SAHARA EMS COLLEGE

NAKURU · KISUMU · KENYA

WHITEPAPER

# INTRAOSSEOUS ACCESS IN PREHOSPITAL EMERGENCY CARE

Evidence, guidelines, devices and practical application – seen through a Kenyan lens, including police and military use.

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SAHARA EMS COLLEGE · CLINICAL GOVERNANCE

# SECONDS MATTER. BONE DOES NOT COLLAPSE.

In a collapsed, shocked or arrested patient the vein you need most is the one you cannot find. Intraosseous (IO) access places a needle into the marrow cavity of a long bone, which drains straight into the central circulation and does not collapse when the patient does. This paper sets out the 2026 evidence, the guidelines, the devices and what it would take to make IO a routine, well-governed skill in Kenyan prehospital care: on the road, in the referral ambulance and in uniform.

## 1

### RELIABLE WHERE VEINS FAIL

In the largest trial, crews told to go to the bone first had working IO access in 94 % of cardiac arrests; crews told to try a vein first succeeded by IV in only 65 %, and a third crossed over to IO.[1] In the Danish trial, access within two attempts succeeded in 92 % vs 80 %.[2] In hypotensive trauma: IO 93 %, peripheral line 67 %, central line 59 %.[3]

## 2

### NO SURVIVAL PENALTY, NO SURVIVAL BONUS

IO-first and IV-first strategies produced the same 30-day survival and neurological outcome in adult out-of-hospital cardiac arrest.[1,2,4] Guidelines therefore keep IV as the first attempt and IO as the route when IV is not secured within two attempts.[5,6] That is an argument for using IO fast, in the right patient.

## 3

### CHILDREN ARE THE CLEAREST CASE

For children, AHA and AAP now treat IV and IO as co-equal initial routes.[7] Kenya's own Basic Paediatric Protocols already prescribe IO when IV fails.[8] In Kenyan county hospitals, shock in children is 94 % diarrhoeal and carries a 34 % case fatality.[9] Access, not fluid volume, is the bottleneck.

## 4

### SAFE IN TRAINED HANDS

Serious complications occur in 0.3 % or fewer of adult insertions; osteomyelitis in well under 1 %.[10,11] The common problems, extravasation, dislodgement and infusion pain, are prevented by technique, lidocaine and a 24-hour limit.[12,13]

## 5

### EQUIPMENT IS THE BARRIER, NOT THE EVIDENCE

None of eight Rwandan district hospitals stocked an IO needle; two of eleven emergency units in northern Tanzania had one; 65 % of Gauteng emergency doctors had never used IO in an adult.[14,15,16] No Kenyan IO data exist. A manual needle costs a quarter to a third of a powered set, and that choice decides whether IO reaches BLS ambulances.

## 6

### A REGULATORY GAP, NOT A PROHIBITION

KMPDC licenses EMS personnel and ambulances but has published no scope of practice; its inspection checklist asks for IV cannulas but no IO device.[17,18] The 922 Lifeline and SHA emergency fund (August 2026) create, for the first time, a payer and dispatch structure into which an IO standard can be written.[19]

### WHO THIS PAPER IS FOR

EMTs, paramedics, nurses and clinical officers on Kenyan ambulances and in emergency units; the operators, counties and regulators who equip and license them; and the medical services of the National Police Service and the Kenya Defence Forces. Sections 3 and 7 are for the hands that hold the needle; sections 2, 5, 6 and 9 for those who decide whether there is a needle to hold.

# THE PATIENT REACHES US LATE, AND OFTEN WITHOUT A VEIN.

Every argument for or against intraosseous access depends on the system around it. A Danish ambulance reaches an arrest in eight minutes with two paramedics and a doctor on the way. A Kenyan casualty is more likely to arrive in the back of a private car, after an hour, having been moved by whoever was nearest. That changes what a reliable vascular access device is worth.



FIGURE 1

**PROXIMAL TIBIAL INTRAOSSEOUS ACCESS IN THE FIELD**

Powered driver held at 90° to the flat antero-medial surface of the tibia, about two finger-breadths below the knee. The supporting hand stabilises the leg from the side, never behind the insertion site. Fluids are infused under pressure.

