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Age differences of arterial trauma – Selection of the most appropriate age classification

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Abstract

Introduction: Studies on age differences of arterial trauma (AT) carry significant methodological differences in terms of selection of the most appropriate age classification.

Aim: This study aims to verify the most optimal age classification when comparing clinical patterns of the civil AT.

Material and methods: 222 AT patients were identified from the Lviv Clinical Regional Hospital. In each case the following clinical patterns were identified: patient age, etiology, mechanism, AT type, topography, diagnostics mode, treatment type. Patients were distributed using six age classifications (Erikson 1950, UN 1989, Quinn 1994, Craig 2000, WHO physical activity recommendations 2010, by decades of life). Generalized linear models (GLMs) were created, with age distributions as predictors and clinical patterns as dependent factors. Akaike information criterion (AIK) was used to compare the quality of statistical sets.

Results and discussion: Six GLMs were obtained, in each age of them age classifications were compared using the AIK. Rating list of age classifications was developed (starting with the most appropriate and ending with the least appropriate): E. Erikson (1950) → V. Quinn (1994) → G. Craig (2000) → UN (1989) → Decades → WHO (2010).

Conclusions: Human development classifications may be preferable in assessing the age differences of AT in patients of wide range.

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1. INTRODUCTION

Arterial trauma (AT) occurs infrequently in the civil setting but may carry substantial morbidity and mortality. Investigators address various aspects of etiology, pathophysiology, management and outcome of AT in their studies. Age differences of AT are also under the scope of recent research. Significant methodological inconsistencies exist between papers regarding how to approach different ages, authors may grade patients by decades of life, evaluate only children or adults, delineate favored age subgroups, etc.[1–9] We thought to attempt to select the most appropriate age classification from the perspective of our experience of AT management.

2. AIM

This study aims to verify the most optimal age classification when comparing clinical patterns of the civil AT.

3. MATERIAL AND METHODS

This is a retrospective single-center study conducted at the Vascular Surgery Division of the Lviv Clinical Regional Hospital, Ukraine. Data of patients with ATs who were on treatment in the Vascular Surgery Division between January 1993 and December 2019 were analyzed. Inclusion criterion was the diagnosis of an AT, exclusion criteria were ATs from drug abuse and injuries of the thoracic aorta.

The following data were collected: patient age, AT etiology, AT mechanism, AT type, injury topography, diagnostics mode, treatment type.

AT etiology was graded through the following patterns: interpersonal conflicts, domestic, iatrogenic, workplace, traffic, others. AT mechanism was defined as penetrating or non-penetrating. AT type was described using the classification as suggested by Chen et al.[10] According to their classification three major vessel injury types were outlined: without disruption, with partial disruption and with complete disruption. Injury topography included head, neck, arm, chest, abdomen or leg. Diagnostics mode was one of the three options: (1) AT diagnosis could be established after physical investigation only, (2) after physical investigation with ultrasound investigation, or (3) after physical with ultrasound investigation and angiography. The latter could be either conventional catheterization or non-catheterization angiography, such as CT/MRI. Treatment type was one of the four options: (1) conservative treatment, (2) simple surgery, such as ligation or vessel repair, (3) complex surgery, such as end-to-end anastomosis or replacement utilizing a vein or a synthetic graft, (4) endovascular or hybrid intervention.

The following age classifications were preliminarily selected:

(1) Erikson (1950). Eight groups: infancy (0–2 years), toddlerhood (2–4 years), early school (5–8 years), middle childhood (9–12 years), adolescence (13–19 years) early adulthood (20–39 years), middle adulthood (40–59 years), late adulthood (60 or above);
(2) UN Convention on the Rights of the Child (1989). Two groups: children under 18 years, adults above 19 years;
(3) Quinn (1994). Seven groups: infants (0–2 years), early childhood (3–6 years), childhood (7–12 years), teens (13–18 years), young adults (19–40 years), adulthood (41–65 years), elderly (above 66 years);
(4) Craig (2000). Seven groups: infancy (0–2 years), early childhood (2–6 years), middle childhood (6–12 years), adolescence and youth (12–19 years), early adulthood (20–40 years), adulthood (40–60 years), late adulthood (above 60 years);
(5) WHO global recommendations on physical activity for health (2010). Three groups: under 17 years, 18–64 years, above 65 years;
(6) Decades of life. Nine groups: 0–10 years, 11–20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, 71–80 years, 81–90 years.

