

Pre-hospital trauma care: A comparison of two healthcare systems

Xi Xiang Tan, Nicholas D. Clement¹, Michael Frink², Frank Hildebrand², Christian Krettek², Christian Probst²

Abstract

Introduction: The management of trauma patients differs depending upon the healthcare system available. **Aim:** To compare the pre-hospital management and outcome of polytrauma patients between two countries with differing approaches to pre-hospital management. **Materials and Methods:** The Scottish trauma and audit group (STAG) and the German trauma registry (GTR) databases were used to compare the management and outcome of trauma patients in Scotland and Germany. Severely injured patients (injury severity score (ISS) > 16) were analyzed for a 3 year period (2000 to 2002). Patient demographics, pre-hospital interventions, ISS, revised trauma score (RTS), time from scene of injury to arrival to the emergency department (ED), 120 day mortality and standardized mortality ratios using TRISS methodology were compared. **Results:** There were 227 patients identified from the STAG registry and 6878 patients from the GTR registry. There was a significant difference in ISS (24.9 vs. 29.8, $P = 0.001$, respectively). No significant difference was observed for the RTS ($P = 0.2$). There was a significantly higher rate of pre-hospital interventions in the German group ($P < 0.001$). The mean time from an injury to arrival to the ED (73 vs. 247 minutes, $P = 0.001$) was longer for the Scottish patients. There was no difference for an unadjusted mortality rate between the groups, but the standardized mortality ratio was significantly greater for the Scottish population (3.8 vs. 2.2, $P = 0.036$). **Conclusion:** Despite variation in pre-hospital transfer times and interventions, no significant difference was demonstrated in RTS upon arrival, or for the unadjusted mortality rates.

Keywords: Acute liver failure, intensive, treatment

Access this article online

Website: www.ijccm.org

DOI: 10.4103/0972-5229.94421

Quick Response Code:



Introduction

Approximately 10,000 people die in England and Wales each year after trauma and in addition to this, there are millions of additional non-fatal injuries.^[1] Trauma is the leading cause of death in children and young adults in the UK,^[2] which has major socio-economic consequences and is only second to cardiovascular disease, as a cause of lost working years from death and disability.^[2] Similarly, in Germany,

approximately 10.9% of the population is involved in accidents annually, and trauma is the second commonest cause of hospitalization.^[3] Trauma registries have been established globally in an effort to improve the management and outcome of trauma patients.

In 1991, the Scottish trauma and audit group (STAG) was established to assess and improve the management of trauma patients in Scotland. This national trauma audit was conducted for a decade, from 1992 to 2002 in 28 hospitals across Scotland, collecting data for 52,676 trauma patients.^[4] At the same time, the *Deutsche Gesellschaft fuer Unfallchirurgie* (DGU), being the German society for trauma surgery, established the German trauma registry (GTR) in 1993 with an aim to develop guidelines for the management of multiply injured patients.^[3] Inclusion of patients was originally voluntary,

From:

Alexandra Hospital / Jurong Health Services, Emergency Department, Singapore, ¹Department of Trauma and Orthopaedic Surgery, Royal Infirmary of Edinburgh, Little France, Edinburgh, ²Trauma, Hannover Medical School, Hannover, Germany

Correspondence:

Dr. Xi Xiang Tan, Foundation doctor Royal Infirmary of Edinburgh, Little France, Edinburgh EH16 4SU, United Kingdom.
E-mail: xi.x.tan.04@aberdeen.ac.uk

it has since become compulsory for trauma units to record this data for audit purposes.

The pre-hospital management of trauma patients differs between Scotland and Germany. The Scottish system relies primarily upon a paramedic service to provide pre-hospital care. The German management of pre-hospital trauma differs; a greater priority is given to include physician input prior to an arrival to the emergency department, with administration of advanced trauma life support® (ATLS).^[5] These differences in approaches to trauma care continue to be an area of debate.

This study compares the management of polytrauma between Scotland and Germany using data from STAG and the GTR registries, respectively. We present the differences of injury severity, anatomical pattern of injury, and the pre-hospital management between the Scottish and German populations, relating these to patient outcome.

