical Services
GCS	- Glasgow Coma Scale
HDC	- Hospital Dispatch Centre
HR	- Hearth Rate
NACA	- National Advisory Committee for Aeronautics
OTI	- Orotracheal intubation
PEMS	- Prague Emergency Medical Services
RR	- Respiratory Rate
RRV	- Rapid Response Vehicle
SD	- Standard Deviation
SpO_2	- Oxygen Saturation
TRG	- Triage

BACKGROUND

Health care providers are paying more and more attention to clinical handover. In the last few years, non-technical skills, including communication and cognitive aids, are playing an increasingly important role (Eberl *et al.* 2017; Lelaidier *et al.* 2017; Marshall, 2017; Marshall and Mehra, 2014).

Previous studies have found that poor handovers resulted in adverse effects for the patient (Jenkin *et al.* 2007). Incorrect patient handover leads to delayed care, repeat examinations, medical misconduct, avoidable readmission and increased costs of care (Bomba and Prakash, 2005; Medicine, 2007; Solet *et al.* 2005). Failures in communication have been identified as one of the major preventable medical errors (Dojmi Di Delupis *et al.* 2014). Miscommunication and information loss during handover are acknowledged as a contributing factor to adverse events (Bost *et al.* 2012; Carter *et al.* 2009; Sue M Evans *et al.* 2010; Jenkin *et al.* 2007; Knutsen and Fredriksen, 2013; Murray *et al.* 2012). A report issued by the American Institute of Medicine suggests that ineffective patient transmission has been identified as one of the leading causes of medical error in emergency departments (Medicine, 2007). Communication failures have been identified as the main cause of over 60% of sentinel events reported by the Joint Commission on Accreditation of Healthcare Organizations (Lingard *et al.* 2004). The rate of adverse events is unacceptably high in the inpatient setting and poor communication is one of the causing factors (Lingard *et al.* 2004). Communication problems during the care transition or handover process may be responsible for 12% of patient safety incidents (Pronovost *et al.* 2006).

Patient safety level can be increased by improving the handover process (Bost *et al.* 2012) and by standardizing procedures (Bost *et al.* 2012; Jenkin *et al.* 2007). Most published studies focus on shift changes of doctors and nurses or handover between hospital departments or facilities (Bost *et al.* 2012). Few studies focusing on pre-hospital to in-hospital handover have been published (Wood *et al.* 2015), and those suggested that the quality of handover procedures varies. The difference seems to be in the method, language, level of education and expertise (Bost *et al.* 2012; Jenkin *et al.* 2007; Owen *et al.* 2009; Yong *et al.* 2008), with the handover from pre- to in-hospital care especially susceptible to error (Bost *et al.* 2012; Sue M Evans *et al.* 2010; Murray *et al.* 2012). The most recent literature review in this field was conducted in 2015 (Wood *et al.* 2015), and since then the situation in health care systems around the world has changed. The handover process is becoming more and more important for patient safety. Studies have already reported information loss during handover (Carter *et al.* 2009; Sue M Evans *et al.* 2010; Jenkin *et al.* 2007). Articles already published have focused on in-person communication and no studies monitored the effectiveness of telecommunication information handover (Peran *et al.* 2019).

Lingard (Lingard *et al.* 2004) identified four types of communication failures: (i) occasion failures (problem in the situation or context); (ii) content failures (insufficiency or inaccuracy in the transferred information); (iii) audience failures (gaps in audience composition); (iv) and purpose failures (unclear, not achieved or inappropriate purpose) (Lingard *et al.* 2004).

Efforts to improve the transfer of patient information should focus primarily on standardizing the structure of the information that is transmitted, for example towards acronyms such as ISBAR (Identification – Situation – Background – Assessment – Recommendation) or ATMIST (Age – Time – Mechanism – Injury/Illness – Signs and symptoms – Treatment) (Haig *et al.* 2006; Talbot and Bleetman, 2007).

