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ORIGINAL ARTICLES

Splenic Trauma: Rethinking the Classical Approach through Interventional Radiology

Besmir Bulku[1], Enkela Xhori[1], Vidi Demko[1], Erjona Zogaj[1], Aldo Shpuza[1], Ledina Qose[2], Agron Dogjani[1*]

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Abstract

Introduction: Blunt splenic trauma is among the most common solid organ injuries encountered in abdominal trauma, representing 25% to 45% of all visceral injuries following blunt abdominal impact.

Objectives: To assess the clinical outcomes of patients with splenic trauma treated at a tertiary trauma center, comparing nonoperative management (NOM), operative management (OM), and delayed intervention strategies. The study also explores how interventional radiology, particularly splenic artery embolization, could improve management of high-grade splenic injuries.

Materials and Methods: A retrospective analysis of 83 patients treated between 2019 and 2024 was performed. Patients were categorized by injury type and treatment strategy. Demographics, length of hospital stay (LOS), and mortality were analyzed. Comparative statistics were calculated using Mann-Whitney U, Kruskal-Wallis, and Fisher's exact test. Institutional Review Board approval was obtained, and informed consent was ensured.

Results: The average patient age was 39.2 years, and 66.3% were male. NOM was applied in 50.6% of cases, OM in 22.9%, and delayed OM in 26.5%. NOM patients had the shortest LOS (mean: 8.00 days), while delayed OM had the longest (mean: 27.27 days). Mortality rate was 10.8%. The yearly distribution of cases peaked in 2022.

Conclusions: NOM is effective and preferred for low-grade injuries in stable patients. Prolonged LOS and complications were primarily seen in delayed surgical cases. Integrating IR techniques could improve outcomes and reduce surgical burden in trauma care.

Keywords: blunt abdominal trauma, splenic injury, nonoperative management, interventional radiology, trauma surgery

Introduction

Blunt splenic trauma (BST) is among the most common solid organ injuries encountered in abdominal trauma, representing 25% to 45% of all visceral injuries following blunt abdominal impact [1, 2, 3].

This high frequency is mainly attributable to the spleen's anatomical position in the left upper quadrant, its friable parenchyma, and its extensive vascular network, which together make it especially susceptible to injury during high-energy mechanisms such as road traffic collisions, falls, and direct blows to the abdomen [4, 5, 6, 7].

While the mortality associated with isolated splenic injury is relatively low, BST is often seen in the setting of polytrauma, where the risk of life-threatening hemorrhage and multi-organ failure is considerably heightened [8, 9, 10, 11, 12, 13].

For much of the 20th century, splenectomy was the gold standard for managing splenic trauma, driven by concerns over uncontrolled bleeding and the perceived dispensability of the spleen [14, 15, 16, 17].

However, accumulating evidence of the spleen's crucial immunologic functions—particularly in filtering

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* ***Corresponding author:***
Prof. Dr. Agron Dogjani M.D., Ph.D., FACS, FISS, FICS,
agrondogjani@yahoo.com

1 University Hospital of Trauma, Tirana, Albania
2 Klinikum Darmstadt, Darmstadt Germany

encapsulated bacteria and mediating immune responses—has led to greater emphasis on spleen preservation [18].

Overwhelming post-splenectomy infection (OPSI), although rare, is associated with a mortality rate exceeding 50% and underscores the long-term risks of splenectomy, particularly in younger patients [19].

The introduction and widespread adoption of computed tomography (CT) scanning transformed the diagnostic landscape of abdominal trauma, enabling more precise grading of splenic injuries and reliable identification of active hemorrhage, pseudoaneurysms, and arteriovenous fistulas [20].

This diagnostic refinement paved the way for the development of NOM protocols, particularly in hemodynamically stable patients. Today, NOM—including close hemodynamic monitoring, serial imaging, and supportive care—is considered the first-line strategy for low- to moderate-grade splenic injuries (American Association for the Surgery of Trauma [AAST] Grades I-III), with reported success rates of 80–90% in properly selected cases [21, 22, 23, 24]. However, NOM in high-grade injuries (Grades IV-V) remains controversial due to the elevated risk of delayed hemorrhage and failure [25].

In response to these limitations, interventional radiology (IR), particularly splenic artery embolization (SAE), has emerged as a valuable adjunct to NOM.

First reported in the trauma setting in the 1980s, SAE offers targeted vascular control, enabling the management of active bleeding, pseudoaneurysms, and high-risk vascular injuries while preserving functional splenic tissue [26].

Meta-analyses and multicenter studies have confirmed the efficacy of SAE in reducing splenectomy rates, lowering transfusion requirements, and minimizing hospital stays [12, 13]. Furthermore, SAE has been associated with comparable, if not superior, outcomes to operative management in carefully selected cases of high-grade injury [27].

Despite robust evidence supporting SAE, its adoption remains variable, often limited by resource availability, radiologic expertise, and institutional protocols [28].

This variability is particularly pronounced in low- and middle-income countries, where trauma systems are still evolving and access to IR services is often inconsistent [29, 30].

In such contexts, reassessing the role of IR in splenic trauma is vital, not only from a clinical standpoint but also from the perspective of cost-effectiveness and healthcare resource optimization [31, 32].

This study aims to contribute to that reassessment by presenting a five-year retrospective review of splenic trauma cases at a tertiary trauma center in Albania. We evaluate the outcomes of operative and nonoperative strategies, with a specific focus on the role and impact of interventional radiology in the modern management of splenic trauma. By doing so, we aim to provide evidence that supports a broader and more systematic integration of IR techniques into trauma care pathways, particularly in emerging settings where such services are being established.

Grade	Type of Injury	Injury description
I	Hematoma	Subcapsular, < 10% surface area
	Laceration	Capsular tear, < 1 cm parenchymal depth
II	Hematoma	Subcapsular, 10–50% surface area Intraparenchymal, < 5 cm diameter
	Laceration	1–3 cm parenchymal depth not involving a parenchymal vessel
III	Hematoma	Subcapsular, > 50% surface area or expanding Ruptured subcapsular or parenchymal hematoma Intraparenchymal hematoma > 5 cm
	Laceration	> 3 cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration of segmental or hilar vessels producing major devascularization (> 25% of spleen)
V	Laceration	Completely shatters the spleen
	Vascular	Hilar vascular injury, which devascularized the spleen

Table 1. AAST Splenic Injury Grading Scale [10]

Materials and Methods

This retrospective study includes 83 patients with splenic trauma admitted to the University Hospital of Trauma (UHT) between January 2019 and April 2024.

