Are current classification and scoring systems adequate for predicting limb salvage versus amputation?

Section 1: Background

Severe open fractures and mangled extremity injuries require early decisions about limb salvage, staged reconstruction or amputation. The decision is difficult because anatomical injury, physiology, contamination, vascular status, soft-tissue reconstructability, patient factors, resource availability and likely function all influence outcome. Classification systems such as Gustilo-Anderson, OTA-OFC and OTS describe injury severity and support communication, audit and research. Scoring systems such as MESS, LSI, PSI, NISSSA, HFS/HFS-97, GHOISS/GHS and Vetrivel Trauma Score attempt to quantify limb threat and predict amputation or salvage. Early derivation studies of MESS and LSI reported high predictive accuracy in highly selected lower-limb vascular injury cohorts, but subsequent larger prospective and modern validation studies showed inconsistent performance, particularly low sensitivity for identifying limbs that eventually required amputation. The clinical relevance is substantial: over-reliance on a score may lead to avoidable amputation, whereas inappropriate salvage may expose patients to repeated operations, infection, prolonged admission, delayed amputation and poor function. The key unknown is whether current systems are sufficiently accurate across contemporary orthoplastic practice, paediatric injury, upper-limb trauma, combat/blast injury and low-resource settings to guide individual decisions, or whether they should be used only as adjuncts within multidisciplinary judgement.

Section 2: Data extraction table

Author, year of publication, Country	Study Design	Sample Size	Study population (Inclusion and exclusion criteria)	Groups compared	Results	Conclusions
Gustilo, Mendoza & Williams, 1984, USA	**Retrospective** clinical series and classification refinement paper for severe type III open fractures.	**87 Type III open fractures** occurring in 75 patients treated at Hennepin County Medical Center between 1976–1979. Patients were followed prospectively with a mean follow-up of 26 months.	Patients with severe type III open fractures, particularly injuries with **extensive contamination, soft-tissue damage, periosteal stripping, and/or vascular injury.**	Type IIIA versus IIIB versus IIIC open fractures; severe open-fracture subtypes linked to soft-tissue coverage, periosteal stripping, and vascular injury requiring repair.	The study proposed the now widely used IIIA/IIIB/IIIC subdivision. **Amputation rates were 0%, 16% and 42% respectively.**	The type III subdivision created the **framework for modern open-fracture classification,** treatment stratification, and subsequent salvage-score research.
Helfet et al., 1990, USA	Development and early validation study of the Mangled Extremity Severity Score (MESS). **Retrospective derivation cohort followed by prospective evaluation at two trauma centres.**	Retrospective derivation: 25 trauma patients with **26 severely injured lower limbs.** Prospective validation: **26 lower-extremity open fractures with vascular injury.**	**Adults with severe lower-extremity skeletal/soft-tissue injury and vascular compromise.** The score used four early clinical domains: skeletal/soft-tissue injury severity, limb ischaemia, shock, and age. Population was focused on mangled lower limbs with vascular compromise rather than all open fractures.	**Limb salvage versus amputation.** MESS <7 versus MESS >=7. Retrospective and prospective cohorts were analysed separately.	Derivation cohort: mean MESS 4.88 in 17 salvaged limbs versus 9.11 in 9 amputated limbs ($p < 0.01$). Prospective cohort: mean MESS 4.00 in 14 salvaged limbs versus 8.83 in 12 amputated limbs ($p < 0.01$). **In both cohorts, MESS >=7 was reported as highly predictive of amputation in this early series.**	MESS was proposed as a simple objective score available early after injury to help discriminate salvageable from unsalvageable mangled lower limbs.
Russell et al., 1991, USA	**Retrospective derivation study of the Limb Salvage Index (LSI),** a multifactor limb-threat score developed for lower-extremity trauma with major arterial injury.	**70 limb-threatening lower-extremity injuries;** 51 limbs ultimately salvaged and 19 amputated.	**Patients with severely injured lower limbs, particularly combined orthopaedic and vascular injuries.** Twenty-six limbs were requiring revascularization. The score was based on warm ischaemia time and quantitative injury to arterial, nerve, bone, muscle, skin, and venous systems.	**Limb salvage versus amputation;** LSI <6 versus LSI >=6. Variables contributing to LSI included arterial, nerve, skeletal/bone, skin, muscle, venous injury, and warm ischaemia time.	Limb salvage was not related to shock or order of repair (orthopaedic versus vascular), and time from injury to operative repair did not differ significantly between amputation and salvage groups. Limb salvage was related to warm ischaemia time and injury severity in arterial, nerve, bone, muscle, skin, and venous systems. **All 51 patients with LSI <6 had successful limb salvage ($p<0.001$), while all 19 patients with LSI >=6 underwent amputation ($p<0.001$).**	**The authors proposed the LSI as an objective tool for assessing severely traumatized extremities with vascular injury**, while emphasizing that scoring cannot replace clinical judgment.
Ozcelik et al., 1994, Turkey	**Retrospective case series** of surgically managed popliteal and trifurcation arterial injuries over a 16-year period ending March 1993.	63 patients with **88 popliteal or trifurcation arterial injuries.**	Patients with popliteal or trifurcation arterial injuries treated at Dicle University. Excluded: isolated vein injuries and patients undergoing primary amputation at presentation. Mechanisms included penetrating trauma and blunt injury. A large proportion presented after >8 hours of ischaemia.	MESS >=7 versus <7; operated <8 hours versus >8 hours; risk classification according to associated nerve injury, soft-tissue injury, and open fracture (one or fewer risk factors versus two or more, and comparison with three risk factors).	Overall outcomes: 14 major amputations (22.2%), 3 minor amputations (4.8%), and 4 deaths (6.3%). Of 40 patients with ischaemia >8 hours, 13 underwent amputation. **MESS >=7 occurred in 28 patients (44.4%); within this group, 13 required amputation** (46.4%). **MESS <7 had 4 amputations out of 35 (11.4%).** Difference in amputation between surgery <8 hours and >8 hours was not statistically significant.	Associated nerve, soft-tissue, and open-fracture risk factors may be more useful than ischaemia duration or MESS score alone in predicting amputation after popliteal/trifurcation arterial injury.
McNamara, Heckman & Corley, 1994, USA	**Retrospective evaluation of MESS** in severe open lower-extremity fractures with development/application of the NISSA modification.	**24 patients** with Gustilo-Anderson type IIIB or IIIC open tibial fractures.	Open fractures of the tibia admitted to a Level I trauma centre. The study specifically evaluated severe type IIIB and type IIIC injuries. **The authors examined MESS performance and then modified the score by including nerve injury and separating soft-tissue from skeletal injury components**.	Amputated versus salvaged limbs; MESS thresholds including >=4 and >=7; original MESS versus modified NISSA score. NISSA = nerve injury, ischaemia, soft-tissue injury, skeletal injury, shock, and age.	The authors report a significant difference. MESS >=4 was most sensitive (100%); MESS >=7 was most specific and had PPV 100%. **After modification to NISSSA, statistical comparison found NISSA more accurate than MESS for predicting amputation ($p<0.005$**), with sensitivity 81.8% versus 63.6% and specificity 92.3% versus 69.2%.	**Adding explicit nerve injury and separating soft-tissue from skeletal injury improved prediction** compared with original MESS in this severe open tibial fracture cohort.
Slauterbeck et al., 1994, USA	**Retrospective** clinical study evaluating the Mangled Extremity Severity Score in severe **upper-extremity trauma.**	**37 patients** with 43 severely injured upper extremities	Patients with severely injured upper extremities. The paper evaluated whether MESS, originally derived for lower-extremity vascular trauma, could guide treatment of mangled upper-limb injuries.	Upper-extremity salvage versus amputation; MESS threshold performance in upper limb trauma.	The study has historically been cited as supportive of MESS use in severe upper-extremity injury, but subsequent upper-limb series showed that **salvage can often be achieved despite MESS >=7 and that function-specific upper-limb considerations differ from lower limb trauma.**	MESS may have some association with severity in upper-limb injury, but **upper-extremity decisions require separate assessment** of viability, sensibility, hand function, reconstructability, dominance, and patient goals.
Seekamp et al., 1999, Germany	**Retrospective analysis of multiply traumatized patients** to determine whether systemic multiple-organ dysfunction parameters predict secondary amputation after attempted limb salvage.	**34 patients** divided into: group A primary amputation (n=15), group B secondary amputation after failed salvage (n=10), group C traumatic lower-limb amputation (n=9).	**Multiply traumatized patients with lower-limb amputation** following type IIIB or IIIC open tibial shaft fracture, and patients with traumatic lower-limb amputation. Organ function was monitored using the **Denver MOD score over 14 days after trauma or up to 7 days after secondary amputation**. Limb injury was evaluated using HFS, MESS, and NISSSA.	Primary amputation versus secondary amputation after failed salvage versus traumatic amputation; systemic organ dysfunction parameters were compared with limb-salvage scores.	**Systemic MOD parameters did not predict the need or timing of secondary amputation**; secondary amputation increased ventilation requirements but did not reliably produce measurable MOD-score differences.	Decision should be based on surgeon experience and not the scoring systems for secondary amputations
Krettek et al., 2001, Germany	**Retrospective** re-evaluation and prospective validation of the **Hannover Fracture Scale 1998 (HFS '98).**	Retrospective evaluation: **182 open fractures of upper and lower extremities** treated June 1994-1996. Prospective	Open fractures of upper and lower extremities/open long bones. The revised score included eight domains with total score range 0-22 and an amputation-recommended	HFS '98 compared with previously established limb salvage scores, including MESS and NISSSA, in the validation group.	**Validation of HFS '98 reported sensitivity 0.82 and specificity 0.99.** Positive predictive value reported as 0.99. MESS and NISSSA had lower sensitivity with the same specificity in the same study group.	**HFS '98 was presented as a reliable extremity salvage score applicable to open long-bone fractures regardless of location.**