## TRAUMA: HALF THE DEATHS HAPPEN BEFORE HOSPITAL

**4,458**
road deaths recorded by NTSA in 2025 (to 2 December); 2026 is running about 11 % higher[20]

**14,926**
WHO's modelled estimate of annual road deaths in Kenya, roughly three times the official count[21]

**51 %**
of injury deaths in a Nairobi death-record review occurred before the patient reached a hospital[22]

Pedestrians and motorcyclists make up the largest share of those killed.[20] The Government's own 2026 review of road deaths named gaps in post-crash response as a system failure and called for highway trauma centres and a "golden hour" framework.[23] How casualties travel has barely changed in fifteen years: in a national survey only 1.4 % of seriously injured road-crash victims arrived by ambulance and three quarters were brought by bystanders;[24] in a Nairobi tertiary hospital 72 % came by private car and only 26 % by ambulance, with a median injury-to-emergency-department time of 70 minutes.[25] The patient who needs circulatory access therefore often first meets a trained provider in a casualty department or in a referral ambulance, an hour or more after injury, cold, hypotensive and with collapsed peripheral veins.

## CHILDREN: ACCESS IS THE BOTTLENECK, NOT FLUID

Kenya loses around 58,000 children under five each year, with pneumonia and diarrhoea among the leading causes.[26] In the Clinical Information Network of county hospitals, 1.5 % of 42,937 admitted children were in clinical shock; 94 % of that shock was hypovolaemic from diarrhoea, and the case fatality was 34 %.[9] Across 13 of those hospitals over three years, diarrhoea with dehydration accounted for 8,562 admissions with 9 % mortality,[27] and severe acute malnutrition for 5,306 of 54,140 under-five admissions (9.8 %) with 15.8 % mortality.[28] In the first half of 2026 alone, 138,833 under-fives were treated for acute malnutrition and 10,449 with complicated severe malnutrition were admitted to stabilisation centres.[29] These are precisely the children in whom a peripheral cannula fails: dehydrated,

cold, with poor peripheral perfusion. The Kenyan response to the FEAST trial (section 5) has rightly restricted fluid boluses; what the protocols still require is a working line for dextrose, antibiotics, anticonvulsants, blood and controlled maintenance fluids. A line that goes in first time, within a minute, is what IO offers.

## MOTHERS, MASS CASUALTIES AND UNIFORMS

Postpartum haemorrhage causes 37–40 % of Kenya's roughly 5,000–6,000 maternal deaths a year, and only 40 % of health facilities can transfuse.[30,31] A bleeding mother in a referral ambulance needs a route for uterotonics, tranexamic acid and fluids that survives the journey. Mass-casualty events recur: Westgate (2013, at least 71 dead and some 200 injured), Garissa University (2015, 148 dead), DusitD2 (2019, 21 dead) and the protest violence of 2024–25, in which the Kenya National Commission on Human Rights counted 115 deaths and more than 1,000 injured, most from gunshot or blunt trauma.[32] Police units in Mandera, Garissa and Lamu take repeated casualties from improvised explosive devices, usually inside armoured vehicles and hours from a level-5 hospital.[33] Those are the circumstances in which tactical medicine worldwide reaches for the humerus or the sternum rather than the forearm.

## CARDIAC ARREST: WE HAVE NO DATA

No Kenyan out-of-hospital cardiac arrest registry exists. The in-hospital picture is sobering: across six Kenyan hospitals, 353 arrests produced return of spontaneous circulation in 29 % and survival to discharge in 4.2 %.[34] Any prehospital arrest programme in Kenya will be built from scratch, and the route of drug delivery will be one of its design choices.