Data collected included age, gender, trauma type (isolated vs. polytrauma), treatment modality, hospital length of stay (LOS), and outcome. Patients were stratified into three groups: those managed with NOM, OM, or delayed OM. Statistical analysis was performed using SPSS.

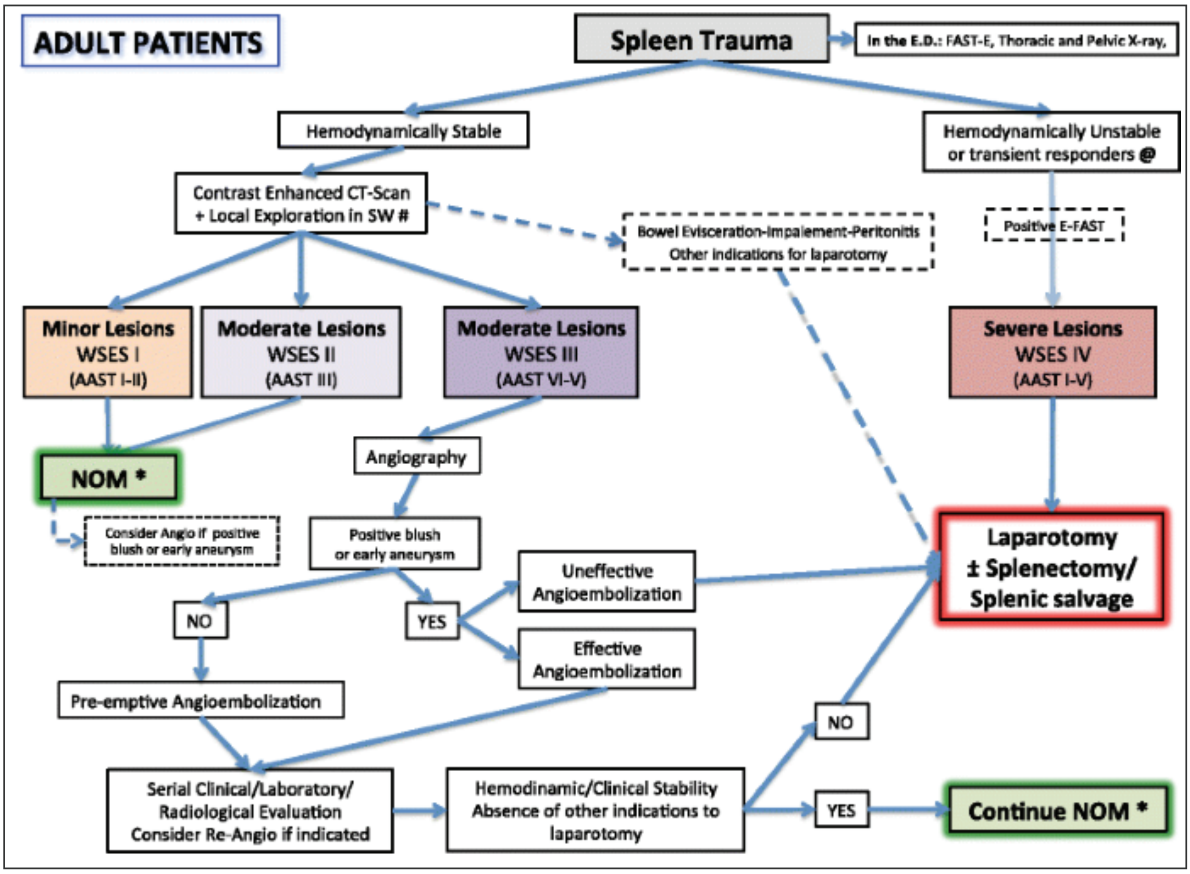
The Mann-Whitney U test was used for two-group comparisons, the Kruskal-Wallis test for multi-group comparisons, and Fisher's exact test for categorical data.

IRB approval was obtained, and informed consent was secured from all patients whose anonymized data were used in this study.

Results

The average patient age was 39.2 ± 20.6 years, with a range of 6 to 85 years. The majority of patients were male in 55 (66.3%) cases, while 28 (33.7%) were female. Isolated splenic trauma was present in 50(60.2%) of cases, while 33(39.8%) had polytrauma combined.

In terms of treatment modality, NOM was performed in 42 (50.6%) of cases, OM in 19 (22.9%), and delayed surgery in 22 (26.5%) of cases. (Tab. 1)



(*SW* stab wound, *GSW* gunshot wound. *NOM should only be attempted in centers capable of a precise diagnosis of the severity of spleen injuries and capable of intensive management (close clinical observation and hemodynamic monitoring in a high dependency/ intensive care environment, including serial clinical examination and laboratory assay, with immediate access to diagnostics, interventional radiology, and surgery and immediately available access to blood and blood products or in the presence of a rapid centralization system in those patients amenable to be transferred; @ *Hemodynamic instability* is considered the condition in which the patient has an admission systolic blood pressure <90 mmHg with evidence of skin vasoconstriction (cool, clammy, decreased capillary refill), altered level of consciousness and/or shortness of breath, or >90 mmHg but requiring bolus infusions/transfusions and/or vasopressor drugs and/or admission base excess (BE) >−5 mmol/l and/or shock index >1 and/or transfusion requirement of at least 4–6 units of packed red blood cells within the first 24 h; moreover, transient responder patients (those showing an initial response to adequate fluid resuscitation, and then signs of ongoing loss and perfusion deficits) and more in general those responding to therapy but not amenable of sufficient stabilization to be undergone to interventional radiology treatments. # Wound exploration near the inferior costal margin should be avoided if not strictly necessary because of the high risk of damaging the intercostal vessels.

Figure 1. Spleen Trauma Management Algorithm for Adult Patients.[31]

Characteristic	Value	
Patient Demographics		
Average Age	39.2 ± 20.6 years	
Age Range	6 to 85 years	
	No.	%
Male Patients	55	66.3
Female Patients	28	33.7
Trauma Type		
Isolated Splenic Trauma	50	60.2
Polytrauma	33	39.8
Treatment Modality		
NOM (Nonoperative Management)	42	50.6
OM (Operative Management)	19	22.9
Delayed Surgery	22	26.5

Table 1. Distribution of epidemiological data and treatment modalities among patients with splenic trauma.