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		validation: 87 open long-bone fractures.	cut-off at >11. Intended to apply beyond tibial fractures.			
Bosse et al. / LEAP Study Group, 2001, USA	Prospective multicentre evaluation of the clinical utility of **five lower-extremity injury-severity scores** within the Lower Extremity Assessment Project (LEAP).	**556 high-energy lower-extremity injuries** were prospectively evaluated; 407 limbs remained in the salvage pathway at six months.	Patients with high-energy lower-extremity trauma treated across level I trauma centres in the LEAP cohort. The study included injuries for which acute limb salvage versus amputation decisions were clinically relevant. Scores were applied to both ischaemic and non-ischaemic limbs and analyses were performed with and without immediate amputations.	**MESS, LSI, PSI, NISSSA, and HFS-97** compared for ability to predict amputation and limb-salvage potential. Ischaemic and non-ischaemic limbs were analysed separately, and immediate amputations were included/excluded in different models.	**For all Gustilo type III tibial fractures including immediate amputations, predictive performance was limited:** MESS sensitivity 0.45, specificity 0.93, AUC 0.78; PSI sensitivity 0.47, specificity 0.84, AUC 0.73; LSI sensitivity 0.51, specificity 0.97, AUC 0.85; NISSSA sensitivity 0.33, specificity 0.98, AUC 0.78; HFS-97 sensitivity 0.37, specificity 0.98, AUC 0.80. In type IIIB injuries, sensitivity was particularly poor despite high specificity: MESS 0.17/0.94/AUC 0.69; PSI 0.35/0.85/AUC 0.68; LSI 0.15/0.98/AUC 0.75; NISSSA 0.13/1.00/AUC 0.69; HFS-97 0.10/1.00/AUC 0.71. In type IIIC injuries, LSI performed best numerically **(**sensitivity 0.91, specificity 0.69, AUC 0.88**)** and HFS-97 also performed relatively well **(**sensitivity 0.67, specificity 0.77, AUC 0.83**),** but performance remained inconsistent across scores. When immediate amputations were excluded, predictive performance fell further, particularly for delayed amputation after attempted salvage: in type IIIB injuries, sensitivities were very low for MESS, LSI, NISSSA and HFS-97 despite high specificity. **Overall, the scores were better at identifying limbs likely to be salvaged than at identifying limbs that required amputation.**	**Classic lower-extremity salvage scores were poor as binary amputation decision rules in a prospective multicentre modern cohort.** Low scores may reassure regarding salvage potential; high scores should not automatically mandate amputation.
Adegbehingbe et al., 2006, Nigeria	**Prospective observational study** of post-traumatic primary limb amputations at a Nigerian university teaching hospital.	**66 trauma patients**; all underwent single-limb primary amputation.	Patients admitted through the Accident and Emergency Unit who underwent primary limb amputation after trauma. **The study describes primary amputation cases rather than comparing amputated and salvaged limbs.**	No direct salvage comparator. Predictive factors for primary amputation were described, including demographic, injury, physiological, and delay variables; MESS was also recorded.	**Mean MESS was 9.4 +/- 1.3 (range 7-12).** Reported factors associated with primary amputation at emergency presentation included age, sex, occupation, limb ischaemia, gangrene, severe open fracture, source/nature of injury, shock, delayed hospital presentation, and MESS.	The authors concluded that identifying predictive factors for primary amputation may reduce trauma-associated morbidity and mortality and support earlier decision-making.
Rajasekaran et al., 2006, India	**Prospective** development and validation study of the Ganga Hospital Open Injury Severity Score (GHOISS/GHS) for Gustilo type IIIA and IIIB open tibial fractures.	**109 consecutive open tibial injuries**: 42 type IIIA and 67 type IIIB.	Patients with **Gustilo-Anderson type IIIA and type IIIB** open tibial fractures. The score graded three major tissue domains from 1 to 5: covering tissues, skeletal structures, and functional tissues; seven comorbid conditions affecting management/prognosis were scored two points each. Type IIIC vascular injuries were not the primary intended population.	**Ganga Hospital score versus MESS and Gustilo classification**; score groups: group I <5, group II 6-10, group III 11-15, group IV >=16; salvage versus amputation and treatment/outcome burden among salvaged limbs.	**A threshold score of 14 for amputation had the best sensitivity/specificity balance.** In the full cohort, GHS compared favourably with MESS: sensitivity 98% versus 99%, specificity 100% versus 17%, PPV 100% versus 97.5%, and NPV 70% versus 50%. For type IIIB injuries, ROC AUC for GHS was 0.988 (+/-0.013 SEM), better than MESS 0.938 (+/-0.039 SEM) and Gustilo classification 0.5 (+/-0.122 SEM). All group IV limbs and one group III limb underwent amputation.	**GHOISS/GHS was designed specifically for Gustilo IIIA/IIIB tibial injuries** and predicted both limb salvage and clinically important treatment/outcome measures better than MESS or Gustilo classification.
Ignatiadis et al., 2008, Greece	**Retrospective case series of paediatric and adolescent severe upper-limb** compound injuries treated over a 6-year period.	**32 patients** aged 1.5-14 years; 10 involved major vascular lesions requiring revascularisation or replantation.	Children and adolescents with compound upper-limb injuries involving multiple tissue types, with or without neurovascular compromise. Injuries were classified using the **SATT system** (Severity, Anatomy, Topography, Type).	Outcomes assessed by injury severity/pattern and SATT classification; paediatric upper-limb injuries with vascular lesions were considered separately from injuries without major vascular compromise.	The study emphasised that outcomes in children/adolescents differ from adults because of superior healing, remodelling, vascularity, and nerve regeneration. **In cases with crush-avulsion injuries S2-Ty2 (S2-A2-T3- Ty2) reconstruction was not possible, while in cases classified as S2Ty1 or S1Ty2 the outcome was more or less improved.**	Management and decision-making for severe paediatric upper-limb injuries should be age-specific; **the SATT classification was considered useful in the decision-making process.**
Brown et al., 2009, UK military	**Retrospective registry** and case-note review evaluating MESS in UK military ballistic mangled extremity injuries.	77 military patients with **86 ballistic mangled lower-limb** injuries; 22 amputations.	UK military patients with ballistic lower-limb open fractures from Iraq and Afghanistan conflicts, identified from the **Joint Theater Trauma Registry** between May 2003 and April 2008. Excluded non bony, closed, non ballistic injuries and traumatic amputations.	Amputation versus successful limb salvage; MESS and skeletal injury components; ischaemic versus non-ischaemic limbs.	The median MESS in the group where limb salvage was attempted was 5 compared with a median MESS of 9 when primary amputation was performed (p<0.0001). **There were 3 patients who ultimately required amputation with a MESS of 6, after an unsuccessful attempt at salvage. There were 9 patients (10 limbs) with a MESS 7 who had limbs that were successfully salvaged.** There was a significant association between amputation and presence of prolonged hypotension (p<0.01) and between amputation and presence of a vascular injury (p<0.01). Although there was an association between skeletal 4 (vs. skeletal 3) and amputation (p<0.05), the majority of skeletal 4 limbs were still salvaged.	Military ballistic extremity injuries should be considered separately from civilian high-energy trauma; **MESS alone is not adequate for early amputation decisions in this population**.
Simmons et al., 2011, USA	**Retrospective** cohort study of popliteal artery injuries at a level I trauma centre with a rural catchment area.	**51 adult patients** with popliteal artery injuries; 9 amputations (17.6%) and 1 death.	**Adults with popliteal artery injury**; all underwent operative vascular repair. Mechanisms were blunt (53%) and penetrating (47%). Variables included BMI, MESS, Gustilo grade, ISS, and time from injury to vascular repair. Excluded patients who died within 24 hours of injury.	Amputation versus limb salvage; delay to vascular repair >6 hours; blunt versus penetrating injury; MESS and other risk factors.	**Patients requiring amputation had higher MESS (7.8 versus 5.3, p<0.01) BMI, ISS, Gustilo grade, and time to repair were not different. Delay >6 hours was not predictive of amputation**. Blunt injury had a higher, but non-significant, amputation rate than penetrating trauma.	**MESS was the best predictor among variables assessed**, but no single scoring system should be used in isolation for lower-extremity amputation decisions after popliteal artery injury.
Doucet et al., 2011, USA	**Comparative registry study** of combat versus civilian open tibia fractures and effect of blast mechanism on limb salvage.	**Civilian registry: 850 open tibia fractures** with 45 amputations. **Military registry: 115 open tibia fractures**; 21 amputation patients, including 3 bilateral.	Civilian level I trauma centre cohort compared with US Navy/Marine Corps combat casualties. Injuries classified by Gustilo-Anderson grade; variables included mechanism including blast, shock, blood loss, prehospital time, ISS, procedures, MESS, and outcomes.	Combat/military versus civilian open tibia fractures; blast versus non-blast mechanisms; **MESS prediction of amputation.**	Military patients were more severely injured, more likely hypotensive, and had higher amputation rates for Gustilo IIIB and IIIC fractures than civilian patients. Blast was common in military cases and rare in civilian trauma. **MESS sensitivity for amputation was poor in civilian cases (0.46; 95% CI 0.29-0.64) and better but still limited in military cases (0.67; 95% CI 0.43-0.85). Limb**	Blast-related open tibia fractures have worse salvage rates than typical civilian mechanisms; **MESS does not adequately predict salvage in either combat or civilian open tibia fractures.**