## THE SYSTEM IN 2026

| ELEMENT | STATUS |
|---|---|
| **Policy** | Kenya Emergency Medical Care Policy 2020–2030 and Strategy 2020–2025 in force; by August 2024, 23 of 47 counties were developing county EMC policies, 13 of them finalised and implementing.[35,36] |
| **Regulation** | By Ministry of Health directive, KMPDC has regulated ambulances and EMS personnel since 2025; counties contest the directive on devolution grounds.[17,37,38] No scope of practice for EMTs or paramedics has been published.[39] |
| **Access and payment** | SHA "922 Lifeline" (5 August 2026): toll-free national number, GPS dispatch, more than 600 linked ambulances and a KSh 8 billion emergency fund paying KSh 4,500 per evacuation within 25 km plus KSh 75 per further kilometre; first 24 hours of emergency care free.[19,40] |
| **Performance** | The Auditor-General's December 2025 audit of emergency care in 16 counties found response times of 20–60 minutes where recorded, no fully functional county dispatch centre and nine in ten audited level-4 hospitals without an ICU or HDU.[41] |
| **Fleet and crews** | Kenya Red Cross E-Plus: 128 ambulances, 302 paramedics, historically about nine BLS units per ALS unit; Rescue.co networks over 800 providers; county fleets are typically nurse-escorted.[42,43] Only 49 % of facilities have access to a functional ambulance.[31] |
| **Cadres** | EMT (certificate) and paramedic (diploma) programmes exist, but provider levels and training standards have never been nationally defined.[44,45] |

### WHAT THIS MEANS FOR INTRAOSSEOUS ACCESS

- **Intervals are long.** A line that takes under a minute and works first time matters more when the patient has already waited an hour.
- **Children and bleeding dominate.** The Kenyan case rests less on adult arrest, where the evidence is neutral, than on shocked children, haemorrhage and transfers, where the alternative is often no access at all.
- **Crews are BLS-heavy.** The device and the training must suit an EMT or a ward nurse, not only a paramedic with 500 insertions behind them.
- **Budgets are real.** At KSh 4,500 per SHA evacuation, a device that costs more than the journey will not reach the vehicle (section 6).

03 · WHAT INTRAOSSEOUS ACCESS IS

# A VEIN INSIDE THE BONE.

Beneath the hard cortex of a long bone lies a spongy medullary cavity whose venous sinusoids drain into the systemic circulation. Held open by bone, it stays patent in shock, hypothermia and cardiac arrest, when peripheral veins have collapsed. A needle in that cavity is, in practice, a large non-collapsible vein.

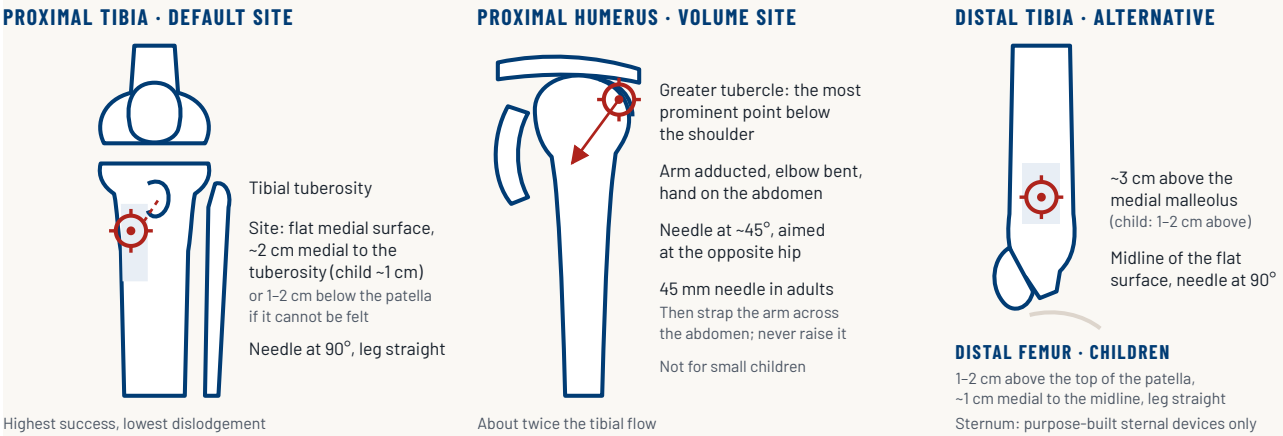


FIGURE 2 · INSERTION SITES AND LANDMARKS (SCHEMATIC; LANDMARKS PER ARROW EZ-IO INSTRUCTIONS FOR USE)[13]