Materials and Methods

The STAG dataset was used to assess the management of trauma patients in Scotland.^[4] Inclusion criteria for this audit were: patients 12 years of age or more, an admission to hospital for at least 72 hours, or died as a result of injury. Patients aged over 65 years of age with an isolated fracture of the neck of femur or pubic rami were excluded. Length of stay and patient mortality at 3 months from presentation were the main outcome parameters. One of the key findings of this audit was that the survival rate for seriously injured patients increased from 65.3% to 78.9% over the duration of the audit from 1992 to 2002.^[4] As a result, this audit was discontinued in 2002 as it was concluded from the improved survival rates that management of trauma patients in Scotland was significantly better than the rest of the UK.

The GTR dataset was used to assess the management of trauma patients in Germany. Criteria for patient inclusion within the registry was admission through the emergency department (ED) after an acute traumatic injury, requiring intensive care unit (ICU) admission for the same time period or dying in the ED. Collection of data remains ongoing. The registry is open to every hospital and trauma department in Germany, in addition, some neighboring countries, such as The Netherlands, Austria and Switzerland, with more than 100 trauma units participate on a voluntary basis.^[6] Maintenance of data is completed by doctors whilst the patient is still in hospital and following that specially trained personnel ensure that a minimum set of mandatory data

is available to allow for participation in the registry. The data undergoes quality control.^[7]

A retrospective analysis of all trauma patients with an injury severity score (ISS) of 16 or more that were entered into both registries (STAG and GTR), from 1st January 2000 to 31st December 2002 was performed. Patients aged over 65 years of age with an isolated fracture of the neck of femur or pubic rami were excluded from the GTR. Data before 2000 for the GTR was not available and was incomplete. Table 1 shows the information that was analyzed from both the databases. The ISS and the revised trauma score (RTS) were used to assess the anatomical injury severity score (AIS) and physiological indices of the injury, respectively. Mortality at 120 days was the primary outcome assessed. The ISS and RTS were used to calculate the trauma and injury severity score (TRISS), which was then used to calculate the standardized mortality ratio (observed / predicted) for both populations.

Data collected from both groups was analyzed using statistical package for the social sciences version 17.0 to derive frequencies, means and percentages for the various parameters and confirmation of normal distribution. The data was normally distribution, and a student's t-test was used for continuous and Chi-squared test was used for discontinuous data. The level of significance was set at $P < 0.05$.

Results

There were 227 patients identified from the STAG

Table 1: Data criteria obtained from the STAG and GTR datasets

Epidemiologic parameters to ascertain the comparability of the 2 populations:

Sex

Age

Type of injury (blunt or penetrating)

Injury severity (general and regional)

Injury pattern

Number of injuries per patient

Pre-hospital Interventions:

Intravenous fluids (regardless of type of solutions)

Anesthetic drugs

Intubation rates

Use of air transportation

Cornerstones of the time line:

Time from incident to arrival at ED

Time patient left ED

Total time spent in ED

STAG= Scottish trauma and audit group; GTR= German trauma registry;
ED= Emergency department

Table 2: Epidemiological and injury characteristics for both groups

Patient demographics	Mean ± S.D or percentage		P value
	Scotland	Germany	
	Number of patients	227	
Age (years)	43.5 ± 20.1	41.2 ± 20.3	0.1024
Gender (% male)	74.0	73.1	0.8387
Type of injury (% blunt)	96.9	95.9	0.4455
Number of injuries	2.4 ± 1.1	2.3 ± 2.1	0.6228
Injury severity score	24.9 ± 20.1	29.8 ± 13.1	0.0011
Revised trauma score	6.51 ± 2.0	6.30 ± 1.9	0.2068

Table 4: Incidence of regional injuries and mean AIS score per region for both groups

Incidence of regional injuries (%)	Scotland	Germany	P value
Head	68.3	63.6	0.6405
Facial	12.8	20.4	0.0006
Chest	48.5	58.8	< 0.0001
Abdominal	21.1	32.1	< 0.0001
Extremity	52.4	58.3	0.0004
External	33.9	26.8	0.1462
AIS score for regional injuries (mean)			
Head	2.1	2.3	0.4187
Facial	0.3	0.3	0.8993
Chest	1.5	1.9	0.0137
Abdominal	0.5	0.9	0.0269
Extremity	1.3	1.5	0.3822
External	0.4	0.3	0.7720

AIS = Anatomical injury severity score

registry and 6878 patients from the GTR registry, were used in our study. Table 2 shows the demographic and injury characteristics of the two populations. The mean age for both groups was > 40 years with a predominantly male population, the majority of which had sustained blunt trauma. The number of injuries sustained per patient in both groups was similar with each patient incurring a mean of 2.3 - 2.4 injuries. The only significant difference was of ISS between the groups, with Scottish patients having an average score of 24.9 and German patients having an average score of 29.8, however, there was no significant difference in the RTS ($P = 0.6$).