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					salvage was often possible despite MESS >=7 when attempted.	
Behdad et al., 2012, Iran	**Prospective/observational validation study** assessing MESS discrimination in children with lower-limb trauma.	**200 children** consecutively referred; 15 amputations (7.5%) and 185 salvaged limbs.	Children with **lower-extremity long-bone open fractures**. Inclusion criteria included open fractures and severe injury patterns involving multiple organ systems of the limb requiring surgical intervention. Excluded traumatic primary amputation.	Amputation versus limb salvage; MESS as continuous score and threshold testing using receiver operating characteristic analysis.	**Mean MESS was 7.5 +/- 1.59 in the amputation group versus 6.4 +/- 2.02 in the salvage group (p=0.04**). Skeletal/soft-tissue injury differed significantly between groups (p=0.0001). Best clinical discriminator was MESS 6.5 with sensitivity 73% and specificity 54%.	MESS may identify children at higher risk of amputation, but the selected threshold had only modest specificity.
Sheean et al., 2014, USA	**Retrospective cohort study** evaluating MESS in combat-related Gustilo-Anderson type III open tibia fractures.	**155 service members** with complete data; 110 limb salvage, 45 lower-extremity amputations.	US military service members with combat-related type III open tibia fractures sustained and treated definitively at a US military medical centre. Injuries commonly resulted from explosions/blast mechanisms.	Amputation versus limb salvage; **MESS >=7 versus <7**	**Mean MESS was 5.8 in amputees versus 5.3 in salvaged limbs (p=0.057), not statistically significant.** MESS >=7 had sensitivity 35%, specificity 87.8%, and positive predictive value 50% for amputation.	**MESS was neither sensitive nor accurate for predicting amputation** in combat-related type III open tibia fractures.
Agel et al., 2014, USA	**Retrospective** chart review of prospectively collected OTA Open Fracture Classification (OTA-OFC) data.	**356 patients** with open fractures.	**Open fractures of femur, tibia, malleoli, humerus, radius/ulna, pelvis, acetabulum, foot, or clavicle at a level I trauma centre in Seattle.** OTA-OFC was completed routinely by trauma fellows at initial debridement. The classification grades skin injury, contamination, arterial injury, muscle injury, and bone loss from 1 to 3.	**OTA-OFC subdomains compared with early amputation** (during initial admission) and common treatments: vacuum-assisted closure, >=3 irrigation/debridements, antibiotic bead placement.	The evaluation of early amputation by anatomic region shows that **skin injury** (OR, 4.0; CI, 1.4–11.7) **and arterial injury** (OR, 3.4; CI, 1.1–11.2**) are significantly related to early amputation in the lower leg**. Contamination (OR, 432.1; CI, 2.4–999) and arterial injury (OR, 58.6; CI, 1.5–999) are significantly related to early amputation in the foot/ankle. Insufficient data to evaluate the OTA-OFC variables for early amputation in the upper body.	OTA-OFC variables were associated with early treatment choices and early amputation. **Skin injury, contamination, and arterial injury were the strongest predictors of early amputation.**
Fochtmann et al., 2014, Austria	**Retrospective prognostic cohort study** of secondary amputation after third-degree open lower-limb fractures.	**93 Gustilo-Anderson type III open diaphyseal tibial fractures** identified from 408 open tibial fractures; 7 primary amputations excluded from salvage analysis; 72 definite salvages and 10 secondary amputations among non-primary-amputation patients.	Patients with third-degree open lower-limb fractures. Excluded primary amputations. Prognostic factors for final salvage versus secondary amputation were evaluated.	Definitive limb salvage versus secondary amputation; **MESS, ISS, fracture complexity, soft-tissue damage, vascular injury, fasciotomy, infection, and vessel occlusion.**	Definite limb salvage was achieved in 72 patients (88%); secondary amputation was required in 10 (12%). Median ISS 11 and median MESS 4 in salvage group and 12.5 and 6 in secondary amputation group. **MESS was significantly higher in the amputation group (p=0.0001).**	MESS was prognostic for secondary amputation, but the classic MESS >=7 threshold should be reconsidered in modern reconstructive practice.
Madhuchandra et al., 2015, India	**Prospective validation study of the Ganga Hospital Open Injury Severity** Score/Ganga Hospital Scoring system in severe open tibial fractures.	**40 patients** analysed after exclusions/losses; 11 type IIIA and 29 type IIIB open tibial fractures.	Patients with Gustilo-Anderson **type IIIA and IIIB open** fractures of the tibia treated at a tertiary referral centre. Of 123 open tibial fractures, type I/II injuries and vascular injuries were excluded; 44 eligible IIIA/IIIB fractures, with 4 lost/referred elsewhere, leaving 40 for analysis. Mean follow-up 24 months.	Ganga Hospital score thresholds versus limb salvage and outcome; type IIIA versus type IIIB injuries. **Vascular injuries were excluded.**	**38/40 limbs with score <14 and 1 limb with score >14 were salvaged. Only 1 patient underwent amputation with a score of 15, after unsuccessful salvage.** Results were reported to correlate with the original Ganga Hospital study. The study reported strong prediction of salvage and outcome using the Ganga Hospital score.	**Ganga Hospital score was considered useful for predicting limb salvage and outcome** in Gustilo type IIIA and IIIB open tibial fractures.