In his article "The Safety of Emergency Medicine", Ramlakhan (Ramlakhan *et al.* 2016) mentions several key factors that affect safety in emergency medicine: *"Interventions such as team training, telephone follow-up, ED pharmacist interventions and rounding, all show some evidence of improving safety in the ED. We further highlight the need for a collaborative whole system approach as almost half of safety incidents in the ED are attributable to external factors, particularly those related to information flow, crowding, demand and boarding."*

Owen identified problems in handover such as the number of people in the communication chain, a stressful and chaotic environment, lack of time, lack of training, and frustration about how to provide an understandable handover (Owen *et al.* 2009). Ineffective handover also can be caused by communicating nonessential information, interruptions, obstacles to data collection, time constraints, difficulties using technology during patient transfer or because of a high workload and lack of clarity (Bost *et al.* 2012; Sue M. Evans *et al.* 2010).

The Prague Emergency Medical Services (EMS) is responsible for pre-hospital care in the Czech capital. The services are provided by Advanced Life Support (ALS) Ambulances with an emergency medical technician and a paramedic (or two paramedics) and Rapid Response Vehicles (RRV) operated by the EMT or a paramedic and physician. Patients are pre-notified to the hospital every time the patient is critical (NACA > 3) or are primarily dedicated to the centre care (acute coronary syndromes, strokes, severe trauma, etc.) or there is a local hospital protocol for pre-notification. Pre-notification is made by phone from the EMS crew to the Emergency Medical Dispatch Centre (EMD) and then by another call from the EMD to the Hospital Dispatch Centre (HDC). The information flow during pre-notification is shown in Figure 1.

This study aims to determine the effectiveness of the standardized process of telecommunication information handover from pre-hospital to in-hospital care with specific acronyms used as a cognitive aid.

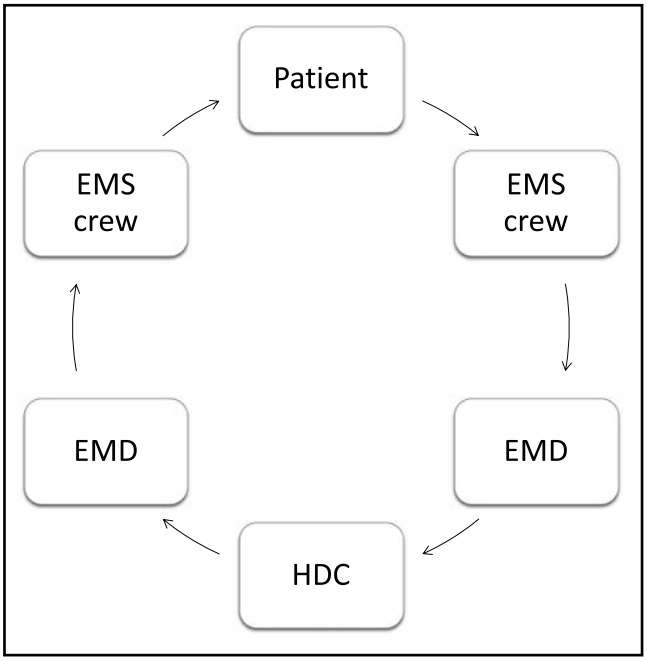

Fig. 1. Information flow during radio pre-notification
EMS Crew – Crew of the Prague Emergency Medical Services in the field
EMD – Emergency Medical Dispatch Centre
HDC – Hospital Dispatch Centre

METHODS

A literature search in the Scopus, Cinahl, Ovid and Medline databases was made prior to this study to determine the acronyms used for handover and/or pre-notification processes (Peran *et al.* 2019). The ATMIST acronym was finally chosen as the one most often used.

A pilot project to design an ATMIST form which might be used in the local environment of the City of Prague was conducted and later a modified Delphi method applying the principles of action research to modify and design the form was used prior to this study (Peřan *et al.* 2019) (Figure 2).