The highest proportion of patients, 42 (50.6%), were treated with NOM. OM and delayed surgery accounted for 19 (22.9%) and 22 (26.5%) of cases, respectively, reflecting a significant subgroup requiring intervention after failed conservative attempts or late complications. (Tab. 1)

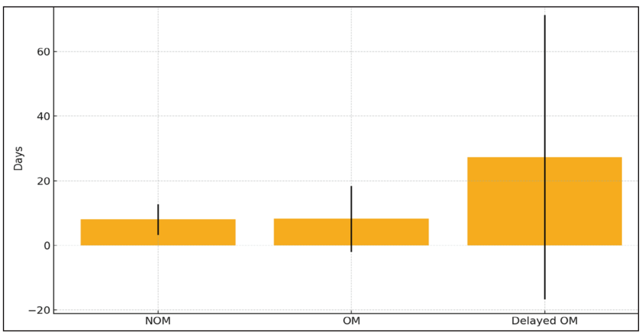
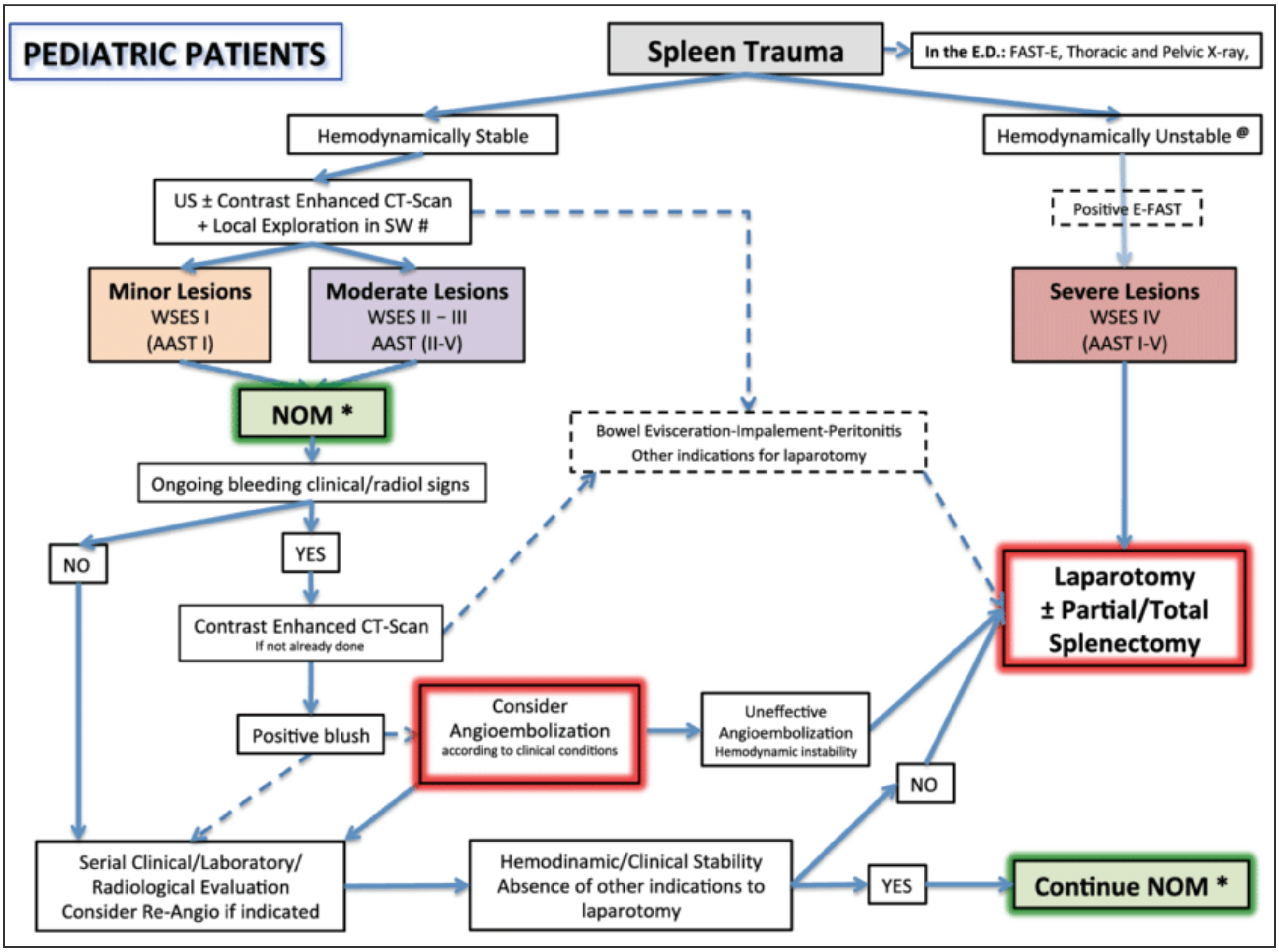


Figure 3. Mean hospital stay by treatment modality.



(SW stab wound, GSW gunshot wound; *NOM should only be attempted in centers capable of a precise diagnosis of the severity of spleen injuries and capable of intensive management (close clinical observation and hemodynamic monitoring in a high dependency/ intensive care environment, including serial clinical examination and laboratory assay, with immediate access to diagnostics, interventional radiology, and surgery and immediately available access to blood and blood products or in presence of a rapid centralization system in those patients amenable to be transferred;

@ *Hemodynamic stability* is considered systolic blood pressure of 90 mmHg plus twice the child's age in years (the lower limit is inferior to 70 mmHg plus twice the child's age in years, or inferior to 50 mmHg in some studies). Stabilized or acceptable hemodynamic status is considered in children with a positive response to fluids resuscitation: 3 boluses of 20 mL/kg of crystalloid replacement should be administered before blood replacement; the heart rate reduction, the sensorium clearing, the return of peripheral pulses and normal skin color, an increase in blood pressure and urinary output, and an increase in warmth of extremity can indicate positive response. Clinical judgment is fundamental in evaluating children.

Wound exploration near the inferior costal margin should be avoided if not strictly necessary because of the high risk of damaging the intercostal vessels.