Ege et al., 2015, Turkey	**Retrospective study** evaluating reliability of MESS in combat-related upper and lower extremity type III open fractures.	**139 Gustilo-Anderson type III open fractures**; 39 amputations and 100 attempted salvages.	**Upper and lower extremity open fractures due to ballistic missiles/explosives** treated at two level-2 trauma centres between 2004 and 2014. Data included transport time, firearm type, ISS, MESS, fracture type, amputation level, fixation, infection, and complications. Excluded traumatic amputations.	Amputation versus limb salvage; upper versus lower extremity; MESS threshold performance.	**Mean MESS in amputated upper/lower extremity groups was 8.8 and 9.24 respectively; in salvaged upper/lower extremities 5.29 and 5.19.** Sensitivity of MESS in upper/lower extremities was 80% and 79.4%; specificity 84% and 86.6%; PPV 55.55% and 83.3%; NPV 95.45% and 90.2%. Authors emphasized poor prediction in the MESS 6-8 range.	**MESS was not sufficiently predictive in combat-related extremity injuries**, especially intermediate scores; limb ischaemia and shock should be considered in initial amputation decision-making.
Fochtmann et al., 2016, Austria	**Retrospective medical chart review** of severe upper-extremity injuries treated at a level I trauma centre and plastic/reconstructive unit.	**54 patients** from 606 screened upper-extremity fracture patients; 61 severe injuries. Survivors available for final limb salvage assessment: 48.	Patients with third-degree open fractures and traumatic sub-/total amputations of the upper extremity. Gustilo-Anderson: IIIA n=30, IIIB n=15, IIIC n=9; traumatic sub-/total amputations n=7. Injuries included forearm, humerus, or combined forearm/humerus fractures.	MESS >=7 versus <7; definitive limb salvage versus amputation/death; severe vascular and neural injury presence.	Median MESS 5 (range 3-10); median ISS 9 (range 4-50). MESS >=7 in 17/54 patients (31%). Severe vascular injury in 21/54 (39%) and neural injury in 22/54 (41%). Six patients died. **Definitive limb salvage achieved in 45/48 survivors (94%), including 9/45 salvaged patients with MESS >=7.**	**Definitive limb salvage in the mangled upper extremity was frequently achieved regardless of MESS**; MESS should not be used alone to determine amputation in upper-limb injury. **Consider limb functionality as well, not salvage alone.**
Yeh et al., 2016, Taiwan	**Retrospective cohort**/prognostic study evaluating the role of **Injury Severity Score (ISS)** in mangled lower-extremity decision-making, particularly for intermediate MESS scores.	**242 patients.**	**Patients with Gustilo IIIB or IIIC lower-extremity open fractures** treated with salvage procedures or amputation at Chang Gung Memorial Hospital. Patients were subgrouped by MESS score.	Primary amputation, successful salvage, and delayed amputation; special focus on patients with MESS 7-9. ISS and Gustilo classification compared between successful salvage and delayed amputation.	33 primary amputations, 160 successful salvages, and 49 delayed amputations. Among MESS <7: 116 successful salvages and 7 delayed amputations. Among MESS 7-9: 44 discharged with salvaged limbs and 39 failed salvage/delayed amputations. In the MESS 7-9 group, successful salvage patients had significantly lower ISS. **ISS >18 was associated with higher delayed amputation rate (p=0.01).**	Systemic injury burden may help distinguish potentially salvageable from potentially unsalvageable limbs in the MESS 7-9 grey zone; patients with **MESS 7-9 and ISS <17 may be salvageable.**
Johnson et al., 2016, USA	**Prospective multicentre observational study** evaluating OTA-OFC prediction of 90-day outcomes.	373 patients with **419 upper and lower limb open fractures.**	Patients with open fractures treated across academic and private-practice centres. **OTA-OFC domains were recorded and related to 90-day amputation**, infection requiring IV antibiotics, and wound healing.	OTA-OFC skin, muscle, arterial, contamination, and bone-loss domains versus amputation, IV-antibiotic infection/readmission, and unhealed wounds.	**Logistic regression showed arterial and skin injury significantly contributed to prediction of lower limb amputation and skin injury for upper limb amputation**. Bone loss and muscle injury contributed to prediction of readmission for IV antibiotics. No OTA-OFC variables significantly predicted unhealed wounds.	**OTA-OFC has predictive value for short-term amputation** and infection requiring IV antibiotics and supports wider clinical validation of the classification.
Venkatadass et al., 2017, India	**Retrospective cohort study** evaluating Ganga Hospital Open Injury Severity Score (GHOISS) for paediatric type IIIB lower-limb open injuries and comparing it with MESS.	**50 children with 52 type IIIB lower-limb open injuries**; 39 tibial and 13 femoral open fractures.	Children aged 0-18 years admitted with open type IIIB injuries of the lower limbs. All patients had MESS and GHOISS calculated. The study focused on children because adult scoring systems may misclassify paediatric injuries.	GHOISS versus MESS for salvage/amputation prediction; salvaged versus amputated limbs.	48/52 injuries were salvaged and 4 amputated. **MESS >=7 had sensitivity 25% for amputation. GHOISS >=17 had sensitivity 75% and specificity 93.75% for determining amputation.**	**GHOISS was a reliable predictor of injury severity and outperformed MESS** for deciding salvage versus amputation in paediatric type IIIB lower-limb injuries.
Loja et al., 2017, USA	**Prospective registry-based prognostic study** using the AAST PROOVIT registry to reassess MESS in modern lower-extremity arterial injury.	**230 patients with lower-extremity arterial injuries** entered into the PROOVIT registry between 2013 and 2015.	Patients with lower-extremity arterial injury recorded in the American Association for the Surgery of Trauma PROspective Vascular Injury Treatment registry. The registry prospectively collected demographic,	Limb salvage versus primary or secondary amputation; **MESS as continuous score and threshold score** (including MESS >=8). Multivariable models controlled for	Overall limb salvage rate was 81.3% with median MESS 4 (IQR 3-5); 18.7% underwent primary or secondary amputation with median MESS 6 (IQR 4-8; p<0.001). **However, after adjustment for confounders, the difference in MESS between**	**The diagnostic accuracy of MESS for predicting amputation has declined in modern vascular/orthoplastic care**; additional