A prospective field experimental open-label study with all 11 Prague hospitals was conducted in February 2018. Every PEMS crew was trained in the use of the ATMIST form for pre-notification of patients from pre-hospital to in-hospital care. The Prague Emergency Medical Dispatch Centre used the form to record the information from the Crews (Protocol 1). The Hospital Dispatch (Protocol 2) used the same form to record the information from the Prague Dispatching. Both forms were then stored in a secured box for analysis.

Basic description of research process:

1) ATMIST form distributed to the dispatch centres.
2) Every patient pre-notification from the crew in the field to the EMS Dispatching was recorded on the ATMIST form (Protocol 1) at the dispatch centre.
3) Every patient pre-notification from the EMS Dispatching to the hospital was recorded on the ATMIST form (Protocol 2) in the hospital.
4) The process was monitored for a month.
5) Data collection from the forms by an office assistant and control by an independent paramedic.
6) Statistical analysis.

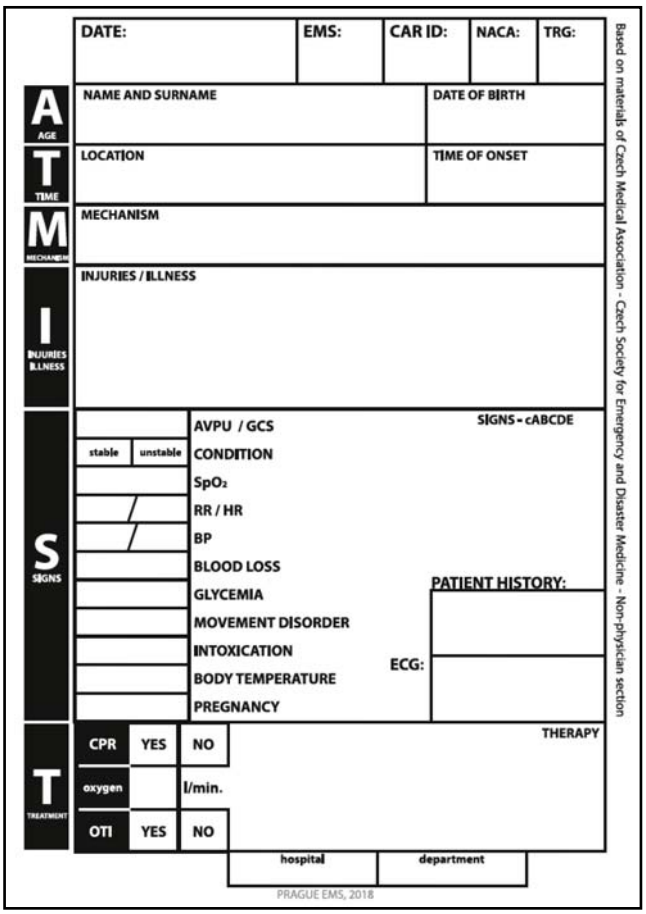

Fig. 2. ATMIST form used during the study

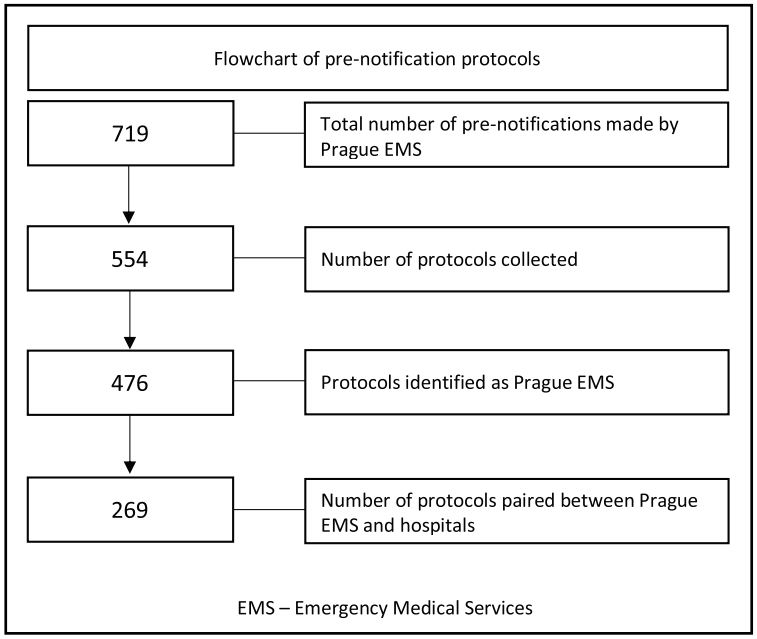

Fig. 3. Flowchart of the protocols

Inclusion and exclusion criteria

The study was conducted for one month (February 2018). Every patient notification from pre-hospital to in-hospital care performed by the Prague Emergency Medical Dispatching was included. The rules for pre-notification differ among hospitals, but basically it is situation with NACA > 3 or the patient is suitable for centred care (myocardial infarction, stroke, trauma, etc.).

Only those forms where Protocol 1 and Protocol 2 cannot be connected were excluded from the final analysis.

Groups identification

In the results, groups of patients pre-notified to (1) trauma department or centre, (2) general medical department, (3) cardiology, and (4) neurology were identified. For these groups, important values/items of the ATMIST form which cannot be skipped during the pre-notification were empirically set, these being (1) mechanism and type of injury, consciousness, stable/unstable, (2) illness, ECG, (3) ECG, and (4) glycaemia and patient history.

Statistical analysis

