

TEMPLATE

Should preliminary wound irrigation with saline be performed in the emergency department prior to surgical debridement?

Section 1: Background (<300 words):

The general management of open fractures is centred on treating these injuries as surgical emergencies that require urgent intervention to prevent serious complications like infection, wound-healing problems, and non-union. Upon arrival, patients are often managed using the Advanced Trauma Life Support (ATLS) protocol. Broad-spectrum parenteral antibiotics should be administered immediately in the trauma bay. The wound is typically covered with sterile dressings, and the fractured limb is immobilized using external splints. Appropriate plain radiographs are obtained to confirm the fracture and assist in planning surgical stabilization. The single most important surgical step in managing open fractures is a thorough irrigation and debridement. This procedure aims to remove all contaminants, foreign matter, and nonviable tissue. Surgeons must meticulously remove all gross debris and dead skin, muscle, fat, fascia, or bone. While various solutions have been used, normal saline is widely considered the standard and has been shown to be superior to castile soap, which is associated with higher reoperation rates. Historically, the "6-hour rule" was the standard for performing I&D, but recent evidence suggests more flexibility. Several studies indicate that as long as I&D is performed within 24 hours of arrival, there may be no significant difference in infection rates. Lower Extremity Considerations: Some data suggests that delay specifically impacts the lower extremity; a delay of more than 8 hours for lower extremity open fractures has been linked to an increased likelihood of infection

Section 2: Data extraction table

S.no	Author, year, country	Study design	Sample size	Study population	Groups compared	Results
1	FLOW Investigators correspondence 2016	Correspondence and post hoc discussion	FLOW trial p	Open fracture wounds	Discussion of irrigation, debridement, VAC, infection	Emphasized that debridement remains the key procedure. FLOW authors reported VAC use was associated with higher infection rates, likely reflecting wound severity.
2	FLOW Investigators, 2010	Study protocol for multicenter RCT	Planned 2280 patients	Open extremity fractures	Soap vs saline; low, high, and gravity-flow pressures	Established lack of consensus regarding irrigation solution and pressure. Normal saline was the most common standard solution.
3	Malhotra et al., 2014, USA	Retrospective cohort	404 patients, 415 open fractures	Blunt open extremity fractures	Debridement ≤8 hours vs >8 hours	Infection was higher when operative D&I was delayed beyond 8 hours,

S.no	Author, year, country	Study design	Sample size	Study population	Groups compared	Results
4	FLOW Investigators, 2015	Multicenter randomized controlled trial	2447 eligible patients	Open extremity fractures requiring surgery	Saline vs castile soap; high vs low vs very-low pressure	especially in lower-limb fractures. Gustilo grade and injury severity were independent predictors. Reoperation rates were similar across pressure groups. Soap had higher reoperation rates than saline. Very-low-pressure saline irrigation was acceptable.
5	Olufemi and Adeyeye, 2017, Nigeria	Prospective randomized study	97 completed follow-up	Gustilo I–IIIA open lower-limb fractures	Isotonic saline vs distilled water	Distilled water had similar infection and healing rates to saline. Saline remained accepted as safe and non-toxic.

S.no	Author, year, country	Study design	Sample size	Study population	Groups compared	Results
6	Srour et al., 2015, USA	Prospective observational study	315 patients	Open extremity fractures	I&D <6 h, 7–12 h, 13–18 h, 19–24 h	Time to I&D did not significantly affect infection if performed within 24 hours. Timing did not affect nonunion, hardware failure, length of stay, or mortality.

Section 3: Results summary write-up (upto 500 words)

Six studies were included. No study directly randomized patients with open fractures to emergency department (ED) saline irrigation versus no ED irrigation prior to operative debridement.