## WHICH SITE, WHEN

| SITE | STRENGTHS | LIMITS | TYPICAL USE |
|---|---|---|---|
| **Proximal tibia** | Easiest landmarks, highest first-attempt success, lowest dislodgement; correct position confirmed on CT in 100 % of a trial subset[2,46] | Lowest flow of the three main sites (about 30 mL/min at 300 mmHg in cadaver studies); drugs reach the heart later than from the humerus[47,48] | Default site for cardiac arrest, children, novice operators, cramped scenes |
| **Proximal humerus** | About twice the tibial flow in cadaver studies; drug delivery times close to a peripheral vein[47,49] | Needs a 45 mm needle and a controlled arm; malposition in 29 % on CT and 20 % dislodgement with short needles in early trials[2,46] | Volume and blood resuscitation in adults; patients with lower-limb injury; tactical settings |
| **Sternum** | Highest and most consistent flow; fastest drug delivery; accessible under body armour[47,48] | Only with purpose-built sternal devices; interferes with chest compressions; retained-needle reports | Military and tactical care with a sternal device |
| **Distal tibia · distal femur** | Alternatives when the proximal tibia is fractured, infected or already used; distal femur well suited to infants | Little comparative data | Second choice in children and lower-limb trauma |

## WHAT GOES IN, AND HOW FAST

Every resuscitation drug, fluid and blood product given intravenously can be given intraosseously at the same dose; British field hospitals in Afghanistan gave more than 5,000 infusions through 1,014 IO devices without a major complication.[13,50] Drugs injected into the proximal humerus reach the heart in about the same time as from a peripheral vein; from the tibia the peak is later and lower but clinically effective.[48,49] Fluids do not run by gravity: infusion needs a 300 mmHg pressure bag or a syringe, and a 5–10 mL flush right after insertion is the most important step for flow.[13] A sample drawn before the flush is usable for point-of-care glucose, lactate and pH, not for potassium or a blood count.[51]

# FASTER AND MORE RELIABLE. NOT, ON ITS OWN, MORE SURVIVAL.

Until 2024 the IO debate ran on observational data that looked alarming: patients who received drugs through the bone in cardiac arrest did worse. Two large randomised trials have since answered the question for adult cardiac arrest, and the answer is reassuring in both directions. The rest of the evidence, in trauma, children, flow rates, complications and training, is less spectacular but more relevant to Kenya.

## 4.1 ADULT CARDIAC ARREST: THE TWO TRIALS THAT SETTLED THE QUESTION

| TRIAL | DESIGN | PRIMARY OUTCOME | OTHER FINDINGS |
|---|---|---|---|
| **PARAMEDIC-3**<br>UK, 11 ambulance services, 2021–24[1] | 6,082 adults in out-of-hospital arrest randomised to IO-first or IV-first drug route; stopped early at 41 % of planned size | 30-day survival 4.5 % IO vs 5.1 % IV, adjusted OR 0.94 (95 % CI 0.68–1.32): no difference | First successful access was by the assigned route in 94 % of the IO-first group but only 65 % of the IV-first group, a third of whom crossed over to IO; yet median call-to-adrenaline time was identical at 24 min; any ROSC 36 % vs 39 % (OR 0.86, 0.76–0.97); favourable neurological outcome 2.7 % vs 2.8 % |
| **IVIO**<br>Denmark, 2022–24[2] | 1,479 adults randomised to IO or IV; the IO arm further randomised to humerus or tibia | Sustained ROSC 30 % IO vs 29 % IV, RR 1.06 (0.90–1.24): no difference | Access within two attempts 92 % vs 80 %; time to access 14 vs 14 min; 30-day survival 12 % vs 10 %; humerus vs tibia: no outcome difference, but CT showed the humeral needle correctly placed in only 71 % against 100 % for the tibia |
| **ILCOR pooled analysis**<br>updated Jan 2026[4] | Meta-analysis of the two trials (about 7,540 patients) after the Taiwanese VICTOR trial was retracted for randomisation irregularities[52] | 30-day survival OR 0.97 (0.80–1.18); favourable neurological outcome OR 1.03 (0.81–1.31) | Sustained ROSC OR 0.89 (0.80–0.99), about 21 fewer per 1,000 with IO-first; moderate certainty |