Data from both protocols were collected by an assistant of the Education and Training Centre, who to avoid researcher bias, had no knowledge of the design and objectives of the study and was also not a medical professional. The assistant compared both protocols and monitored whether the information from the field was correctly transferred to the hospital. Another comparison was made by a second assistant who is a medical professional, but also was not informed about the concept of the study. In the second comparison, the first assistant focused on checking and editing the result sheet for medical misunderstandings, and connecting every pre-notification to a medical group (e.g. cardiology, neurology, trauma, etc.) so that the subsequent comparison of the groups can be made. Descriptive statistics were used, and for further analysis a cluster dendrogram to compare which information is transferred similarly and for the group analysis the Pearson's chi-square test was used. The significance level for this test is a value for which a P-value is less than or equal to 0.05. Important (signature) items in different groups to determine if the results differ between the groups were empirically set. It was expected that the chosen signature items will be transferred more frequently in the specified groups than in the other groups.

RESULTS

In February 2018 there were 719 pre-notifications in total. Five hundred fity-four protocols were collected, of which 476 were identified as Prague EMS (because hospitals also used the ATMIST form for other EMS providers – Central Bohemian Region and private services). Two hundred sixty-nine Protocols 1 and 2 (37.41% of all pre-notifications) were paired (Figure 3 – Flowchart of the protocols).

In the 269 protocols there were 7,262 possible pieces of information to be transferred in total. 82.95% (n=6024) of all information was transferred correctly (the blank fields included); only 17.05% (n=1238) of the information was not transferred or not transferred correctly. The crews of the Prague EMS noticed 3,313 pieces of information, 77.94% of which were transferred correctly (n=2582) and 22.06% (n=731) were not transferred or not transferred correctly. Details of the results