- The FLOW trial protocol emphasized the fundamental role of formal operative irrigation and debridement in the treatment of open fractures, while identifying substantial variability in surgeons' preferences regarding irrigation technique, pressure, and solution. Among available solutions, normal saline represented the most frequently used option in routine clinical practice.
- The completed FLOW randomized controlled trial remains the most robust investigation evaluating irrigation strategies during surgical management of open fractures. In a cohort of 2,447 patients, the risk of subsequent reoperation was similar regardless of whether high-pressure, low-pressure, or very-low-pressure lavage was used. In contrast, the addition of castile soap resulted in a significantly greater need for reoperation compared with saline irrigation, favoring saline as the standard irrigating solution.

- Further discussion of the FLOW findings emphasized that meticulous removal of devitalized and contaminated tissue is likely more important than the choice of irrigation technique itself. Reported relationships between adjunctive wound therapies, including negative-pressure wound treatment, and infection should be interpreted cautiously, as these interventions are often selected for more complex and severely contaminated injuries.
- Malhotra et al. identified delayed operative irrigation and debridement beyond 8 hours as a risk factor for infection, particularly among patients with open fractures of the lower extremity. Increasing Gustilo-Anderson classification and overall injury severity were additional predictors of infectious complications. These findings support prioritizing timely definitive surgical treatment rather than performing ED-based irrigation if this could postpone operative care.
- Srour et al. reported comparable infection outcomes when operative debridement was performed within a 24-hour window, suggesting that immediate surgery may not be required in all cases provided that early antibiotic therapy, wound protection, and appropriate interim management are instituted.
- Olufemi and Adeyeye compared isotonic saline with distilled water for irrigation of open lower-extremity fractures and observed no meaningful differences in infection rates or wound healing outcomes. Despite these findings, saline continues to be favored because it is physiologic, readily available, and has an established safety profile.

In summary, there is no available study demonstrates that routine ED saline irrigation before operative debridement improves infection rates, healing outcomes, or the need for subsequent surgery in patients with open fractures.

Section 4: Discussion (<1000 words)

The management of open fractures is a coordinated surgical emergency that requires rapid intervention to minimize complications such as deep infection, nonunion, and wound-healing failures. Current standards emphasize a multidisciplinary orthoplastic approach

where orthopaedic and plastic surgery consultants concurrently plan fixation and coverage. Broad-spectrum intravenous antibiotics should be administered as soon as possible, ideally within one hour of injury. Prophylaxis typically involves a first-generation cephalosporin for Gustilo Grade I fractures, with an aminoglycoside added for Grade II and III injuries. Standard protocols often continue antibiotics for 72 hours or until 48 hours after the final operative debridement. Required for wounds with gross contamination (e.g., agricultural, sewage) or associated vascular compromise.

- Within 8 Hours: For solitary high-energy open fractures.
- Within 24 Hours: For all other low-energy open fractures. Some evidence suggests delays beyond 8 hours specifically increase infection risk in lower extremity fractures.

Debridement must meticulously remove all nonviable skin, fat, muscle, and bone until tissue with adequate bleeding and contractility is reached. Once completed, further procedures in that session are considered "clean" and require fresh instruments and a full re-prep and drape. The practical consensus is therefore selective rather than universal. All open fractures should receive early intravenous antibiotics, tetanus prophylaxis, gross neurovascular assessment, sterile saline-moistened dressing or sterile dressing, immobilization, and timely operative debridement. Preliminary saline irrigation may be added when gross contamination is present or operative delay is unavoidable, but it should not be mandated for every open fracture.

Normal saline is the preferred irrigant. Castile soap is associated with significantly higher reoperation rates. Distilled water is considered a favorable, low-cost alternative to saline in resource-limited settings. The FLOW trial established that very low pressure (gravity flow) is an acceptable, low-cost alternative to high-pressure irrigation, as reoperation rates are similar across all pressures. High pressure may actually drive particulate matter deeper into tissues or damage bone architecture. Minimum irrigant volumes are standardized by Gustilo-Anderson grade: 3 liters for Type I, 6 liters for Type II, and 6 to 9 liters for Type III fractures. Definitive soft tissue closure or coverage should ideally be achieved within 72 hours of injury if not possible during the initial debridement. Definitive internal stabilization (e.g., plates or nails) should only be performed if it can be immediately followed by definitive soft tissue cover. While Vacuum-Assisted Closure (VAC) is used for temporary management, it is controversial; post hoc analyses from the FLOW trial found VAC was associated with a significantly increased risk of infection across all fracture types