Three conclusions follow. First, the earlier observational signal of harm, including an adjusted odds ratio of 0.24 for good neurological outcome in one registry,[53,54] is explained by confounding: the sickest patients got IO because their veins had already failed. Second, IO is not a shortcut to earlier drugs; in both trials the first drug arrived at the same minute whichever route was tried first, because access is only one of many things a crew does in the first fifteen minutes. The earlier three-trial meta-analysis that included the retracted VICTOR trial reached the same conclusion.[55] Third, the small ROSC disadvantage with IO-first is real enough that the guidelines keep a peripheral vein as the first attempt, in patients where a vein is realistically available.[5,6] The older single-centre trial that found 91 % first-attempt success at the tibia against 43 % for a peripheral line remains the clearest demonstration of what IO adds when the vein is not there.[46]

### KENYA LENS

These trials were run in systems where a paramedic reaches the patient in minutes and a vein is usually findable. Their result, "no difference", means that where a vein is *not* findable within two attempts, going to the bone costs the patient nothing in outcome and saves the crew minutes of failed attempts. For a Kenyan crew with one trained provider and a long drive ahead, that is the practical reading.

## 4.2 TRAUMA AND HAEMORRHAGE: WHERE SPEED IS THE OUTCOME

In the largest prospective study of vascular access in hypotensive trauma patients, run across 19 American trauma centres with video review of 1,410 attempts, IO succeeded on the first attempt in 93 %, a peripheral cannula in 67 % and a central line in 59 %; the median IO procedure took 36 seconds, and patients whose first access was IO began resuscitation about a minute earlier.[3] A 2023 meta-analysis of trauma studies put IO first-attempt success at 1.46 times that of IV and the procedure time 5.7 minutes shorter.[56] In adults with inaccessible peripheral veins in the emergency department, IO beat a central line on first attempt (85 % vs 60 %) and on time (2 vs 8 minutes).[57]

The military registries supply the safety data. British field hospitals in Afghanistan recorded 1,014 IO devices in 830 adults, through which 5,124 infusions of blood products and fluids and 32 different drugs were given, with no major and 1.4 % minor complications.[50] Israeli field data over 14 years show first-pass success of 67 % and cumulative success of 81 % at the point of injury, with each failed IV attempt beforehand reducing the odds of IO success.[58] Tranexamic acid given through the bone achieves the same total exposure as intravenously in animal models,[59,60] and whole blood runs through a single humeral IO at roughly 65–80 mL/min with a pressure bag, about double that through two sites and a third more with a push-pull syringe technique, without a measurable rise in free haemoglobin.[61,62] No study has shown that IO improves survival in trauma; registries consistently show that IO patients are the sickest. The claim the evidence supports is narrower and more useful: in a bleeding patient without a vein, IO is the fastest and most reliable way to deliver tranexamic acid, blood and drugs.

## 4.3 CHILDREN: THE STRONGEST CASE

The paediatric evidence is old, small and consistent. In sixty severely dehydrated infants and toddlers in India, IO access succeeded in 100 % within five minutes (mean 67 seconds) against 66 % for a peripheral line (mean 129 seconds).[63] A German nationwide surveillance study of 549 IO attempts in children found overall success of 98 %, first-attempt success of 82 % and placement within three minutes in two thirds; dislodgement occurred in 12 %, and insertions that took longer than two minutes carried 2.6 times the complication rate.[64] Infants under six months are the hardest group (71 % needle success), and neonates carry the highest potentially serious complication rate, 6 %.[65,66] Needle length matters more than weight: ultrasound of 237 children showed that the 15 mm needle marketed for 3–39 kg would be too short in 43 %, which is why the 5 mm visible-mark rule, not the weight band, decides the needle (section 7).[67] From Bamako, the only recent West African series, 22 children received IO through manual needles, 77 % after a failed peripheral cannula, with 86 % success and 9 % extravasation; cost and lack of training were named as the limits.[68]

### KENYA LENS

The Kenyan child who needs IO is the dehydrated, malnourished or septic child in whom the ward nurse has failed twice. The protocol already tells her to go to the bone and even permits a hypodermic needle if nothing else is available.[8] What the evidence adds is that success depends on a device that fits the child, a needle long enough and a provider who has practised the landmarks, and that the fluids given through the line must follow the post-FEAST protocol, not the enthusiasm of the moment.