Table 3 shows the comparison of pre-hospital management interventions. There was a significant difference between both populations, with a considerably higher rate of pre-hospital interventions in the German group.

Table 4 shows the regional incidence of injuries and the mean AIS score for each region. German patients sustained significantly more facial, chest, abdominal and extremity injuries than the Scottish population. There was, however, no significant difference for the incidence

Table 3: Pre-hospital interventions for both groups

Pre-hospital management	Mean or percentage		P value
	Scotland	Germany	
Intravenous fluids (ml)	320	1671	< 0.0001
Anesthetic drugs*	0%	83.2%	< 0.0001
Intubation	2%	64.4%	< 0.0001
Air transportation	9.7%	45.0%	< 0.0001

* Propofol, opiates, adrenaline

Table 5: Patient outcomes for both groups

Patient outcome	Mean ± S.D or percentage		P value
	Scotland	Germany	
Mortality during treatment	23.8%	22.2%	0.5608
Standardized mortality ratio	3.8	2.2	0.0359

of head and external injuries. The severity of these regional injuries only reached a significant difference for chest and abdominal injuries.

Both, the mean time from injury to arrival to the ED (73 vs. 247 minutes, $P = 0.001$) and the time spent in the ED (83 vs. 168 minutes, $P = 0.001$), were significantly longer for the Scottish patients [Figures 1 and 2].

Table 5 illustrates the outcome parameters. There was no significant difference in unadjusted mortality rate between the groups. The standardized mortality ratio was significantly greater for the Scottish population [Table 5].

Discussion

Overall, patient demographics were comparable between the groups. There was, however, a large difference in the cohorts analyzed with 227 patients in the Scottish group and 6878 patients in the German group. This difference is probably related to the actual population size of the individual countries, with over 5 million in Scotland^[8] and over 80 million in Germany.^[9] The population density also differs, as Scotland's average population density is 66 persons per square kilometer, and in Germany, there are 230 persons per square kilometer. Therefore we critically accepted the different cohort sizes. A recent prospective study^[10] in the West of Scotland compared the outcomes of patients suffering moderate to severe trauma in urban versus rural environments. They demonstrated no significant differences for length of inpatient stay or mortality for either group, despite a significantly longer time from scene to the ED for rural patients. These results are supported by our study, as the longer transfer times we observed, are probably related to distance from the ED

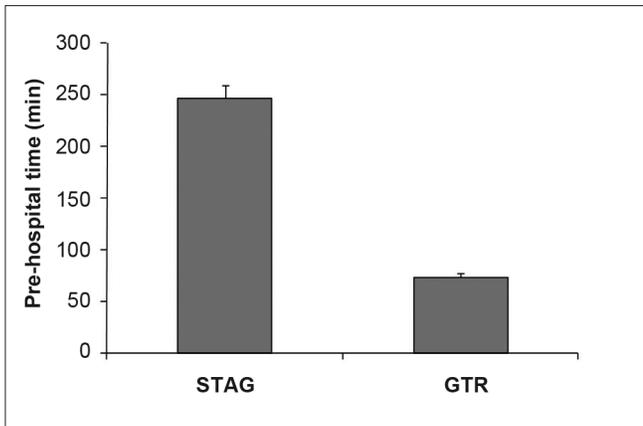


Figure 1: Mean time from injury to arrival to the ED for both groups (73 vs. 247 minutes, $P = 0.001$)

