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The ATLS® classification of hypovolaemic shock: A well established teaching tool on the edge?

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ABSTRACT

Uncontrolled bleeding is the leading cause of shock in trauma patients and delays in recognition and treatment have been linked to adverse outcomes. For prompt detection and management of hypovolaemic shock, ATLS® suggests four shock classes based upon vital signs and an estimated blood loss in percent. Although this classification has been widely implemented over the past decades, there is still no clear prospective evidence to fully support this classification. In contrast, it has recently been shown that this classification may be associated with substantial deficits. A retrospective analysis of data derived from the TraumaRegister DGU® indicated that only 9.3% of all trauma patients could be allocated into one of the ATLS® shock classes when a combination of the three vital signs heart rate, systolic blood pressure and Glasgow Coma Scale was assessed. Consequently, more than 90% of all trauma patients could not be classified according to the ATLS® classification of hypovolaemic shock. Further analyses including also data from the UK-based TARN registry suggested that ATLS® may overestimate the degree of tachycardia associated with hypotension and underestimate mental disability in the presence of hypovolaemic shock. This finding was independent from pre-hospital treatment as well as from the presence or absence of a severe traumatic brain injury. Interestingly, even the underlying trauma mechanism (blunt or penetrating) had no influence on the number of patients who could be allocated adequately. Considering these potential deficits associated with the ATLS® classification of hypovolaemic shock, an online survey among 383 European ATLS® course instructors and directors was performed to assess the actual appreciation and confidence in this tool during daily clinical trauma care. Interestingly, less than half (48%) of all respondents declared that they would assess a potential circulatory depletion within the primary survey according to the ATLS® classification of hypovolaemic shock. Based on these observations, a critical reappraisal of the current ATLS® classification of hypovolaemic seems warranted.

Introduction

The Advanced Trauma Life Support (ATLS®) represents a standardised and priority orientated approach to assess and manage severely injured trauma patients in the Emergency Department (ED) [1]. To date, ATLS® is educated in over 60 countries worldwide and more than 1.5 million providers have been taught according to this concept. Consequently, ATLS® has become one of the world's most successful training programmes for the initial management of trauma victims [1,2].

Uncontrolled haemorrhage is still the most common cause of shock in trauma and delayed recognition and treatment has been linked to adverse outcomes including increased organ dysfunction and mortality [1,3,4]. Therefore, early detection of hypovolaemia is one of the essential priorities in the initial assessment of severely injured trauma patients [3]. For this purpose, ATLS® promotes four classes of hypovolaemic shock based upon vital signs upon the patient's initial presentation and an estimated blood loss in

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percent. Although this classification has become widely accepted as a teaching tool within the ATLS® course concept and is also recommended by the up-dated European guideline for the management of bleeding and coagulopathy following major trauma with grade 1C together with patient physiology, anatomical injury pattern, mechanism of injury and the patient's response to initial resuscitation, its prospective validation is still lacking [5]. Furthermore, its clinical validity has recently been questioned by two retrospective analyses on the UK-based TARN (Trauma Audit and Research Network) registry and the German TraumaRegister DGU® including >140,000 trauma patients [6–9].

We provide a brief synopsis and comment on the recently published data that have triggered a critical discussion about the clinical validity and confidence in the ATLS® classification of hypovolaemic shock.

The ATLS® classification of hypovolaemic shock

For the initial evaluation of circulatory depletion, ATLS® has implemented a classification of hypovolaemic shock [1]. The current ATLS® classification is summarised in Table 1. According to this classification, the clinical symptoms of volume loss in class I patients (estimated blood loss up to 15%) are minimal. No measurable changes occur in systolic blood pressure (SBP) or mental status and only a mild tachycardia (<100 beats/min) may be observed. In class II (estimated blood loss 15–30%) a tachycardia of >100 beats/min may be present and subtle changes in mental status, e.g. anxiety, are described. In contrast, SBP is still within normal limits. As blood loss increases to 30–40% (class III), a marked tachycardia (120–140 beats/min), a measurable hypotension and an impaired mental status occur. A further depletion of blood volume (>40%) is characterised by a significant hypotension, a tachycardia of >140 beats/min and a markedly depressed mental status, which may further proceed into a complete loss of consciousness. For each class, ATLS® allocates therapeutic recommendations, for example either the replacement of intravenous fluids (class I–IV) or the administration of blood products (class III–IV) [1]. In principle, these guidelines are based on the 3-for-1 (3:1) rule, which derives from the empiric observation that most patients in haemorrhagic shock require as much as 300 ml of electrolytes for each 100 ml of blood loss.