## 4.4 FLOW AND PHARMACOKINETICS BY SITE

Cadaver studies under 300 mmHg pressure give flows of roughly 94 mL/min at the sternum, 57 at the proximal humerus and 31 at the proximal tibia, although a second cadaver study with first-time users found the humerus no faster than the tibia, a reminder that flow depends on where the needle actually sits.[47,69] Drugs injected at the sternum reach the central circulation in about 53 seconds and at the tibia in about 107 seconds, with a lower peak;[48] humeral delivery is close to intravenous.[49] Those differences matter for volume resuscitation and probably little for a cardiac-arrest drug. In the IVIO trial, humerus and tibia produced identical outcomes, and the tibia was placed correctly far more often.[2] The practical rule is therefore: tibia by default, humerus when you need flow and have a 45 mm needle and a controlled arm.



FIGURE 3

**PAEDIATRIC PROXIMAL TIBIAL ACCESS**

A 15 mm needle on the antero-medial tibia with a rolled towel under the knee and the leg held from the side. A 2–5 mL saline flush is watched for extravasation. Fluid volumes follow the Basic Paediatric Protocols, not the capacity of the line.

## 4.5 COMPLICATIONS

Pooled adult data put serious complications at 0.3 % of 2,332 insertions and all complications after successful insertion at 4.6 % of 6,525.[10,70] A Scandinavian user survey of 1,802 cases reported extravasation in 3.7 %, displacement in 8.5 %, slow flow despite a pressure bag in 8.8 %, a bent or broken needle in 4 %, compartment syndrome in 0.6 % and osteomyelitis in 0.4 %.[12] A Danish registry that followed 5,012 patients with prehospital IO for 180 days found osteomyelitis in fewer than 0.1 %, no osteonecrosis and no compartment syndrome.[11] Fat emboli to the lungs are demonstrable in animals after IO infusion but no clinical fat-embolism syndrome attributable to IO has been shown in human registries.[71]

| EVENT | RATE (ADULTS) |
|---|---|
| Any complication | 3–8 % |
| Extravasation | about 4 % |
| Dislodgement | about 8 % (12 % in children) |
| Compartment syndrome | 0–0.6 % |
| Osteomyelitis | <0.1–0.4 % |
| Fracture, needle break | rare; 4 % bent/broken needles |
| Serious events, all | ≤0.5 % |

TABLE 4.5 · POOLED COMPLICATION RATES[10,11,12,64]

Almost every serious complication in the literature traces to one of three errors: a needle too short or a site missed, so that fluid runs into soft tissue; a device left in beyond 24 hours; or an unmonitored limb. Extravasation into a child's calf with a pressure bag running is the mechanism of compartment syndrome and amputation. That is why the technique section insists on a visible 5 mm mark, a flush watched by eye, a secured limb and a documented removal time.

## 4.6 PAIN

Insertion with a powered driver is tolerable in conscious patients (visual analogue scores of 3–4 out of 10); it is the flush and infusion that hurt, at 5–8 out of 10 and worst at the tibia.[72] The manufacturer's regimen of 2 % preservative-free lidocaine, 40 mg over two minutes with a one-minute dwell, flush, then 20 mg, brings infusion pain down to around 2; the paediatric dose is 0.5 mg/kg to a maximum of 40 mg.[13,72] No placebo-controlled trial exists; the regimen rests on volunteer studies and consistent clinical experience. Without lidocaine, conscious patients and combat casualties describe infusion pain worse than their injuries, and some infusions have to be stopped.

## 4.7 BLOOD SAMPLES FROM THE NEEDLE

The first aspirate, before any flush, agrees well with arterial blood for pH, glucose and lactate; sodium reads a few mmol/L low, potassium 2–3 mmol/L too high, and haemoglobin, cell counts and coagulation are unreliable because of marrow contamination.[51] In animal haemorrhage models lactate and glucose drift as shock deepens, so treat an IO lactate as a screening value and confirm from a vein once one is available.[73] Warn the laboratory: marrow clogs analysers.