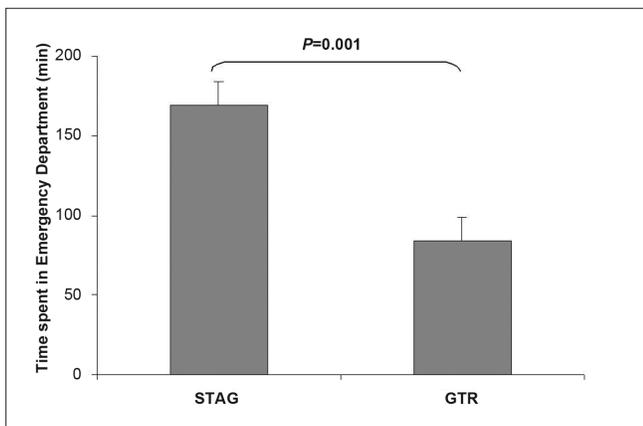


Figure 2: Mean time spent in the ED for both groups (83 vs. 168 minutes, $P = 0.001$)

and may not result in a worse outcome; The standardized mortality ratio was greater for the Scottish population, although several authors have concerns in the use of TRISS methodology to compare differing trauma centers.^[11]

Most registries do not include patients who are dead at the scene or die on route to the ED. These patients are lost to the analysis and are not included in the STAG or GTR datasets. Therefore, we cannot conclude if patients, who die before reaching the ED, may have survived if they had reached definitive care earlier. This may have led to a selection bias in our study groups, with critically ill patients dying before arrival to hospital in Scotland, therefore, being excluded, whereas the same critical patient in Germany may arrive at hospital earlier and become part of the register. This is reflected by the significantly increased ISS observed for the German population.

The shorter pre-hospital times in the German group are probably due to greater use of air transportation of

polytrauma patients by helicopter emergency medical services (HEMS) in Germany. The main advantages of HEMS are: 1) Shortened overall time to patient arrival at hospital, 2) Potentially better pre-clinical therapy due to the presence of a highly qualified medical team, 3) Efficient, fast, and if needed, long-distance transport to level 1 trauma centers.^[12] Scotland only has 4 air ambulance aircrafts,^[13] whereas Germany has far more units available in all regions, allowing for more flexible usage and shorter pre-hospital times. The use of air transport has been shown to have a positive effect on the mortality of polytrauma patients. A prospective study,^[12] comparing patients transferred by ground ambulance or HEMS to hospital of polytrauma patients revealed that primary transfer by HEMS to a level 1 trauma center reduced mortality, compared with transfer to a regional hospital by ground ambulance. They attributed this to superior pre-hospital therapy by the HEMS team in combination with specialist care at the level 1 trauma center.

Legislative differences exist between the countries that may contribute to the difference in pre-hospital times. In Germany, there exists legislation called the *Rettungsdienstgesetze* (Emergency Medical Services Act)^[14] that governs rescue protocols and the *Hilfsfrist* (period to help);^[15] the time it takes from receiving the emergency call to the arrival of adequate emergency assistance to the scene. This varies regionally throughout Germany, but on average, the deadline for emergency assistance to reach the scene is 10 to 15 minutes.^[16] This Act demands that emergency medical services providers to fulfill the deadline in 95% of emergencies. Thus, unlike in Scotland where such legislation does not exist, there is an additional responsibility upon the German rescue services and consequently shorter pre-hospital times.

Scottish polytrauma patients received less pre-hospital interventions, compared to the German patients who received more aggressive intravenous fluid replacement, a higher rate of intubations, and prescribed more anesthetic drugs. This may be related to difference in practice between the countries. The first responders to the scene in Scotland are mainly ambulance paramedics or technicians who perform basic life support (BLS) techniques.^[17] They do receive training in endotracheal intubation, intravenous cannulation and fluid administration, and in the use of anesthetic drugs, but the rate at which these are used is relatively low.^[18] This may be due to a desire for prompt transfer to a facility for definitive treatment or inexperience of the practitioner.^[18] Despite this variation in pre-hospital interventions, there was no significant difference

demonstrated of physiological parameters upon arrival to the ED, reflected by similar RTS for both populations.

It is possible for advanced life support (ALS) providers to tailor their on-scene management to stabilize the severely injured patient and not delay transfer to definitive management, as this may be detrimental to patient outcome.^[19] Patient with an ISS of 16 or more, have a significantly increased risk of mortality, and it is this group of patients that benefit most from rapid evacuation to definitive care.^[20] Previous studies^[20-22] have discussed if there is a tendency for ALS personnel to waste precious time performing ALS procedures. Trunkey *et al*^[23] and Lewis *et al*^[24] have suggested that some ALS skills are necessary whilst others are a waste of precious time in the field.