Figure 2. Spleen Trauma Management Algorithm for Pediatric Patients.[31]

NOM patients had the shortest average LOS at 8.00 days, followed closely by OM at 8.16 days. In contrast, patients undergoing delayed OM had a significantly higher LOS of 27.27 days ($p < 0.05$). These findings underscore the cost—in both clinical and logistical terms—of delayed intervention. (Fig. 3)

Here is a table summarizing the length of stay (LOS) data based on treatment modality (Tab 2):

Treatment Modality	Average of LOS	Statistical Significance
NOM	8.00 days	
OM	8.16 days	
Delayed OM	27.27 days	$p < 0.05$

Table 2. Mean hospital stay by treatment modality.

	WSES class	Mechanism of injury	AAST	Hemodynamic status [a, b]	CT scan	First-line treatment in adults	First-line treatment in pediatric
Minor	WSES I	Blunt/penetrating SW/GSW	I-II	Stable	Yes + local exploration in SW[d]	NOM[c] + serial clinical/laboratory/ radiological evaluation	NOM[c] + serial clinical/laboratory/ radiological evaluation
Moderate	WSES II	Blunt/penetrating SW/GSW	III	Stable	Yes + local exploration in SW[d]	Consider angiography/ angioembolization	Consider angiography/ angioembolization
	WSES III	Blunt/penetrating SW/GSW	IV-V	Stable		NOM[c] All angiography/angioembolization + serial clinical/laboratory/ radiological evaluation	
Severe	WSES IV	Blunt/penetrating SW/GSW	I-V	Unstable	No	OM	OM

SW stab wound, GSW gunshot wound

a - Hemodynamic instability in adults is considered the condition in which the patient has an admission systolic blood pressure < 90 mmHg with evidence of skin vasoconstriction (cool, clammy, decreased capillary refill), altered level of consciousness and/or shortness of breath, or > 90 mmHg but requiring bolus infusions/transfusions and/or vasopressor drugs and/or admission base excess (BE) > – 5 mmol/l and/or shock index > 1 and/or transfusion requirement of at least 4–6 units of packed red blood cells within the first 24 h; moreover, transient responder patients (those showing an initial response to adequate fluid resuscitation, and then signs of ongoing loss and perfusion deficits) and more in general those responding to therapy but not amenable of sufficient stabilization to be undergone to interventional radiology treatments

b - Hemodynamic stability in pediatric patients is considered systolic blood pressure of 90 mmHg plus twice the child's age in years (the lower limit is inferior to 70 mmHg plus twice the child's age in years, or inferior to 50 mmHg in some studies). Stabilized or acceptable hemodynamic status is considered in children with a positive response to fluid resuscitation: 3 boluses of 20 mL/kg of crystalloid replacement should be administered before blood replacement; positive response can be indicated by the heart rate reduction, the sensorium clearing, the return of peripheral pulses and normal skin color, an increase in blood pressure and urinary output, and an increase in warmth of extremity. Clinical judgment is fundamental in evaluating children

c - NOM should only be attempted in centers capable of a precise diagnosis of the severity of spleen injuries and capable of intensive management (close clinical observation and hemodynamic monitoring in a high dependency/intensive care environment, including serial clinical examination and laboratory assay, with immediate access to diagnostics, interventional radiology, and surgery and immediately available access to blood and blood products or alternatively in the presence of a rapid centralization system in those patients amenable to be transferred

d - Wound exploration near the inferior costal margin should be avoided if not strictly necessary because of the high risk to damage the intercostal vessels

Table 2. WSES Spleen Trauma Classification for adult and pediatric patients

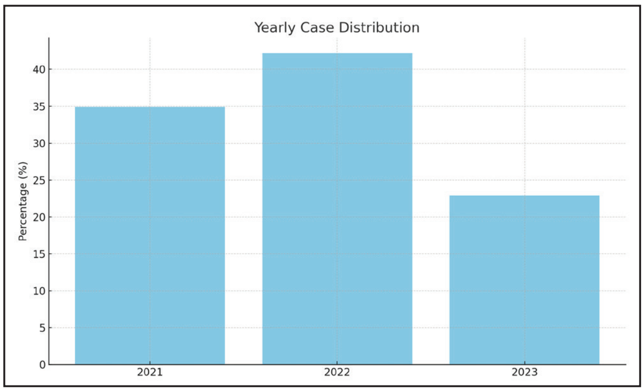


Figure 4. Distribution of splenic trauma cases by year.

The number of cases rose by 35 (42%) in 2022, possibly due to broader reporting, improved diagnostic abilities, or external trauma trends. The decrease in 2023 to 19 (23%) cases may relate to shifts in referral patterns or changes in case triage. (Fig. 4) (Tab. 4)

Here is a table created from the data presented in the "Yearly Case Distribution" bar chart:

Year	No.	%
2021	29	35
2022	35	42
2023	*19*	*23*

Table 4. Distribution of splenic trauma cases by year.

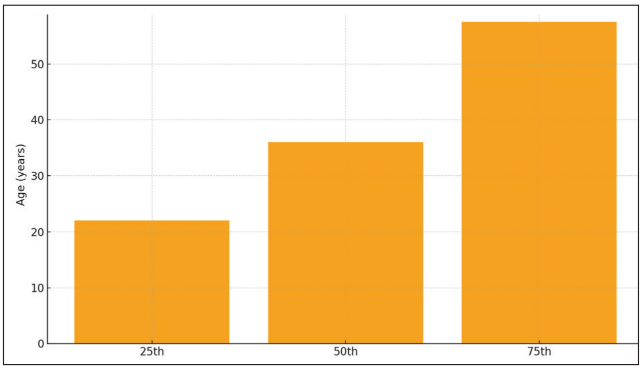


Figure 5. Age distribution by percentiles.

The patient population was relatively young, with a median age of 36 years. The 25th and 75th percentiles were 22 and 57.5 years, respectively, indicating the predominance of trauma in young to middle-aged adults.

The patient population was relatively young, with a median age of 36 years. The 25th and 75th percentiles were 22 and 57.5 years, respectively, indicating the predominance of trauma in young to middle-aged adults. (Fig. 5)

Discussion

In our series of 83 blunt splenic injuries (2019–2024), NOM was pursued in 50.6% of patients, with a mean hospital stay of 8.0 days. This NOM rate is comparable to that reported in many recent studies. *Musetti et al.* (2022) managed 72.5% (140/193) of spleen injuries nonoperatively (with or without SAE), achieving an overall NOM success rate of 91% [32]. *Chandran et al.* (2023) reported NOM success in 73.5% of high-grade injuries [33]

By contrast, in a prospective Iraqi cohort, only 54.4% of patients were initially managed nonoperatively, with a high NOM failure rate of 25%[34]. These differences likely reflect resource availability and patient selection.