Section 5: Risk of bias of included studies

Study	Risk of bias
FLOW correspondence, 2016	High – correspondence and post hoc analysis; not designed to test ED irrigation.
FLOW protocol, 2010	Low for design rationale, but not outcome evidence.
Malhotra et al., 2014	Moderate–High – retrospective cohort; timing affected by injury severity and logistics.
FLOW Investigators, 2015	Low – large multicenter RCT, but studied operative irrigation rather than ED irrigation.
Olufemi and Adeyeye, 2017	Moderate – randomized prospective study, but smaller sample and limited setting.
Srour et al., 2015	Moderate – prospective observational study, not randomized by timing.

Section 5: Response/Recommendation (1-2 lines as a conclusion and recommendation statement for the question)

There is currently no evidence demonstrating that preliminary wound irrigation with saline in the emergency department prior to surgical debridement provides additional clinical benefit. It should never delay antibiotics, splintage, transfer, or definitive operative irrigation and debridement.

Section 6: Level/ strength of Evidence:

LOW

Justification: No included study directly evaluates emergency department saline irrigation before operative debridement. The recommendation is based on indirect evidence from operative irrigation trials, timing-to-debridement studies, and expert interpretation of open fracture principles.

Wound Irrigation for Open Fractures: Key Results from the FLOW Trial

Irrigation Solution: Soap vs. Saline

Normal Saline:
The Gold Standard



11.6%
Reoperation Rate

Patients irrigated with saline had a significantly lower reoperation rate than the soap group.

11.6%

VS.

Castile Soap:
Increases Reoperation Risk



14.8%
Reoperation Rate

Using soap increased the risk of reoperation by **32%** compared to normal saline.

14.8%



Evidence-based guidelines for irrigation solutions, pressures, and timing in initial open fracture management.

KEY FINDING: Soap Linked to Implant-Exchange Procedures.

Soap irrigation was specifically associated with higher rates of surgery for established nonunion.

Pressure Dynamics and Operative Timing

Very Low Pressure is Highly Effective

High Pressure
(>20 psi)



13.2%
Reoperation Rate

Low Pressure
(5–10 psi)



12.7%
Reoperation Rate

Very Low Pressure
(1–2 psi)



13.7%
Reoperation Rate

No significant difference in reoperation rates between gravity flow, low, and high pressure.

The 8-Hour “Golden Window” for Lower Extremities



Within 8 Hours:
Golden Window



Beyond 8 Hours:
Doubles Infection Risk



Upper Extremity Resilience to Delay

Unlike lower extremities, delay beyond 8 hours did not significantly increase infection in upper extremities.

Study Type	Fracture Location	Gustilo-Anderson Grade	Irrigation Solution	Irrigation Pressure	Time to Debridement (Hours)	Reoperation Rate (%)	Infection Rate (%)	Nonunion Rate (%)	Source
RCT	Extremity	I, II, III	Castile soap vs. Normal saline	High (> 20 psi), Low (5 – 10 psi), Very low (1 – 2 psi)	Mean ~ 10	13.2	Not in source	Not in source	[1]
Prospective	Extremity	I, II, III	Not in source	Not in source	< 24	Not in source	4.4	5.1	[2]
Retrospective	Upper and Lower extremity	I, II, III	Not in source	Not in source	Mean 4.97 (early) vs. 11.07 (delayed)	Not in source	13.0	Not in source	[3]
Prospective	Lower extremities	I, II, IIIa	Normal saline vs. Distilled water	Not in source	< 24	Not in source	34.0–44.0	Not in source	[4]

[1] article 4.pdf

[2] article 6.pdf

[3] article 3.pdf

[4] article 5.pdf

Clinical Standards for Open Fractures: A Time-Critical Guide