Despite a significantly higher ISS in the German group, the unadjusted mortality rates were similar for both populations. One explanation for the higher ISS observed in the German population could be the greater use of computer tomography scans used for their patients (73.6% vs. 78.5%, $P = 0.03$). This may have resulted in more covert chest and abdominal injuries being identified, for which we demonstrated a significantly higher prevalence in the German population. This would have also influenced the TRISS and hence the observed difference in the standardized mortality rates, despite similar unadjusted mortality rates. On the other hand, regional injury severity also differed significantly for chest and abdominal injuries. Here, one would expect, that the higher rate of CT scans had no influence, since e.g. severe pulmonary contusions would also be visible on plain chest X-ray. Furthermore, comparison of ISS alone between differing populations does not take into account other case-mix variables, such as pre-existing medical conditions that influence mortality, although these have a lesser affect on severely injured trauma patients (ISS > 16).^[25,26]

It would seem the observed diversity in pre-hospital times and pre-hospital interventions between the groups do not make a difference to overall survival. This seems illogical. Management of the trauma patient is a multifaceted process, where management and transport to the ED is just one step. The Scottish population spent longer in the ED after arrival. This may reflect the need for longer resuscitation, which in Germany has already been commenced pre-hospitalization and hence less time is spent in the ED. This theory, however, is not supported by the initial physiological parameters, with similar RTS for both groups.

It is neither an aim nor in the scope of this study to draw conclusions or derive indications as to which approach to trauma management is superior. This is due to the multi-factorial reasons, unique to individual countries and regions, some of which have been discussed. Further research in the form of prospective randomized controlled trials is needed.

Conclusion

This study is a novel comparison of two differing populations and their hospital management of the severely injured patient. Both the Scotland and German populations have similar demographics. The German population, however, present with more severe injuries which may be reflected in the lower standardised mortality ratio. Despite longer pre-hospital transfer times and more interventions in the German group, no significant difference was demonstrated in RTS upon arrival, or unadjusted mortality rates.

References

1. Trauma Audit and Research Network. Available from: <https://www.tarn.ac.uk/Login.aspx>. [Last cited on 2011 Mar 8].
2. Pape HC, Oestern H, Leenen L, Yates D, Stalp M, Grimme K, *et al*. Documentation of blunt trauma in Europe. *Eur J Trauma* 2000; 26:233-47.
3. Schmidt U. The German trauma system: infrastructure and organization. *Trauma Quarterly* 1999;14:227-31.
4. Scottish Trauma Audit Group (STAG). Available from: <http://www.stag.scot.nhs.uk/>. [Last cited on 2011 Mar 8].
5. Westhoff J, Hildebrand F, Grotz M, Richter M, Pape H, Krettek C. Trauma care in Germany. *Injury* 2003;34:674-83.
6. Neugebauer E, Bouillon B, Schlosser L. Guidelines in Multiple Injured Patients: The Approach of the German Trauma Registry. *Euroacademia Multidisciplinaria Neurotraumatologica*. Available from: http://www.emn-neurotrauma.de/publications/1999_congress4_tenerife/119emn99.pdf. [Last cited 2011 Mar 8].
7. Grimme K, Pape HC, Probst C, Seelis M, Sott A, Harwood P, *et al*. Calculation of different triage scores based on the German Trauma Registry. *Eur J Trauma* 2005;31:480-7.
8. Population of Scotland, Statistics of Scottish city Population. Official online gateway to Scotland. Available from: <http://www.scotland.org/about/fact-file/population/>. [Last cited on 2011 Mar 8].
9. Statistisches Bundesamt Deutschland. Bevölkerung nach dem Gebietsstand. Available from: <http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Statistiken/Zeitreihen/LangeReihen/Bevoelkerung/Content75/lrbev03a,templateId=renderPrint.psml>. [Last cited on 2011 Mar 8].
10. McGuffie AC, Graham CA, Beard D, Henry JM, Fitzpatrick MO, Wilkie SC, *et al*. Scottish urban versus rural trauma outcome study. *J Trauma* 2005;59:632-8.
11. Demetriades D, Chan L, Velmanos GV, Sava J, Preston C, Gruzinski G, *et al*. TRISS methodology: an inappropriate tool for comparing outcomes between trauma centers. *J Am Coll Surg* 2001;193:250-4.
12. Biewener A, Asehenbrenner U, Rammelt S, Grass R, Zwipp H. Impact of helicopter transport and hospital level on mortality of polytrauma patients. *J Trauma* 2004;56:94-8.
13. The Scottish Ambulance Service. Available from: <http://www.scottishambulance.co.uk/>. [Last cited on 2011 Mar 8].
14. Rettungsdienstgesetz. Available from: <http://www.agn.at/html1.php?hid=213>. [Last cited on 2011 Mar 8].
15. Sefrin P, Distler K. The importance of access-to-patient-period in the