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			diagnostic, treatment, and outcome data. Mean age was 34 years (range 4-92); blunt mechanism accounted for 47.4%.	mechanism, degree/location of arterial injury, ISS, and associated injuries.	**salvaged and amputated limbs was no longer significant.** A MESS cut-off of 5 had the best sensitivity/specificity balance but predicted amputation in only 20.2%; MESS >=8 predicted amputation in 43.2%.	predictors and team-based decision-making are needed.
GHOISS assessment letter, 2020, India	**Observational stud**y reported as a letter to the editor evaluating GHOISS in type IIIB injuries.	**20 type IIIB open injuries**; 18 salvaged and 2 amputated.	Patients with Gustilo type IIIB open injuries managed at ESIC MC PGIMSR Hospital, Bengaluru, India.	**GHOISS versus MESS for determining amputation** and guiding reconstruction; GHOISS thresholds linked to protocols such as Fix and Close, Fix/Bone Graft/Close, Fix and Flap, and Stabilize/Watch/Assess/Reconstruct.	**Using MESS >=7, sensitivity for amputation was 25%. GHOISS >=17 had sensitivity 75% and specificity 93.75% for amputation**. The authors stated GHOISS also guided reconstruction according to injury severity.	**GHOISS was considered more accurate than MESS for amputation prediction in type IIIB injuries** and useful in planning reconstructive protocols.
Gupta et al., 2020, India	**Prospective comparative study** comparing multiple open-injury scores in type IIIB open tibial fractures. Treating surgeons were blinded to the calculated scores.	219 patients with **225 type IIIB open tibial fractures**.	Consecutive patients with type IIIB open tibia fractures. Decision for salvage or amputation was by consensus of senior orthopaedic and plastic surgeons, blinded to MESS, LSI, OTA-OFC, and GHS calculated independently after initial debridement. Follow-up 1-2 years; four deaths within 1 year were excluded from outcome analysis.	**MESS versus Limb Salvage Index (LSI) versus OTA-OFC versus Ganga Hospital Score (GHS**); salvage versus primary amputation, primary delayed amputation, and secondary amputation.	Final outcomes: 193 successfully salvaged limbs (85.7%), 19 primary amputations without attempted debridement (8.4%), 3 primary delayed amputations within 72 hours (1.3%), and 6 secondary amputations after 72 hours (2.7%). All four scores performed well for salvage. **GHS was superior for predicting amputation**. MESS, LSI, and OTA-OFC tended to underscore amputations because they weighted vascular injury heavily, whereas many type IIIB amputations do not have major vascular injury. **GHS uniquely includes a 'grey zone' around threshold values.**	**GHS performed better than MESS, LSI, and OTA-OFC for type IIIB tibial injuries** because it was designed for this injury group and incorporates a grey zone for individualized decisions.
Garner et al., 2021, USA	**Retrospective review** from two high-volume level I trauma centres evaluating OTA-OFC as an outcome prediction tool in open tibial shaft fractures over 5 years.	**501 consecutive open tibial shaft fractures**; 419 had 90-day follow-up for wound complication assessment.	Open tibial shaft fractures from two level I trauma centres. **Variables included OTA-OFC subdomains**, definitive closure method, 90-day wound complication, unplanned reoperation, non-union, and amputation.	OTA-OFC domains (skin, muscle, arterial, contamination, bone loss) versus closure type, 90-day wound complications, unplanned secondary procedures, non-union, and amputation.	**OTA-OFC muscle** predicted non-union (OR 2.2, 95% CI 1.2-4.1) and amputation (OR 9.3, 95% CI 3.7-23.7). OTA-OFC **arterial predicted amputation** (OR 4.8, 95% CI 2.5-9.3).	OTA-OFC muscle and arterial injury are particularly important predictors of amputation.
Sivagnanam et al., 2021, India	Original research validation study of the **Vetrivel Trauma Score in Gustilo IIIB and IIIC open fractures.**	**144 open fracture cases** screened; 82 Gustilo grade III injuries; 35 grade IIIB or above scored using Vetrivel, GHOISS, and MESS.	Patients with Gustilo-Anderson grade IIIB and IIIC open fractures treated in Tamil Nadu institutions. **The study was motivated by persistent grey-zone uncertainty with existing scores.**	**Vetrivel Trauma Score versus GHOISS versus MESS** for predicting amputation versus salvage.	The area under the curve for Vetrivel trauma score was 0.983 ± 0.015, the Ganga hospital open injury severity score was 0.973 ± 0.028, and the Mangled extremity severity score was 0.970 ± 0.028. A score of 39 or more had the highest predictability for amputation according to the authors.	**Vetrivel Trauma Score was proposed as a more accurate predictor** of injury severity and amputation requirement in Gustilo IIIB/IIIC open fractures.
Ebanezer & Jaba, 2023, India	**Prospective comparative study** of multiple lower-extremity injury severity scoring systems.	**35 high-energy lower limb injuries** in 32 patients.	High-energy severe open injuries of the leg treated prospectively at Ganga Hospital, Coimbatore. Patients were resuscitated and assessed for systemic and limb-threatening injury before scoring. Excluded patients treated at another institution and life-threatening head injuries.	**Seven lower-extremity injury severity scores** including MESS, NISSSA, LSI, PSI, and HFS-97; limb salvage versus amputation.	MESS and NISSSA had higher specificity (71.4% and 81%) than LSI, PSI, and HFS-97 (61.9%, 47.6%, 47.6%), but lower sensitivity (85.7% and 64.3%) than LSI, PSI, and HFS-97 (100%). PPV was higher for MESS/NISSSA (66.6%, 69.2%) than LSI/PSI/HFS-97 (63.6%, 56%, 56%); NPV was lower for MESS/NISSSA (88.2%, 77.2%) than LSI/PSI/HFS-97 (100%).	Existing scores tended to trade sensitivity against specificity; none achieved the ideal 100% sensitivity and specificity required for a definitive amputation/salvage decision tool.