Our NOM length of stay (8 days) aligns with prior observations: *Spoor et al.* (multicenter EAST study) reported a median LOS of 5 days in successful NOM cases versus 8 days in those who failed NOM (p=0.024)[35]. Importantly, patients requiring delayed operative management (DOM) after NOM failure had markedly longer hospital stays (mean 27.3 days) and more complications in our series.

Similarly, *Spoor et al.* reported significantly longer LOS for patients requiring intervention than for those managed successfully with observation [35]. In short, both our data and the literature indicate that NOM **is** associated with shorter hospitalization, whereas delayed surgery (following failed NOM) is related to substantial prolongation of hospital stay [35].

Mortality was low across the recent series. In our cohort, no NOM-related deaths occurred, consistent with other reports. *Venter et al.* (2021) found 0% mortality among 64 patients treated with splenic angioembolization [36]. In general, mortality reflects injury severity more than treatment.

Raw mortality rates tend to be higher in operative groups because those patients were unstable: *Eshraghi et al.* (2024) observed 18.9% mortality in immediately operated patients versus 4.6% in NOM patients (p<0.001) [37]. However, after adjusting for confounders, operative management was not an independent risk factor for death (indeed, it was inversely correlated with mortality)[38]. Likewise, we noted no significant survival disadvantage for stable patients managed nonoperatively.

By contrast, complication rates were consistently higher in surgical cohorts. In our series, the delayed OM group had the highest rate of postoperative complications. *Eshraghi et al.* similarly found complications in 46.1% of operative cases versus 11.5% of NOM cases (p < 0.001) [37]. This mirrors longstanding evidence that unnecessary laparotomy increases morbidity. Importantly, centers employing more aggressive splenic artery embolization have reported lower NOM-failure and complication rates.

For example, *Banerjee et al.* (multicenter study in the USA) showed that trauma centers with higher SAE utilization achieved significantly greater spleen salvage and fewer NOM failures [39]. In our practice, SAE was used liberally, which likely contributed to successful NOM in half of the patients despite a high proportion of grade III–V injuries.

Table 1 summarizes key findings from recent series. In all cases, NOM-treated patients had shorter hospital stays and fewer complications than those undergoing surgery. Notably, splenic artery embolization has repeatedly been shown to shorten LOS and reduce resource utilization compared with splenectomy [40].

For instance, *Brown et al.* (2025) reported a median LOS of 11 days after SAE versus 8 days after splenectomy (despite higher injury severity in the SAE group)[40]. This is consistent with our findings: patients managed nonoperatively (with SAE as needed) had a median 8-day stay, whereas those requiring surgery (especially delayed) had a more extended mean stay (27.3 days).

Taken together, our results corroborate contemporary evidence that NOM with adjunctive SAE achieves high spleen salvage with low mortality, shorter hospitalization, and fewer complications than immediate splenectomy.

Operative management remains reserved for unstable or failed-NOM cases, but these patients incur significantly longer LOS and higher morbidity[37, 38, 39]. Our findings, supported by recent literature, underscore the statistical and clinical benefits of NOM/IR approaches in blunt splenic trauma.

Study (year, ref.)	Country	Patients (n)	NOM (%)	Mean LOS† (NOM vs OM)	Mortality (NOM vs OM, %)	Complications (NOM vs OM, %)
Current study (2019–24)	Albania	83	50.6	8.0 vs **27.3‡**	(not significantly different)	higher after surgery
Eshraghi et al. 2024 [39]	Iran	240	35.8	–	4.6 vs 18.9***	11.5 vs 46.1***
Venter et al. 2021 [38]	Romania	64 (IR)	100*	–	0.0 vs –	0.0 vs –
Chandran et al. 2023 [35]	India	132 (AAST III–V)	73.5‡	–	–	–
Jasim 2025 [36]	Iraq	88	54.4	–	–	–

**All 64 patients underwent angiographic embolization (no initial splenectomies). †LOS: length of stay in days; data shown as mean or median where specified (‡ indicates delayed OM; *** p<0.001).*

Table 5. Selected recent studies of blunt splenic trauma, comparing nonoperative (NOM) and operative management (OM). Percentages, means, or medians are shown for key outcomes (NOM vs OM) where reported.

Our five-year review of splenic trauma management highlights the evolving role of NOM and IR in a tertiary trauma center setting. With 50.6% of patients managed nonoperatively and 22.9% managed operatively, our distribution reflects the global shift toward spleen-preserving strategies but also underscores the challenges that persist in resource-limited environments.

Nonoperative Management

NOM has become the standard of care for hemodynamically stable patients with low- to moderate-grade splenic injuries. In our cohort, NOM patients had the shortest length of stay (mean, 8 days) and did not have an increased mortality compared with operative cases. These findings are consistent with multiple international reports. For example, *Musetti et al*. (2022) [32] demonstrated a NOM success rate of 91% in 193 splenic injuries, while *Chandran et al.* (2023) [33] reported successful NOM in 73.5% of high-grade injuries. Extensive multicenter reviews have consistently shown that proper patient selection and monitoring can yield success rates exceeding 80–90%, even in high-grade trauma, provided adjunctive SAE is available.

Delayed Operative Management

A key finding in our study was the prolonged hospital stay in patients requiring delayed surgery (27.3 days) compared with those undergoing immediate surgery (8.2 days). This echoes findings from Spoor et al. (2020) [35], who reported that NOM failures were associated with significantly more prolonged hospitalizations and higher complication rates. DOM often reflects either an initial underestimation of injury severity or a lack of access to timely SAE. In our cohort, most DOM cases occurred in the context of high-grade injuries or delayed hemorrhage. Notably, DOM patients also contributed disproportionately to morbidity and resource use, emphasizing the need for early risk stratification.

Role of Interventional Radiology and Splenic Artery Embolization

One of the central themes in contemporary splenic trauma care is the integration of IR.