- emergency service. *Anesthesiol Intensivmed Notfallmed Schmerzther* 2001;36:742-8.
16. Hilfsfristen der Bundesländer . Available from: http://www.forplan.de/tl_files/downloads/Hilfsfrist%20Bundeslaender.pdf. [Last cited on 2011 Mar 8].
 17. Sukumaran S, Henry J, Beard D, Lawrenson R, Gordon M, O'Donnell J, *et al*. Prehospital trauma management: a national study of paramedic activities. *Emerg Med J* 2005;22:60-63.
 18. Deakin CD, Peters R, Tomlinson P, Cassidy M. Securing the prehospital airway: a comparison of laryngeal mask insertion and endotracheal intubation by UK paramedics. *Emerg Med J* 2005;22:64-7.
 19. Gold CR. Prehospital advanced life support vs "scoop and run" in trauma management. *Ann Emerg Med* 1987;16:797-801.
 20. Spaite DW, Tse DJ, Valenzuela TD, Criss EA, Meislin HW, Mahoney M, *et al*. The impact of injury severity and prehospital procedures on scene time in victims of major trauma. *Ann Emerg Med* 1991;20:1299-305.
 21. Smith JP, Bodai BI, Hill AS, Frey CF. Prehospital stabilization of critically injured patients: a failed concept. *J Trauma* 1985;25:65-70.
 22. Border JR, Lewis FR, Aprahamian C, Haller JA, Jacobs LM, Luterma A. Panel: prehospital trauma care--stabilize or scoop and run. *J Trauma* 1983;23:708-11.
 23. Trunkey DD. Is ALS Necessary for pre-hospital trauma care? *J Trauma* 1984;24:86-7.
 24. Lewis FR. Ineffective therapy and delayed transport. *Prehosp Disaster Med* 1989;4:129-30.
 25. Hollis S, Lecky F, Yates DW, Woodford M. The effect of pre-existing medical conditions and age on mortality after injury. *J Trauma* 2006;61:1255-60.
 26. Senkowski CK, McKenney MG. Trauma scoring systems: a review. *J Am Coll Surg* 1999;189:491-503.

How to cite this article: Tan XX, Clement ND, Frink M, Hildebrand F, Krettek C, Probst C. Pre-hospital trauma care: A comparison of two healthcare systems. *Indian J Crit Care Med* 2012;16:22-7.

Source of Support: Nil, **Conflict of Interest:** None declared.

Author Help: Online submission of the manuscripts

Articles can be submitted online from <http://www.journalonweb.com>. For online submission, the articles should be prepared in two files (first page file and article file). Images should be submitted separately.

1) **First Page File:**

Prepare the title page, covering letter, acknowledgement etc. using a word processor program. All information related to your identity should be included here. Use text/rtf/doc/pdf files. Do not zip the files.

2) **Article File:**

The main text of the article, beginning with the Abstract to References (including tables) should be in this file. Do not include any information (such as acknowledgement, your names in page headers etc.) in this file. Use text/rtf/doc/pdf files. Do not zip the files. Limit the file size to 1024 kb. Do not incorporate images in the file. If file size is large, graphs can be submitted separately as images, without their being incorporated in the article file. This will reduce the size of the file.

3) **Images:**

Submit good quality color images. Each image should be less than **4096 kb (4 MB)** in size. The size of the image can be reduced by decreasing the actual height and width of the images (keep up to about 6 inches and up to about 1800 x 1200 pixels). JPEG is the most suitable file format. The image quality should be good enough to judge the scientific value of the image. For the purpose of printing, always retain a good quality, high resolution image. This high resolution image should be sent to the editorial office at the time of sending a revised article.

4) **Legends:**

Legends for the figures/images should be included at the end of the article file.