Altintas et al., 2024, Turkey	**Observational study of firearm-related isolated lower-extremity injuries** evaluating damage control orthopaedics versus early comprehensive treatment and MESS usability.	**93 adult patients** with isolated firearm-induced lower-extremity injury requiring surgery for open bone fractures.	Adults treated at a level I trauma centre in Diyarbakir, Turkey. Included isolated firearm-related lower-extremity injuries requiring surgical intervention for open fractures. MESS was calculated retrospectively from records. Excluded soft tissue only injuries.	Damage control orthopaedics (DCO) versus traditional early comprehensive treatment (TECT); mortality, amputation, salvage, non-union; MESS values by outcome.	DCO was used in 54.8% (51/93). Amputation and limb salvage differed significantly between DCO and TECT groups (chi-square 6.234, p<0.05). **Mean MESS was 8.9 +/-0.7 in fatalities, 6.3 +/-1.1 in amputations, and 3.8 +/-1.5 in salvaged limbs**. Non-union differed between groups, higher in DCO (18.2%) than TECT (7.1%).	**MESS may assist outcome prediction and treatment strategy selection in isolated firearm-related lower-extremity injuries,** while DCO was preferentially used for more severe injuries.
Kwizera et al., 2025, Rwanda	**Prospective cohort study** evaluating Ganga Hospital Open Injury Severity Score in open tibia fractures in Rwanda.	**111 adult participants.**	Patients aged >=18 years with **open tibial fractures** treated in Kigali, Rwanda. GHOISS was calculated and patients were divided into Group I (1-13), Group II (14-16), and Group III (>=17). Outcomes collected at 1 and 6 months.	GHOISS groups versus amputation, limb salvage, infection, hospital stay, and soft-tissue reconstruction requirement.	**GHOISS predicted amputation with high sensitivity 100% and specificity 96.03%,** PPV 71.4%, NPV 100%. ANOVA showed significant group differences (F[2,108]=21.12; p<0.001).	**GHOISS showed strong discriminative ability for predicting amputation/salvage** and may also predict related outcomes such as soft-tissue reconstruction need in Rwanda.
Okuku et al., 2025, Uganda	**Prospective cohort study** of GHOISS as predictor of early failure of limb salvage in Gustilo IIIA/IIIB tibia fractures.	**49 Gustilo IIIA/IIIB tibia fractures**	Adult patients with Gustilo type IIIA and IIIB open tibia fractures presenting to two tertiary hospitals in Uganda. Injury severity was scored using GHOISS; salvage decisions were made independent of GHOISS. Follow-up was 14 days to assess early secondary amputation/failure of salvage. Excluded paediatric patients.	GHOISS threshold performance for salvage versus amputation; primary and secondary amputation outcomes.	Among 49 fractures, 43 were successfully salvaged and 6 required amputation (4 primary, 2 secondary). **A GHOISS cut-off of 13 provided maximum specificity 90.7% and sensitivity 83.3% for predicting amputation.** AUC was 0.923 (95% CI 0.804-0.977), indicating strong discrimination.	**GHOISS reliably predicted early outcome in Gustilo IIIA/IIIB tibia fractures in Uganda**; score >=13 was associated with early failure of limb salvage.
Schade et al., 2025, Malawi	**Prospective cohort study** evaluating whether open-fracture classification systems predict functional and clinical outcomes in a low-income country.	**287 adults with open tibia fractures** recruited across six hospitals; 252 photographs (88%) and 274 radiographs (95%) available for classification.	Adults with open tibia fractures treated in Malawi. Radiographs and clinical photographs were classified using **Gustilo-Anderson, Orthopaedic Trauma Society (OTS), Muller, and Tscherne** classifications. Outcomes were assessed at 6 weeks, 3 months, 6 months, and 1 year.	Four classification systems versus patient-reported function, fracture-related infection, and amputation.	Kendall correlation with 1-year function was 0.34 for OTS, 0.18 for Gustilo, 0.17 for Tscherne, and -0.02 for Muller. Correlation with 1-year FRI was 0.34 for OTS, 0.31 for Gustilo, 0.24 for Tscherne, and -0.02 for Muller. **Correlation with amputation was 0.39 for OTS, 0.24 for Gustilo, 0.24 for Tscherne, and 0.12 for Muller.** Most correlations were weak/negligible.	**Existing open-fracture classifications showed weak correlation** with functional outcome, infection, and amputation in Malawi; treatment factors and context may strongly influence outcomes.
Omoto et al., 2025, Japan	**Retrospective case-control** reassessment of MESS cut-off criteria for amputation in contemporary **severe open extremity fractures**; level III evidence.	**54 patients total**: preservation group n=36 and amputation group n=18.	**Patients with Gustilo-Anderson type IIIB or IIIC open limb fracture**s treated at two tertiary hospitals in Osaka, Japan. The study compared MESS values in patients who underwent limb preservation with those requiring amputation at any time during the hospital admission.	Limb preservation versus amputation; traditional MESS >=7 threshold versus revised MESS >=8 threshold; ROC analysis for MESS cut-off performance.	Mean total MESS was significantly lower in the preservation group than in the amputation group (5.7 +/- 1.5 versus 8.0 +/- 1.4; p<=0.001). MESS >=7 had sensitivity 83% and specificity 78%. MESS >=8 increased specificity to 92% with slightly reduced sensitivity 78%. AUC for MESS was 0.86; **the performance of MESS >=8 was significantly higher than MESS >=7 (p=0.020).**	The authors concluded that a revised MESS cut-off of 8 may better reflect modern trauma and reconstructive capabilities than the traditional threshold of 7.