Statistical analysis was performed using the STATISTICA v. 13.3 software (StatSoft Inc., Tulsa, OK, USA). The distributions were checked for normality; the non-Gaussian distributions were described using the median and interquartile range 25–75 (IQR). In the generalized regression model (GLM), the independent predictor was the patient cohort age pattern as distributed according to one of the age classifications (Erikson 1950, UN 1989, Quinn 1994, Craig 2000, WHO 2010, decades of life). The dependent predictor was of one of the AT attributes (AT etiology, AT mechanism, AT type, injury topography, diagnostics mode, treatment type). Therefore, six GLMs were developed, with six predictors in each of the models, interactor correlations were omitted and only independent contributions taken into account. The predictors in the GLMs were ranged using the Akaike information criteria (AIK).

4. RESULTS

Medical records of $n = 222$ patients were obtained. Median age was 32 years (IQR 21; 71); ranging from 8 days to 84 years. The etiology of AT was the following: workplace ($n = 7$; 3.1%), traffic ($n = 9$; 4.1%), iatrogenic ($n = 25$; 15.8%), interpersonal conflicts ($n = 45$; 20.2%), domestic ($n = 101$; 45.5%), others ($n = 25$; 11.3%). The mechanism was non-penetrating ($n = 53$; 23.9%), penetrating ($n = 154$; 69.4%), unknown ($n = 15$; 6.7%). AT types: without vessel disruption ($n = 24$; 10.8%), complete disruption ($n = 58$; 26.1%), partial disruption ($n = 116$; 52.3%), unknown ($n = 24$; 10.8%). Injury topography: chest ($n = 8$; 3.6%), abdomen ($n = 10$; 4.5%), head ($n=12$; 5.4%), neck ($n = 16$; 7.2%), arm ($n = 78$; 35.1%), leg ($n = 99$; 44.6%). Diagnostic modes: physical investigation with ultrasound and angiography ($n = 22$; 9.9%), physical investigation only ($n = 89$; 40.1%), physical investigation with ultrasound ($n = 111$; 50%).Treatment types: endovascular or hybrid intervention ($n = 3$; 1.4%),

Table. AIK levels in the constructed GLMs.

Age classification	GLM					
	etiology	mechanism	topography	AT type	diagnostic mode	treatment type
E. Erikson (1950)	719.76	352.31	606.68	527.06	420.11	390.22
UN (1989)	719.80	356.46	608.39	529.78	418.68	409.63
V. Quinn (1994)	727.73	352.70	607.36	528.64	419.87	397.15
G. Craig (2000)	733.13	352.42	607.69	528.08	421.41	402.01
WHO (2010)	738.74	356.53	608.21	531.75	422.73	411.56
Decades	744.40	352.31	605.27	529.57	424.53	426.59

conservative treatment (n = 17; 7.7%), simple surgery (n = 94; 42.3%), complex surgery (n = 100; 45%).

The AIK levels in the constructed GLMs are given in Table.

AIK levels given in Table may be compared within one regression GLM only, but not between the different GLMs. For example, in the column 'etiology,' the most appropriate age classification was Erikson (1950) since it scored the smallest number of 719.76, the second most appropriate was the UN (1989) because it scored 719.80, etc. As for the column 'mechanism,' the most appropriate age classifications appeared Erikson (1950) and by decades of life, followed by Quinn (1994), etc. To compare the entire data set, we graded the age classifications from 1 to 6 within each column. For example, in the column 'etiology,' Erikson (1950) graded 1, UN (1989) graded 2, etc. Finally, the grades between the columns were summed and the following rating list was obtained (starting with the most appropriate and ending with the least appropriate age classification): Erikson (1950) → Quinn (1994) → Craig (2000) → UN (1989) → Decades → WHO (2010).

5. DISCUSSION

The bottom-line of this paper shows that to assess the AT age differences, it appears preferably to use more sophisticated age classifications, rather than dividing the patients into children and adults, or grading them by the decades of life. It is noteworthy that previous investigators utilized various age classification approaches in their studies relating to vascular trauma age aspects.

Some collected data on vascular trauma, divided patients into corresponding decades and obtained four to eight subgroups. This approach allowed them to observe the relative incidence of the disease in different ages.[1–4] Li et al. followed this pattern and also compared the etiology of the disease between the delineated subgroup.[2] At the same time, other attributes have not been compared between the age subgroups in these studies.[1–4]

Other investigators studied only children or adults.[5–9,11–19]

In their papers on children, Allen et al. published data about 81 patients and divided them into two groups (under 13 years and 14–17 years), Ammar et al. – 36 patients and three groups (under 2 years, 2–7 years and 7–12 years), Wahlgren and Kragsterman – 222 patients and four groups (under 2 years, 2–6 years, 7–12 years and 12–15 years), Jaipuria et al. – 83 patients and three subgroups (under 6 years, 6–13 years and 14–18 years), Silva et al. – 37 patients and three groups (under 6 years, 6–14 years, and 14–17 years), Corneille et al. – 95 patients and two groups (under 10 years and 10–17 years).[5–7,11,12,20] Allen et al. compared topography and treatment types were between the groups, Jaipuria et al. compared topography and trauma mechanisms, Corneille et al. compared angiography utilization and treatment types.[7,11,12] Other authors stated the number of patients in the created subgroups.