Tab. 1. Results of the information transfer

	Item	Compliance % (n protocols)	Non-compliance % (n protocols)
	NACA	**98.88 (266)**	1.12 (3)
	Triage	**95.91 (258)**	4.09 (11)
A	Name	**79.18 (213)**	20.82 (56)
	Age	**95.54 (257)**	4.46 (12)
T	Place	**87.36 (235)**	12.64 (34)
	Time of onset	**66.54 (179)**	33.46 (90)
M	Mechanism	**60.59 (163)**	39.41 (106)
I	Injuries / Illnesses	**90.71 (244)**	9.29 (25)
S	GCS	**72.86 (196)**	27.14 (73)
	Stable / Unstable	**55.76 (150)**	44.24 (119)
	SpO_2	**73.61 (198)**	26.39 (71)
	Respiratory Rate	**83.64 (225)**	16.36 (44)
	Heart Rate	**68.40 (185)**	31.60 (85)
	Blood Pressure	**77.70 (209)**	22.30 (60)
	Blood Loss	**93.68 (252)**	6.32 (17)
	Glycaemia	**82.27 (224)**	16.73 (45)
	Movement Disorder	**82.87 (231)**	14.13 (38)
	Intoxication	**84.76 (228)**	15.24 (41)
	Body Temperature	**95.17 (256)**	4.83 (13)
	Pregnancy	**99.63 (268)**	0.37 (1)
	Patient History	**83.64 (225)**	16.36 (44)
	ECG findings	**81.41 (219)**	18.59 (50)
T	CPR?	**96.65 (260)**	3.35 (9)
	Oxygen	**90.33 (243)**	9.67 (26)
	Tracheal Intubation	**95.17 (256)**	4.83 (13)

Results of the information transfer of each item from the ATMIST form. The total amount of potential information was 7,262 in 269 protocols. Table 1 shows the percentage of correctly transferred information (and number of protocols).

of information transmitted by Protocols are shown in Table 1.

The cluster analysis shows in the dendrogram that there are three groups of fields that were transferred similarly (Figure 4). Group 1 (NACA, Triage, Date of Birth, Location, Injuries / Illness, Respiratory Rate, Blood Loss, Movement Disorder, Intoxication, Body Temperature, Pregnancy, Patient History, ECG, CPR, O2, Intubation, Hospital) – the percentage of correctly transmitted information in group 1 was 91% (SD 0.29). Group 2 (Mechanism, Condition) – the percentage of correctly transmitted information in group 2 was 58%, (SD 0.49). Group 3 (Name, Time of Onset, GCS, SpO2, Heart Rate, Blood Pressure, Glycaemia) – the percentage of correctly transmitted information in group 3 was 74% (SD 0.44).

The group analyses with the chosen signature items of the ATMIST form of chosen groups show no significant differences. The comparison of the groups by the signature items is shown in Table 2.

DISCUSSION

This study aims to determine the effectiveness of the standardized process of telecommunication information handover from pre-hospital to in-hospital care with specific cognitive aid. Overall, 77.94% of all written information was transferred correctly (n=2582), but all the information must be included, as no information was recorded without the source in the field and thus the final result based on all possible information which might be transferred (the blank fields included) is that 82.95% (n=6024) of all information was transferred correctly when all stakeholders used the ATMIST form.

Probably the most important parts of the information handover are the current medical conditions,