Assessing the validity of the ATLS® classification of hypovolaemic shock

In a retrospective analysis from the TraumaRegister DGU® database, 36,504 severely injured trauma patients were classified according to the ATLS® classification of hypovolaemic shock by using a combination of the three vital signs heart rate (HR), systolic blood pressure (SBP) and Glasgow Coma Scale (GCS). Interestingly, only 3411 (9.3%) matched one of the ATLS® classes when a combination of all three vital signs was assessed [6] (Fig. 1). The vast majority of these patients (91.0%) was allocated to class I, representing the phenotypic "normal" patient with a regular SBP, a GCS = 15 and only a mild increase in heart rates (<100 beats/min).

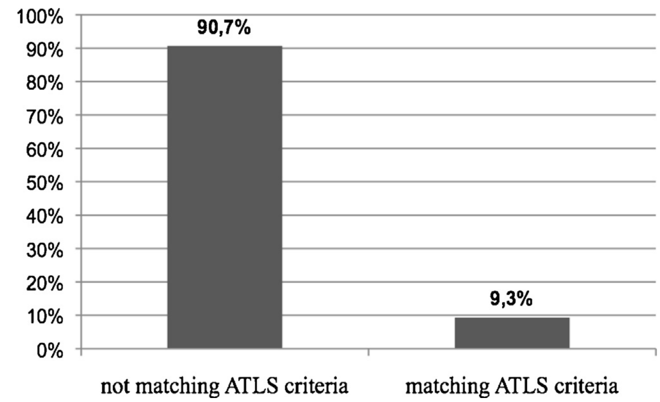

Fig. 1. Percent of patients matching the criteria according to the ATLS® classification of hypovolaemic shock.
Modified according to [5].

The remaining classes (II–IV) were only represented marginally. In contrast, 90.7% (n = 33,093) of all trauma patients did not match one of the shock classes suggested by ATLS®.

Recently, Guly and colleagues substantiated these results by analysing datasets of 107,649 trauma patients derived from the UK-based TARN registry [7]. According to their analysis, there was an inter-relationship between derangements of heart rates, systolic blood pressures and GCS values in the presence of hypovolaemic shock but not to the same degree as postulated by the ATLS® classification of hypovolaemic shock [7]. In detail, when trauma patients were classified according to their initial heart rate into one of the four ATLS® shock classes, a decline of systolic blood pressure between the classes I–IV was seen. However, a distinct hypotension for the classes III and IV – as postulated by ATLS® – was not observed. Similar results have been reported in a large cohort of trauma patients derived from the TraumaRegister DGU® [6]. Furthermore, through the classes I–IV, ATLS® seems to dramatically underestimate the degree of mental disability associated with increasing heart rates. Further observations were made by classifying trauma patients into the ATLS® shock classes by their SBP upon ED admission. Both, within the TARN registry and the TraumaRegister DGU®, there was no significant alteration in heart rates associated with decreasing blood pressures and no group showed a relevant tachycardia [6,7]. Consequently, the proclaimed association between hypotension and tachycardia as postulated by ATLS® seems not reflect clinical realities.

Already back in 2003, Victorino and colleagues demonstrated in a cohort of 14,325 trauma patients that increasing heart rates are not a reliable sign of hypotension after trauma and are not necessarily associated with decreasing blood pressures [10]. Within their cohort of hypotensive patients (SBP < 90 mmHg), only 65% presented tachycardic reflected by a heart rate >90 beats/min. Consequently, 35% of the hypotensive patients still presented normofrequent. In contrast, when patients were analysed by their heart rate, even 39% of their tachycardic patients still had a SBP > 120 mmHg.

Table 1
The ATLS® classification of hypovolaemic shock [1].

	Class I	Class II	Class III	Class IV
Blood loss in %	<15	15–30	30–40	>40
Pulse rate	<100	100–120	120–140	>140
Blood pressure	Normal	Normal	Decreased	Greatly decreased
Pulse pressure	Normal or increased	Decreased	Decreased	Decreased
Respiratory rate	14–20	20–30	30–40	>35
Mental status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic
Urine output (mL/hr)	>30	20–30	5–15	Minimal

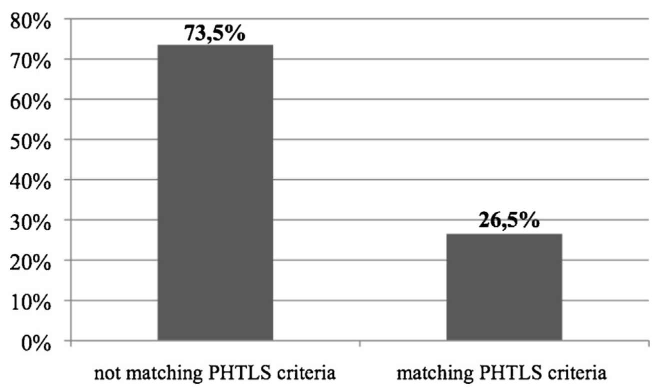

Fig. 2. Percent of patients matching the criteria according to the PHTLS® classification of hypovolaemic shock.
Modified according to [12].