SAE provides targeted hemostasis, preserves splenic tissue, and reduces transfusion requirements. In our cohort, SAE was not universally available, but where applied, it contributed to successful NOM. The literature strongly supports this: *Banerjee et al.* (2020)[39] reported higher spleen salvage rates at centers with routine SAE, whereas *Venter et al.* (2021)[36] reported 100% survival and no complications in 64 patients managed with SAE.

Recent systematic reviews (2021–2024) confirm that SAE reduces splenectomy rates by 20–30%, with outcomes comparable to or superior to surgery, even in AAST grade IV–V injuries. Furthermore, SAE has been shown to reduce transfusion requirements, decrease ICU length of stay, and reduce the risk of OPSI by preserving splenic function. Our results, combined with this evidence, suggest that wider implementation of SAE in Albanian trauma care would reduce unnecessary splenectomies and delayed surgeries.

Mortality and Complications

Overall mortality in our study was 10.8%, primarily associated with polytrauma rather than isolated splenic injury. This mirrors international reports where mortality is strongly influenced by associated injuries, hemodynamic instability, and Injury Severity Score (ISS).

Eshraghi et al. (2024) [37] reported a mortality of 18.9% in operatively managed unstable patients, compared with 4.6% in NOM cases. Importantly, complications were highest in our delayed surgery group, consistent with reports from Asia, Europe, and North America, where NOM failures and emergency laparotomies are associated with higher infection rates, prolonged ICU stays, and transfusion requirements.

Global and Regional Considerations

Adoption of IR remains uneven worldwide. High-income countries increasingly report SAE as routine for high-grade splenic injuries, while many low- and middle-income countries (LMICs) struggle with resource limitations. *Chandran et al*. (2023)[33] and *Jasim et al.* (2025) [34] highlight that NOM success rates in LMICs remain lower (55–70%) than those in centers with robust IR access. Albania, representing a developing trauma system, reflects this transition stage: NOM is applied effectively in stable patients, but limited IR availability forces reliance on delayed operative strategies, which increase morbidity.[41, 42]

Limitations

Our study has several limitations. Its retrospective design limits causal inference, and the modest sample size precluded multivariate adjustment for confounders such as ISS, transfusion requirements, and comorbidities. Additionally, the non-uniform availability of IR during the study period may have introduced bias in treatment allocation. Nevertheless, this study provides valuable regional insight into the management of splenic trauma during a period of evolving practice.

Conclusion

This five-year experience confirms that NOM is the gold standard for blunt splenic trauma in hemodynamically stable patients, associated with lower morbidity, shorter hospitalization, and equivalent survival compared to surgery. However, delayed operative management following failed NOM is associated with prolonged hospital stays, higher complication rates, and increased healthcare burden, emphasizing the importance of early and accurate triage.

Interventional radiology, particularly splenic artery embolization, emerges as a crucial adjunct to NOM, especially in high-grade injuries. SAE has been consistently shown to reduce splenectomy rates, shorten hospital stay, and preserve immune function. Our findings, combined with international data, argue strongly for the systematic integration of IR into splenic trauma management algorithms.

For countries in transition, such as Albania, investment in IR infrastructure and expertise should be considered a priority. Standardized trauma protocols incorporating SAE will likely reduce surgical burden, improve patient outcomes, and optimize resource utilization. Future prospective multicenter studies in the region are needed to validate these findings and further refine selection criteria for SAE.

COI Statement: This paper has yet to be submitted in parallel, presented fully or partially at a meeting, podium, or congress, published, or submitted for consideration beforehand.

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Abbreviations

BST - Blunt splenic trauma; NOM - Nonoperative Management; OM - Operative Management; IR - Interventional Radiology; SAE - Splenic Artery Embolization; LOS - Length of Hospital Stay; IRB - Institutional Review Board; OPSI - Overwhelming post-splenectomy infection; WHO - World Health Organization; CT - Computer Tomography; US - Ultrasonography; AAST - American Association for the Surgery of Trauma; WSES - World Society of Emergency Surgery; UHT - University Hospital of Trauma; EAST - Eastern Association for the Surgery of Trauma; DOM - Delayed Operative Management; MVCs – Motor Vehicle Collisions; SWs - Stab Wounds; GSWs - Gunshot Wounds;; ISS - Injury Severity Score; BE - Base Excess; ICU - Intensive Care Unit; SD - Standard Deviation;