Author, year of publication, Country	Study Design	Sample Size	Study population (Inclusion and exclusion criteria)	Groups compared	Results	Conclusions
Bansal et al., 2026, India	**Prospective observational comparative validation study** of open injury scores in type IIIB tibial fractures.	**307 patients with type IIIB open tibial fractures**.	Patients with Gustilo-Anderson type IIIB open tibial fractures treated at a tertiary care centre in North India. **MESS, LSI, and GHOISS were assessed** after first surgical debridement. Limb salvageability was defined as limb retention at 6 months.	MESS versus LSI versus GHOISS for predicting salvageability/amputation in type IIIB tibial fractures.	Limb salvage achieved in 93.5%; amputation in 6.5%, particularly in GHOISS grey-zone scores 15-16. Higher scores on all systems associated with amputation ($p<0.001$). **ROC analysis: GHOISS AUC 0.997, MESS AUC 0.958, LSI AUC 0.953.** GHOISS demonstrated superior predictive accuracy and specificity.	**GHOISS was the most reliable predictor of limb salvageability in this large type IIIB tibial fracture cohort** and may best support clinical decision-making in this injury group.
Hao et al., 2016, USA	Retrospective observational cohort study; Level IV evidence. Single Level I trauma centre.	**512 patients** with **open long-bone fractures**. 352 male, 160 female; mean age 41.1 ± 16.2 years, range 18–85. **19 patients underwent amputation**: 16 lower-extremity and 3 upper-extremity amputations.	Consecutive adult patients presenting with **open long-bone fractures.** Inclusion: age ≥18 years and minimum follow-up ≥3 months. Exclusion: initial treatment at an outside facility or insufficient medical records. OTA-OFC and Gustilo-Anderson classifications were compared for prediction of amputation, infection, and soft-tissue coverage requirement.	**OTA-OFC versus Gustilo-Anderson classification** for prediction of postoperative complications and treatment outcomes. Specific comparisons included: amputation vs limb salvage; infection vs no infection; need for soft-tissue coverage vs no soft-tissue coverage. ROC analysis was used to identify an OTA-OFC summative threshold for amputation risk.	**Amputation:** 19/512 patients (3.7%) underwent amputation; 10 acute and 9 delayed. **Gustilo-Anderson:** no statistically significant difference between outcome groups: amputation group 3.7 ± 1.7 vs limb salvage 2.4 ± 1.4, $p = 0.08$; infection 3.0 ± 1.5 vs no infection 2.4 ± 1.5, $p = 0.10$. **OTA-OFC:** summative scores differed significantly: amputation 10.9 ± 3.4 vs limb salvage 6.37 ± 1.8, $p < 0.001$. Skin injury was the only independent predictor of limb amputation among OTA-OFC domains: OR 5.44, 95% CI 2.37–12.47, $p < 0.001$. ROC analysis identified **OTA-OFC summative score ≥10** as the best threshold for amputation risk: sensitivity 78.9%, specificity 94.2%, false-positive rate 5.8%, false-negative rate 21.1%, PPV 34.1%, NPV 99.1%.	**OTA-OFC performed better than Gustilo-Anderson** in this cohort for predicting treatment outcomes after open long-bone fractures. A summative OTA-OFC score ≥10 identified patients at substantially increased risk of amputation, although the authors cautioned that the findings should be interpreted carefully because of the retrospective design.