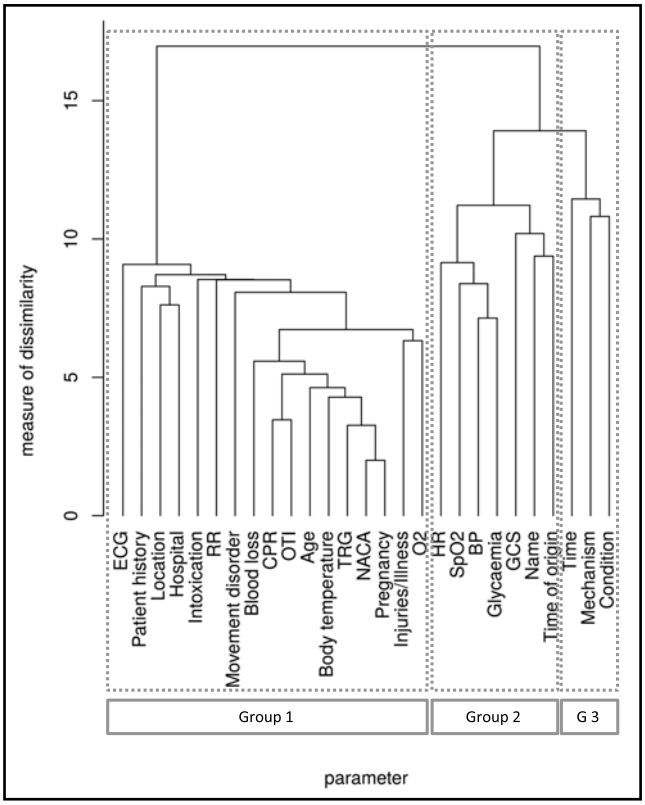

Fig. 4. Cluster dendrogram

represented by the Injuries/Illnesses part, which was transmitted in more than 90% of cases (90.71%, n=244 protocols). Surprisingly, the current conditions expressed by the Stable/Unstable patient checkbox was transferred only in 55.76% (n=150 protocols) of cases. This checkbox was one of the last parts to be added, so it might contribute to a poorer result.

From the Treatment part of the ATMIST (supplementary oxygen, resuscitation, intubation etc.), more than 90% of information was correctly transmitted (96.65%, 90.33% and 95.17% respectively). This information is important for the hospital to know what procedures were already done and what steps might follow in the hospital.

If a standardized handover is used, then it must be used by both the providers and the receivers of the information (Owen *et al.* 2009), because effective handover requires experience, active listening and a common language (Sue M. Evans *et al.* 2010; Owen *et al.* 2009). Though standardized handover has advantages, it does not help receiving staff recall the information (Talbot and Bleetman, 2007). This study was conducted with all Prague hospitals with the support of the managers. The ATMIST form respects all of these points – the fact that it is in writing helps with information recall. The same form is used by both sides and thus helps build a common language.

The reasons for not transferring some information were not examined in this research, but stress might be one of the possible causes. Chronic levels of cortisol as one of the main stress hormones can negatively affect prospective memory (Nakayama *et al.* 2005). A mild correlation between cortisol and memory functions was also found by other authors (Flegr *et al.* 2012; Galecki *et al.* 2013).

The cluster analysis shows in the dendrogram that there are three groups of fields that were transferred similarly (Figure 4). Group 1 is the biggest group, with both minor and high priority fields, but also with low-frequency information, and was correctly transmitted most often (91%, SD 0.29). One reason why the transfer of information is at such a level may be that this information is frequently transmitted. Group 2 represents a Mechanism and a Condition field, which is important in the case of patients with severe trauma, and 58% (SD 0.49) of information was transmitted correctly. Group 3 contains the main parts of the Signs fields like heart rate, blood pressure, oxygen saturation, glycaemia or level of consciousness. This group also includes the name and time of onset. Information in this group was transmitted correctly in 74% (SD 0.44) of cases.

Basic verbal handover does not contain enough information and the information delivered is not memorable for the receiver (Al Mahmud *et al.* 2009; Scott *et al.* 2003). With the ATMIST form, all the information is recorded in writing, so all the employees in the hospital have the same information.

If standardized handover is implemented in a mnemonic way (like ATMIST), greater consistency in the sequence of information can be expected, as well as a higher frequency of necessary information, less questions asked and time needed (Iedema *et al.* 2012). This presents an opportunity for further research – qualitative analysis of the pre-notification (time needed, frequency of unnecessary information, number of questions, etc.). An electronic solution might also be applied to reduce the time needed for information exchange as well as for the reduction of human factors, stress and forgetfulness (Vostry *et al.* 2019; Vostry, 2018).

The group analyses with the chosen signature items of the ATMIST form of chosen groups show no significant differences. Despite the fact that different situations require special emphasis on different items (e.g. ECG for patient transferred to cardiology), the results show that there is no connection between the patient's clinical condition and the awareness of the health care providers during the information handover. This is another field where human factors are necessary and it seems that they fail. The question is whether the effect is in low situational awareness, in stress conditions or in lack of time when providing the telecommunication handover.

More research is needed to determine the impact of human factors and the time spent on pre-notification, because obviously as the amount of information to be transferred increases, so does the amount of time spent. One possible solution might be electronic pre-notification, but more research is needed in this regard.