## 4.8 WHO CAN LEARN IT, AND HOW FAST

Success depends more on site, needle length and training than on cadre. Anaesthesia nurses matched anaesthesiologists in a randomised 12-month study, with the warning that a third of users showed unsafe handling of a spring-loaded device at follow-up while the powered device stayed safe.[74] In simulation with novices, powered and single-use push devices achieve 90–100 % success in 9–14 seconds, the spring-loaded bone injection gun about 90 %, and manual needles anywhere from 43 to 90 % depending on the study.[75,76,77] In the field, prehospital success was 87 % with a powered tibial device against 72 % with a sternal device,[78] and a randomised comparison of a manual needle, the bone injection gun and a sternal device found no significant difference in success.[79] A one-hour hands-on workshop within a four-hour course brought medical students to competence on an objective structured examination,[80] and 40 minutes of lecture plus 30 minutes of practice gave novices around 90 % simulated success.[77] No study defines a decay curve for IO specifically; the 12-month unsafe-handling finding and the general procedural literature argue for a hands-on refresher at least every six to twelve months.

## 4.9 WHAT IT COSTS

A French registry analysis of 5,350 cardiac arrests priced a powered IO needle set at €109 against €0.60 for an intravenous cannula and concluded that, with no survival benefit, routine IO-first in cardiac arrest is not economically defensible and selective use after failed IV is.[81] No cost-effectiveness analysis of IO exists for any low- or middle-income setting. The economics in Kenya are therefore an open question that this paper addresses from first principles in section 6: the per-access cost of a powered system is a large multiple of the SHA evacuation tariff, while manual and reusable-driver systems bring it within a few hundred shillings.

### THE EVIDENCE IN ONE PARAGRAPH

IO access works first time in nine of ten patients where veins fail, takes under a minute, delivers every drug, fluid and blood product at the intravenous dose, and causes a serious complication in fewer than one in two hundred insertions. It does not improve survival in adult cardiac arrest compared with a vein that can be found, and it should not be used as a reason to give fluids a protocol does not call for. Its value lies in the shocked child, the bleeding patient and the long transfer: exactly the patients Kenyan providers see most.

# TWO ATTEMPTS, THEN THE BONE.

Every major resuscitation and trauma body updated its guidance in 2025 or 2026 with the new trials in hand. The consensus is remarkably uniform for adults, more permissive for children, and explicit about tactical care. Kenya's only national protocol that mentions IO predates the trials but points the same way.

| GUIDELINE | YEAR | RECOMMENDATION ON IO (PARAPHRASED) | NOTES |
|---|---|---|---|
| AHA Adult ACLS, Part 9[5] | 2025 | Attempt IV first (Class 1, Level A). IO is reasonable if initial IV attempts are unsuccessful or not feasible (Class 2a, Level A). Endotracheal drug administration removed. | Both upgraded from 2020. Tibia vs humerus: knowledge gap. |
| AHA/AAP Pediatric ALS, Part 8[7] | 2025 | Rapid initiation of IV *or* IO access recommended (Class 1); choose the initial route by availability, expertise and timeliness (Class 1). IO described as rapid, safe and effective as an initial route. | No IV-first hierarchy in children. |
| AHA/AAP Neonatal, Part 5 · ILCOR NLS[82,83] | 2025 | Umbilical venous catheter preferred at birth; IO may be considered when umbilical access is not possible, and is reasonable once the umbilical vein is no longer patent. | RCUK/ERC: IO first line out of hospital without UVC skills; do not aspirate.[84] |
| ERC Adult ALS[6] | 2025 | Attempt IV rather than IO first; if IV cannot be rapidly achieved within two attempts, it is reasonable to consider IO. | Identical wording adopted by RCUK and ANZCOR.[85] |
| ERC/RCUK Paediatric LS[86] | 2025 | In the shocked child, spend no more than five minutes attempting IV access before inserting an IO; provide analgesia unless the child is comatose. | Point-of-care ultrasound for cannulation where competent. |
| ILCOR CoSTR ALS 2046[4] | 2024, updated 2026 | Suggest IV as the first attempt (weak recommendation, low certainty). Good-practice statement: if IV not achieved within two attempts, consider IO. | Pooled analysis revised after the VICTOR retraction; conclusions unchanged. |
| ATLS, 11th ed.[87] · PHTLS, 10th ed.[88] | 2025 · 2023 | IO is the standard alternative when peripheral access cannot be obtained quickly in the injured patient; access must not delay transport. ATLS 11 reorders the primary survey to xABCDE and favours whole blood and early tranexamic acid. | Physician (ATLS) and prehospital (PHTLS) trauma standards. |
| TCCC Guidelines (CoTCCC)[89] | 1 May 2026 | IV or IO access indicated in haemorrhagic shock, risk of shock or need for non-oral drugs; 18-gauge IV or saline lock preferred; IO if IV not quickly obtainable. TXA 2 g IV/IO; cold-stored whole blood first; calcium IV/IO. | Device and site training sits in the medic and paramedic curricula. |
| TECC (C-TECC)[90] | 2019 | In indirect-threat care, start an 18-gauge IV or obtain IO access if fluid resuscitation is needed. Paediatric appendix: consider IO as the primary route per agency protocol. | Civilian and law-enforcement adaptation of TCCC. |
| ENA / INS nursing position[91] | 2019/20 | Trained registered nurses may insert, maintain and remove IO devices; IO is the first alternative when peripheral access fails; dwell 24 h, 48 h only if no alternative. | Relevant to nurse-staffed Kenyan ambulances and wards. |
| WHO Pocket Book of Hospital Care for Children[92] | 2013 | Insert an IO line when IV access is not possible in the shocked child; a step-by-step IO procedure is given in the annex. | The basis of ETAT+ training in Kenya. |
| AFEM Emergency Care Curriculum[93] | 2017 | Lists "basic vascular access: IV, intraosseous" among keystone skills, separate from advanced access. | IO classed as a basic skill for African emergency care. |