Section 3: Results summary write-up

Across the included evidence, current scoring and classification systems show variable and context-dependent performance. Early derivation studies suggested strong predictive ability for MESS and LSI, but these were based on small, selected cohorts, often enriched for vascular injury. The prospective LEAP evaluation was more clinically challenging and showed that classic scores were poor in binary decisions. For all Gustilo type III tibial fractures including immediate amputations, sensitivity was low for MESS, PSI, LSI, NISSSA and HFS-97 despite generally high specificity; in type IIIB injuries sensitivity was particularly poor. This means high scores may identify some severely injured limbs, but many limbs ultimately requiring amputation are missed. MESS repeatedly performed inconsistently across settings. It was weak in combat and blast-related tibial injuries, paediatric lower-limb trauma, upper-limb trauma and modern vascular injury cohorts. Some studies found MESS prognostic, but several suggested that the traditional threshold of 7 is too crude in contemporary reconstructive practice. GHOISS/GHS was the most consistently favourable score for Gustilo IIIA/IIIB and especially type IIIB open tibial injuries, with high reported AUCs and sensitivity/specificity in Indian, paediatric and low-resource cohorts. However, much of this evidence comes from specialist centres or context-specific populations. OTA-OFC improved anatomical description and showed associations between skin, muscle, arterial injury and amputation/non-union, but its predictive performance is not uniformly sufficient as a standalone amputation rule. Gustilo-Anderson remains useful for broad stratification but lacks granularity and performs poorly for individual limb-salvage decisions. Overall, the evidence supports use of these systems for structured assessment, communication and risk stratification, not as definitive determinants of amputation.

Section 4: Discussion

The evidence indicates that current classification and scoring systems are not adequate as independent predictors of limb salvage versus amputation. Their value lies in standardising assessment and prompting consideration of key injury domains, rather than replacing clinical judgement. The central limitation is heterogeneity: limb-threatening injuries differ by anatomical site, mechanism, vascular status, contamination, tissue viability, patient physiology, available reconstructive expertise and healthcare context. A single numerical threshold is unlikely to capture these interacting variables.

The historical appeal of MESS was its simplicity and early availability. In the original derivation and validation cohorts it appeared highly predictive, but later studies showed reduced performance when applied to broader and more modern populations. LEAP is particularly important because it prospectively evaluated several established scores across a multicentre cohort. The consistent pattern was high specificity but low sensitivity: a low score may be reassuring for salvage potential, but a high score cannot reliably mandate amputation. This is clinically important because the harm of a false-positive amputation prediction is irreversible.

Several subgroups demonstrate why generalisation is problematic. Combat and ballistic injuries have mechanisms and tissue zones that differ from civilian blunt trauma. Paediatric limbs have different healing, vascular and remodelling potential, so adult thresholds underperform. Upper-limb decisions must incorporate hand function, sensibility and dominance, and MESS does not adequately address these. Low-resource settings introduce further variation because delayed presentation, treatment availability, infection risk and follow-up capacity influence outcomes beyond the injury score itself.

GHOISS/GHS is the strongest candidate among condition-specific systems for Gustilo IIIA/IIIB open tibial fractures. Its advantage is that it grades covering tissue, skeletal injury and functional tissue separately, includes comorbid factors, and explicitly recognises a grey zone. This design aligns better with orthoplastic decision-making than scores dominated by vascular injury. Nevertheless, GHOISS is not universal: validation remains strongest for tibial injuries and it should still support rather than dictate decisions.

OTA-OFC is useful because it separates injury severity into domains such as skin, muscle, arterial injury, contamination and bone loss. This improves description and allows more nuanced analysis than Gustilo-Anderson. Studies show individual domains, particularly skin, muscle and arterial injury, correlate with amputation or treatment burden. However, the OTA-OFC is more a classification framework than a definitive salvage score, and a summative score may oversimplify domain-specific prognostic information.

Therefore, the consensus position should be cautious. Current systems are adequate for communication, audit, research stratification and as adjuncts to multidisciplinary decision-making. They are not adequate as standalone binary tools to decide amputation versus salvage. The decision should integrate score outputs with serial debridement findings, vascular reconstruction feasibility, soft-tissue cover, bone loss, contamination, systemic injury, patient priorities, likely function, rehabilitation burden, local expertise and resource context. Future prediction tools should be prospectively validated, injury-specific, externally calibrated, and include patient-reported functional outcomes rather than limb survival alone.

Section 5: Risk of bias of included studies

Overall risk of bias: MODERATE to HIGH. The evidence base is dominated by retrospective cohorts, single-centre series, derivation studies, and small amputation-event numbers. Many studies are vulnerable to selection bias because the decision to attempt salvage or perform primary amputation was made clinically before outcome assessment, and the most severe limbs may have been excluded from salvage cohorts. Observer bias is possible because some scores were calculated retrospectively from records and because intraoperative findings may alter classification. Outcome definitions vary substantially, including primary amputation, secondary amputation, infection, non-union, limb retention and functional outcomes. Treatment-era bias is important: older studies predate modern orthoplastic care, free-flap pathways, negative-pressure dressings, contemporary vascular repair and staged reconstruction. Generalisability is also limited because

combat, paediatric, upper-limb, civilian, high-income and low-resource cohorts behave differently. The strongest studies are prospective multicentre or large prospective cohorts, but even these show heterogeneity and limited ability to guide individual decisions.

Section 5: Response/Recommendation

Current classification and scoring systems are not adequate as standalone tools for predicting limb salvage versus amputation. They should be used as structured adjuncts to multidisciplinary decision-making, with GHOISS/GHS considered particularly useful for severe open tibial Gustilo IIIA/IIIB injuries and OTA-OFC useful for domain-based injury description.

Section 6: Level/strength of Evidence

Overall strength of evidence: MODERATE for the conclusion that existing scores are inadequate as sole decision tools; LOW to MODERATE for using any individual score to decide amputation in a specific patient. This judgement is based on a sizeable observational evidence base, including prospective multicentre data and multiple external validation cohorts, but no randomised trials, substantial heterogeneity, inconsistent thresholds, variable outcome definitions and important context-specific performance differences.

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