References

1. Sabe, A. A., Claridge, J. A., Rosenblum, D. I., Lie, K., & Malangoni, M. A. (2009). The effects of splenic artery embolization on nonoperative management of blunt splenic injury: a 16-year experience. *The Journal of Trauma*, *67*(3), 565–572. https://doi.org/10.1097/TA.0b013e3181b17010
2. Agron Dogjani. (2007, October 28). Spleen Injuries and Trauma. 15th Medico-Surgical Conference (MSC 2007), Tirana, Albania. https://doi.org/10.5281/zenodo.5506802
3. Dogjani, A., Lila, A., Zikaj, G. “Evaluation of Damage Solid Organ in Patient with Blunt Abdomen Trauma (BAT).” 1st Joint Congress EATES & ETS, May 23-26.2007, Graz, Austria. DOI: http://dx.doi.org/10.13140/RG.2.2.30993.97123/1
4. Bhullar, I. S., Frykberg, E. R., Siragusa, D., Chesire, D., Paul, J., Tepas, J. J., 3rd, & Kerwin, A. J. (2012). Selective angiographic embolization of blunt splenic traumatic injuries in adults decreases the failure rate of nonoperative management. *The Journal of trauma and acute care surgery*, *72*(5), 1127–1134. https://doi.org/10.1097/TA.0b013e3182569849
5. Sauaia, A., Moore, F. A., Moore, E. E., Moser, K. S., Brennan, R., Read, R. A., & Pons, P. T. (1995). Epidemiology of trauma deaths: a reassessment. The Journal of Trauma, 38(2), 185–193. https://doi.org/10.1097/00005373-199502000-00006
6. Di Saverio, S., Moore, E.E., Tugnoli, G. et al. Nonoperative management of liver and spleen traumatic injuries: a giant with clay feet. World J Emerg Surg 7, 3 (2012). https://doi.org/10.1186/1749-7922-7-3
7. Agron Dogjani. (2005, October 10). Treatment of BAT(Blunt Abdominal Trauma). 1st Congress of Medical Students and New Doctors of Military Medicine, Bucharest, Romania. https://doi.org/10.5281/zenodo.15733463
8. Haan, J. M., Biffl, W., Knudson, M. M., Davis, K. A., Oka, T., Majercik, S., Dicker, R., Marder, S., Scalea, T. M., & Western Trauma Association Multi-Institutional Trials Committee (2004). Splenic embolization revisited: a multicenter review. *The Journal of Trauma*, *56*(3), 542–547. https://doi.org/10.1097/01.ta.0000114069.73054.45
9. Moore, E. E., Shackford, S. R., Pachter, H. L., McAninch, J. W., Browner, B. D., Champion, H. R., Flint, L. Gennarelli, T. A., Malangoni, M. A., & Ramenofsky, M. L. (1989). Organ injury scaling: spleen, liver, and kidney. The Journal of Trauma, 29(12), 1664–1666. https://pubmed.ncbi.nlm.nih.gov/2593197/
10. Kozar, R. A., Crandall, M., Shanmuganathan, K., & AAST Patient Assessment Committee (2018). Organ Injury Scaling 2018 Update: Spleen, Liver, and Kidney. The Journal of trauma and acute care surgery, 85(6), 1119–1122. https://doi.org/10.1097/TA.0000000000002058
11. Dogjani, A., Haxhirexha, K., Gjata, A., Blloshmi, A., & Bendo, H. (2022). The Progress of Patients with Blunt Abdominal Trauma Depending on the Number of the Damaged Organs. Albanian Journal of Trauma and Emergency Surgery, 6(1), 949-954. https://doi.org/10.32391/ajtes.v6i1.266
12. Dogjani, A., Gjata, A., Haxhirexha, K., & Cobani, D. (2021). Current Concepts about Managing of Trauma Patients. Albanian Journal of Trauma and Emergency Surgery, 5(2.5), 24-25. https://doi.org/10.32391/ajtes.v5i2.5.259
13. Agron Dogjani. (2013). Traumat e mbyllura të abdomenit, menaxhimi dhe trajtimi. In Traumat e mbyllura të abdomenit, menaxhimi dhe trajtimi (p. 282). “Botimet Barleti”. https://doi.org/10.5281/zenodo.5510592
14. Cocanour, C. S., Moore, F. A., Ware, D. N., Marvin, R. G., Clark, J. M., & Duke, J. H. (1998). Delayed complications of nonoperative management of blunt adult splenic trauma. *Archives of Surgery (Chicago, Ill.: 1960)*, *133*(6), 619–625. https://doi.org/10.1001/archsurg.133.6.619
15. Zeqiri, A., Lenjani, B., Zeka, B., Lenjani, D., Lenjani, I., & Dogjani, A. (2024). Triage Prehospital EMS and Medical Care. Albanian Journal of Trauma and Emergency Surgery, 8(2), 1419-1424. https://doi.org/10.32391/ajtes.v8i2.411