In their papers on adults, Baram et al. published data on 47 patients, mean age 24.8 years, Wani et al. – 192 patients, mean age 31.32 ± 3.2 years, Shor et al. – 846 patients, mean age 31 ± 6 years, Gupta and Rao – 153 patients, median age 32 years (IQR 25–75 19–68 years).[8,14,19,21] Other investigators mentioned the age of the patients with different vascular trauma conditions. Depboylu et al. published data on 45 patients and compared the age of males and females, Perkins et al. – 256 patients, compared the age of clients with acute and blunt trauma, De'Ath and Galland – 89 patients, compared the age of clients with non-iatrogenic and iatrogenic injuries, Gupta and Rao – 153 patients, compared the age of clients with different topography injuries.[9,14,15,22]

Siracuse et al. investigated the National Inpatient Sample (USA), divided patients into three age groups (0–15 years, 16–45 years and 46 years and more) and studied the frequencies of firearm and non-firearm vascular injuries in each of these groups.[23] Hicks et al. also looked at the Nationwide Inpatient Sample (USA) and reported the frequencies of limb amputations and mortality in patients of different races, aged 16–64 years and 65 years and more.[24] Branco et al. in their analysis of the National Trauma Database (USA) compared the age of patients treated with surgical and endovascular techniques.[25] Konstantinidis et al. conducted another review of the National Trauma Database (USA) and compared adult with geriatric patients in terms of etiology, blunt and penetrating trauma, topography, lethality and length of hospital stay.[26] Barmparas et al. in their analysis of the National Trauma Database (USA) compared children and adults and reported on the frequencies of penetrating and blunt trauma, topography, hospital and ICU stay length, amputations and mortality.[27]

In this study, a rating list of age classifications based on GLMs was created. The rating list showed the most and the least appropriate age classifications. The list can be evaluated with two approaches – quantitative and qualitative.

Quantitatively, the classifications with high number of subgroups tended to be more favorable as compared to the classifications with low number of subgroups. In the Erikson (1950), Quinn (1994) and Craig (2000) there were 8, 7 and 7 subgroups, while in the UN (1989), decades and WHO (2010) classifications there were 2, 9 and 3 subgroups correspondingly.

Qualitatively, those classifications, which respected the age-related morphological and social aspects of life more carefully, appeared to be more optimal. It is known that growth and development in childhood in non-linear, with peaks in infancy and teen age, followed by maximal physiological activity of several decades in adulthood, after which involution of various organs and systems gradually occur. These morphological and physiological changes are accompanied by certain social activity patterns. These features are reflected by the classifications of Erikson (1950), Quinn (1994), Craig (2000) and, to some extent, in the WHO physical activity grouping (2010). At the same time, distinct features are less appreciated in the classifications of the UN (1989) and division by decades.

We observe significant diversities between various investigators regarding the age differences of vascular trauma, as well as paucity of detailed information about the age differences of AT. From the perspective of our results, grading the patients with AT according to their decades of life might provide with the least significant results of age differences. Gross comparison between the children and adults appears less precise. The AT contrasts should become evident if the patients are compared using other classification criteria. It is interesting to note that the latter are actually borrowed from the human development studies.

This study carries some limitations. The Vascular Surgery Division of the Lviv Clinical Regional Hospital is not the only vascular surgery center of the region, so a considerable number of patients might have been not included into the study. The exclusion criteria omitted clients with thoracic aorta and drug abuse consequences, which could impact on the patient distribution pattern. The AIK criteria used in the GLM regressions did not appreciate the absolute power of the predictors, they rather point to the relative effectiveness of the factors, as compared between each other. In the current analysis, only ATs were included, as opposed to classical approaches when both arterial and venous injuries had been studied. Albeit the percentage of venous injuries is usually much lower as compared to the arterial, this aspect should be considered in additional studies. Finally, we concentrated on the development of assessment tool in analyzing the age differences of AT, while in the future investigations practical implications on diagnostics and treatment will need to be delineated.

6. CONCLUSIONS

(1) Comparison of six age classifications to find the best fitting for the AT attributes was performed, which allowed to find the most and the least optimal distribution patterns.
(2) Dividing the patients into children/adults or by decades was the least effective in detecting the age differences of AT.
(3) To assess the age differences of ATs, it is preferable to group patients of various ages using the human development classifications.

Conflict of interest

None declared.

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None declared.

Ethics

The study protocol was approved by the Ethics Committee of Danylo Halytskiy Lviv National Medical University. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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