Tab. 2. Group results of information transfer

		Traumatology	General medicine	Cardiology	Neurology	*p*
Mechanism	Compliance (n)	36	53	24	47	0.86
	Non-compliance (n)	25	31	14	35	
	Compliance (%)	59,02	63,10	63,16	56,63	
	Non-compliance (%)	40,98	36,90	36,84	42,17	
Injury/Illness	Compliance (n)	56	76	33	76	0.76
	Non-compliance (n)	5	8	5	6	
	Compliance (%)	91,80	90,48	86,84	91,57	
	Non-compliance (%)	8,20	9,52	13,16	7,23	
GCS	Compliance (n)	45	62	28	60	0.99
	Non-compliance (n)	16	22	10	22	
	Compliance (%)	73,77	73,81	73,68	72,29	
	Non-compliance (%)	26,23	26,19	26,32	26,51	
Stable / unstable	Compliance (n)	36	42	26	46	0.28
	Non-compliance (n)	25	42	12	36	
	Compliance (%)	59,02	50,00	68,42	55,42	
	Non-compliance (%)	40,98	50,00	31,58	43,37	
ECG	Compliance (n)	46	68	31	72	0.29
	Non-compliance (n)	15	16	7	10	
	Compliance (%)	75,41	80,95	81,58	86,75	
	Non-compliance (%)	24,59	19,05	18,42	12,05	
Glycemia	Compliance (n)	50	73	28	69	0.33
	Non-compliance (n)	11	11	10	13	
	Compliance (%)	81,97	86,90	73,68	83,13	
	Non-compliance (%)	18,03	13,10	26,32	15,66	
Patient history	Compliance (n)	50	70	34	67	0.73
	Non-compliance (n)	11	14	4	15	
	Compliance (%)	81,97	83,33	89,47	80,72	
	Non-compliance (%)	18,03	16,67	10,53	18,07	

Table 2 shows the result of group analyses with chosen signature items from the ATMIST form. These results show that there is no connection between the patient's clinical condition and the awareness of the health care providers during the information handover.

LIMITATIONS

This study has several limitations. Not all of the handover protocols were collected, possibly due to human factors, as there were a lot of dispatchers in the process and some of them did not use it regularly, which is a possible cause of selection bias. Also, we were not able to pair all of the protocols between EMS and hospitals, because of missing data like date and time or patient name, etc.

This study did not evaluate the effect of the human factors in the process of the telecommunication handover. It is considered to be one of the main limits. The research was open-label, which is also a limitation, as all of the participants knew that the protocols are monitored. The effect of the human factors might be higher if there were a blind methodology.

The cognitive aid is used as a form for all categories of patients. Not all information is relevant for every patient. Therefore, we also used all blank parts of the form. When the information was not recorded in the field, we analysed if the blank part was not filled in with non-relevant information later in the transmission process.

CONCLUSION

This is the first study evaluating the use of a standardized handover tool for telecommunication information handover. During the study period, 269 handovers were analysed. There were 7,262 possible pieces of information to be transferred in total. 82.95% (n=6024) of all information was transferred correctly. Only 17.05% (n=1238) of the information was not transferred or not transferred correctly. The clinical condition of patients does not play any role in how the information is transferred or which information is transferred, possibly due to human factors.

DECLARATIONS

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Ethics approval and consent to participate

No interventions on patients were provided, the institutional review board approval is not applicable as well as the consent to participate, as the study works only with information which is part of the national legislation (Act No. 374/2011 Coll., on Emergency Medical Services).

Competing interests

The authors declare no conflicts of interest.

Authors' contributions

DP, JP, PChC, MN and DM contributed equally to this work. DP, JP and PChC conducted the field research, DP and MN carried out the analysis. DP and DM led the methodology of the research. DP, JP and PCHC wrote the paper and MN and DM made corrections. All of the authors made important intellectual contributions to the manuscript and all authors approved the final version before submission.

Availability of data and materials

The data set is available upon reasonable request from the corresponding author.

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