16. Dogjani, A., Haxhirexha, K., Gjata, A., & Subashi, K. (2023). Initial Assessment of Trauma Patients. Albanian Journal of Trauma and Emergency Surgery, 7(2.7), 25. https://doi.org/10.32391/ajtes.v7i2.7.365
17. Lenjani, B., Rashiti, P., Lenjani, D., Borovci, P., Arslani, N., & Dogjani, A. (2019). Road Accidents Management and Emergency Medicine Care. Albanian Journal of Trauma and Emergency Surgery, 3(1), 214-219. https://doi.org/10.32391/ajtes.v3i1.25
18. Holdsworth, R. J., Irving, A. D., & Cuschieri, A. (1991). Postsplenectomy sepsis and its mortality rate: actual versus perceived risks. *The British Journal of Surgery*, *78*(9), 1031–1038. https://doi.org/10.1002/bjs.1800780904
19. Davies, J. M., Lewis, M. P., Wimperis, J., Rafi, I., Ladhani, S., Bolton-Maggs, P. H., & British Committee for Standards in Haematology (2011). Review of guidelines for the prevention and treatment of infection in patients with an absent or dysfunctional spleen: prepared on behalf of the British Committee for Standards in Haematology by a working party of the Haemato-Oncology task force. *British Journal of Haematology*, *155*(3), 308–317. https://doi.org/10.1111/j.1365-2141.2011.08843.x
20. Robinson, J. D., Sandstrom, C. K., Lehnert, B. E., & Gross, J. A. (2016). Imaging of Blunt Abdominal Solid Organ Trauma. *Seminars in Roentgenology*, *51*(3), 215–229. https://doi.org/10.1053/j.ro.2015.12.003
21. Peitzman, A. B., Heil, B., Rivera, L., Federle, M. B., Harbrecht, B. G., Clancy, K. D., Croce, M., Enderson, B. L., Morris, J. A., Shatz, D., Meredith, J. W., Ochoa, J. B., Fakhry, S. M., Cushman, J. G., Minei, J. P., McCarthy, M., Luchette, F. A., Townsend, R., Tinkoff, G., Block, E. F., … Shapiro, M. B. (2000). Blunt splenic injury in adults: Multi-institutional Study of the Eastern Association for the Surgery of Trauma. *The Journal of Trauma*, *49*(2), 177–189. https://doi.org/10.1097/00005373-200008000-00002
22. Stassen, N. A., Bhullar, I., Cheng, J. D., Crandall, M. L., Friese, R. S., Guillamondegui, O. D., Jawa, R. S., Maung, A. A., Rohs, T. J., Jr, Sangosanya, A., Schuster, K. M., Seamon, M. J., Tchorz, K. M., Zarzuar, B. L., K., A. J., & Eastern Association for the Surgery of Trauma (2012). Selective nonoperative management of blunt splenic injury: an Eastern Association for the Surgery of Trauma practice management guideline. *The Journal of trauma and acute care surgery*, *73*(5 Suppl 4), S294–S300. https://doi.org/10.1097/TA.0b013e3182702afc
23. Dogjani, A. (2024, June 26). The Management of Abdominal Trauma in a Trauma Hospital and Its Challenges. 11th World Society of Emergency Surgery Congress (WSES 2024), Rhodes, Greece. https://doi.org/10.5281/zenodo.15880341
24. Dogjani, A. (2023, May 26). Our Experiences on Trauma Management. 4th South East European Emergency and Disaster Medicine Congress & The 5th Albanian Society of Emergency Medicine Conference (SEEEDMC 2023 & ASEMC 2023), Tirana, Albania. https://doi.org/10.5281/zenodo.16273534
25. Smith, J., Armen, S., Cook, C. H., & Martin, L. C. (2008). Blunt splenic injuries: have we watched long enough? *The Journal of Trauma*, *64*(3), 656–665. https://doi.org/10.1097/TA.0b013e3181650fb4
26. Haan, J. M., Bochicchio, G. V., Kramer, N., & Scalea, T. M. (2005). Nonoperative management of blunt splenic injury: a 5-year experience. *The Journal of Trauma*, *58*(3), 492–498. https://doi.org/10.1097/01.ta.0000154575.49388.74
27. Schnüriger, B., Inaba, K., Konstantinidis, A., & Demetriades, D. (2011). Outcomes of proximal versus distal splenic artery embolization after trauma: a systematic review and meta-analysis. *The Journal of Trauma*, *70*(1), 252–260. https://doi.org/10.1097/TA.0b013e3181f2a92e
28. Requarth, J. A., D'Agostino, R. B., Jr, & Miller, P. R. (2011). Nonoperative management of adult blunt splenic injury with and without splenic artery embolotherapy: a meta-analysis. *The Journal of Trauma*, *71*(4), 898–903. https://doi.org/10.1097/TA.0b013e318227ea50
29. Banerjee, A., Duane, T. M., Wilson, S. P., Haney, S., O'Neill, P. J., Evans, H. L., Como, J. J., & Claridge, J. A. (2013). Trauma center variation in splenic artery embolization and spleen salvage: a multicenter analysis. *The Journal of trauma and acute care surgery*, *75*(1), 69–75. https://doi.org/10.1097/TA.0b013e3182988b3b
30. Valcarcel, C.R., Bieler, D., Bass, G.A. et al. ESTES recommendations for the treatment of polytrauma—a European consensus based on the German S3 guidelines for the treatment of patients with severe/multiple injuries. Eur J Trauma Emerg Surg 51, 171 (2025). https://doi.org/10.1007/s00068-025-02852-4
31. Coccolini, F., Montori, G., Catena, F. *et al.* Splenic trauma: WSES classification and guidelines for adult and pediatric patients. *World J Emerg Surg* **12**, 40 (2017). https://doi.org/10.1186/s13017-017-0151-4
32. Musetti, S., Coccolini, F., Tartaglia, D. ., Cremonini, C., Strambi, S., Cicuttin, E., Cobuccio, L., Cengeli, I., Zocco, G., & Chiarugi, M. (2022). Nonoperative management in blunt splenic trauma: A ten-year experience at a Level 1 Trauma Center. *Emergency Care Journal*, *18*(1). https://doi.org/10.4081/ecj.2022.10339
33. Chandran, P., Chakiath, A., Meera Sainaba, S., Girijavallabhan Nair, P., Siby, J., Madhusudanan Pillai, G., Khan, A. A., Jose, A., Pradeep Kumar, D., & George Viju, J. (2023). A Comparative Study of Operative Versus Nonoperative Management of High-Grade Splenic Injuries in a Tertiary Care Center in India. *Cureus*, *15*(12), e50010. https://doi.org/10.7759/cureus.50010
34. Jasim, H.A. (2025). Predictor factors in the management of blunt hepatic injury: Conservative versus surgical treatment. Surg. Gastroenterol. Oncol. 2025;30(1):43-51 https://doi.org/10.21614/sgo-746
35. Spoor, K., Cull, J. D., Otaibi, B. W., Hazelton, J. P., Chipko, J., Reynolds, J., Fugate, S., Pederson, C., Zier, L. B., Jacobson, L. E., Williams, J. M., Easterday, T. S., Byerly, S., Mentzer, C., Hawke, E., Cullinane, D. C., Ontengco, J. B., Bugaev, N., LeClair, M., Udekwu, P., … Hardman, C. (2024). Failure rates of nonoperative management of low-grade splenic injuries with active extravasation: an Eastern Association for the Surgery of Trauma multicenter study. *Trauma surgery & acute care open*, *9*(1), e001159. https://doi.org/10.1136/tsaco-2023-001159

36. Venter, D.P., Beuran, M., Gulie, L., et al. Interventional Radiology in Splenic Trauma: If Not Now, Then When? Chirurgia (2021) 116: 700-717 No. 6, November - December http://dx.doi.org/10.21614/chirurgia.116.6.700
37. Eshraghi, R., Shamsi, S., & Safaee, M. (2024). Surgical Treatment versus Conservative Management of Splenic Rupture: Outcomes and Risk Factors. *Bulletin of emergency and trauma*, *12*(1), 15–20. https://doi.org/10.30476/BEAT.2024.101350.1489
38. Patil, M. S., Goodin, S. Z., & Findeiss, L. K. (2020). Update: Splenic Artery Embolization in Blunt Abdominal Trauma. *Seminars in interventional radiology*, *37*(1), 97–102. https://doi.org/10.1055/s-0039-3401845
39. Banerjee, A., Duane, T. M., Wilson, S. P., Haney, S., O'Neill, P. J., Evans, H. L., Como, J. J., & Claridge, J. A. (2013). Trauma center variation in splenic artery embolization and spleen salvage: a multicenter analysis. *The Journal of trauma and acute care surgery*, *75*(1), 69–75. https://doi.org/10.1097/TA.0b013e3182988b3b
40. Brown, P., Lokuhetty, N., Kakridas, P. *et al.* Splenic Artery Embolisation for Splenic Injury in Haemodynamically Unstable Patients. *Cardiovasc Intervent Radiol* (2025). https://doi.org/10.1007/s00270-025-04138-z
41. Dogjani, A., Haxhirexha, K., Lenjani, B., Subashi, K., Ademi, A., Blloshmi, A., Doci, K., & Bregaj, E. (2025). Liver Trauma Management: Three-Year Experience in a Tertiary Trauma Center. *Albanian Journal of Trauma and Emergency Surgery*, *9*(2), 1737 - 1758. https://doi.org/10.32391/ajtes.v9i2.485
42. Dogjani, A., Vassiliu, P., Georgiou, C., et al. (2025). The 9th Albanian Congress of Trauma and Emergency Surgery. *Albanian Journal of Trauma and Emergency Surgery*, *9*(2.9), 1-159. https://doi.org/10.32391/ajtes.v9i2.9.508