In an analysis on the Los Angeles county trauma system database, Ley and colleagues have shown that 44% of their patients presented even with a relative bradycardia, defined as a HR < 90 beats/min and a SBP < 90 mmHg [11]. Additionally, heart rate at ED admission has been proven to be inaccurate in predicting injury severity, the need for immediate surgical intervention, or transfusion requirements [12]. Consequently, the importance and reliability of isolated vital signs, e.g. heart rate and systolic blood pressure, for the detection of hypovolaemia have to be questioned [6,7,10–12].

The validity of the classification of hypovolaemic shock in the pre-hospital phase of care

When assessing vital signs upon emergency department arrival, it has to be acknowledged that the pre-hospital treatment, e.g. the administration of intravenous fluids or vasopressors, may have influenced these variables. To overcome this objection, the classification of hypovolaemic shock, which is also used by the PreHospital Trauma Life Support programme (PHTLS®), was assessed in the pre-hospital setting on datasets of 46,689 trauma patients derived from the TraumaRegister DGU® [13]. Only one out of four trauma patients (26.5%) could be classified according to the classification of hypovolaemic shock if a combination of all three parameters (HR, SBP and GCS) was assessed (Fig. 2). Consequently, 73.5% of all trauma patients did not match the classification criteria given by PHTLS® when the pre-hospital vital signs were evaluated. Interestingly, there was no relevant difference in the percentage of classified trauma patients observed when blunt and penetrating trauma was analysed separately. Furthermore, subgroup analysis on patients with and without a significant traumatic brain injury (TBI) was performed. However, even in the absence of severe TBI more than two third of these patients could not be allocated to one of the respective shock classes [13].

The ATLS® classification of hypovolaemic shock in daily trauma care

In order to assess the actual use and appreciation of the ATLS® classification of hypovolaemic shock in daily trauma care, an online survey among 383 European ATLS® course instructors and directors has been conducted [14] Ninety-eight percent of all respondents declared that they follow the ATLS® principles in daily trauma care and 84% stated that they are confident with the current classification of hypovolaemic shock as a didactic tool. However, when the ATLS® members were asked how they would assess circulatory depletion within the primary survey in daily clinical practice, only 48% stated that they would use the ATLS® classification of hypovolaemic shock. The remaining half tended to rely more on their clinical experience, physical examination and laboratory findings [14]. Interestingly, this number was even higher (53.5%) in the group of ATLS® course directors. One possible explanation may be related to the high percentage of respondents that stated that more than 50% of their trauma patients cannot be allocated to one of the suggested ATLS® shock classes. Additionally, a remarkable number of respondents declared that the current classification has no impact in guiding fluid resuscitation and blood product transfusion strategies within the initial management of severely injured trauma patients [14].

Conclusions

The results presented in this synopsis demonstrate that the ATLS® classification of hypovolaemic shock displays substantial deficits for the adequate assessment of trauma patients in haemorrhagic shock. Over 90% of all trauma patients may not be allocated correctly into the shock classes suggested by ATLS® when the combination of the three suggested vital signs, e.g. heart rate, systolic blood pressure and Glasgow Coma Scale, is assessed. The analyses on the UK-based TARN registry and the German TraumaRegister DGU® including >140,000 trauma patients if combined clearly showed that ATLS® seems to overestimate the degree of tachycardia associated with hypotension and to underestimate mental disability in the presence of hypovolaemic shock. These findings were independent from pre-hospital treatment, trauma mechanism and the presence of traumatic brain injury. An online survey among ATLS® course directors and instructors revealed that the ATLS® classification of hypovolaemic shock may be considered as a useful teaching tool, but in clinical practice this classification seems to be of rather limited value only. From our perspective, a critical revision of the ATLS® classification of hypovolaemic shock is warranted.

A reasonable alternative, when "thinking outside of the ATLS box", may be a system based on alterations in base deficit (BD) [15,16]. A recent comparison between the accuracy of the current ATLS® classification for hypovolaemic shock with a system based on early BD alterations demonstrated a greater correlation with transfusion requirement, need for massive transfusion (MT) and mortality in favour of the latter [15]. In reflecting several of the earlier findings associated with the clinical value of BD measurement in acute trauma care and in risk stratifying bleeding trauma patients, this study was the first one to define and validate a BD-orientated classification system as alternative. Base-deficit measurement can easily be incorporated into initial trauma triage in all settings where point-of-care (POC) testing is readily available.

Conflicts of interest

There are no conflicts of interest associated with this article.

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