## KENYA'S OWN PROTOCOL

The Ministry of Health's Basic Paediatric Protocols (5th edition, 2022), the document every Kenyan paediatric ward and emergency unit works from, list intraosseous needles as essential circulation equipment and state that when IV access fails the IO line is a rapid, safe and reliable route for blood sampling, drugs, fluids and blood. The protocol specifies the antero-medial surface of the tibia at the junction of the upper and middle thirds, a 15–18 G IO or bone-marrow needle, or a 16–21 G hypodermic needle if nothing else is available, confirmation by aspiration and a 3 mL saline flush watched for leakage or calf swelling, and replacement by an IV line within eight hours. Ringer's lactate in diarrhoeal shock is written as "IV/IO".[8] The protocol does not say who may perform the procedure, sets no time or attempt threshold before switching to IO, and has no prehospital section. Those three silences are the gaps this paper proposes to close (section 9).

### THE FEAST NUANCE: ACCESS IS NOT A LICENCE TO BOLUS

The FEAST trial, run in Kenya, Uganda and Tanzania, randomised 3,141 febrile children with impaired perfusion to a 20–40 mL/kg bolus of saline or albumin or to no bolus; 48-hour mortality was 10.5–10.6 % with a bolus and 7.3 % without.[9,4] Kenyan guidance has since restricted rapid boluses to children with all four signs of shock and diarrhoea with dehydration; the 2022 protocol writes "do not bolus" for impaired circulation without dehydration, gives malnourished children 20 mL/kg over two hours and transfuses rather than fills the severely anaemic child.[8] An IO needle changes none of that. It gives the nurse a route for dextrose, antibiotics, anticonvulsants, blood and protocol-rate fluids in a child whose veins have closed. Any IO training in Kenya must teach the fluid protocol alongside the drill.

### THE CONSENSUS IN THREE LINES

- **Adults:** a vein first, if one can be found within two attempts; then the bone, without further delay.
- **Children:** IO is a legitimate first choice when the child is shocked or arrested and a vein is not immediately available; never more than five minutes of cannulation attempts.
- **Trauma and tactical care:** IO whenever IV is not quickly obtainable; tranexamic acid, blood and calcium go through it at full dose.

# FIVE WAYS INTO THE BONE. ONE DECISION: COST PER ACCESS.

All current devices put a 15- to 18-gauge needle with a stylet through the cortex; they differ in what drives it, which sites they are licensed for, whether anything is reusable, and what each insertion costs. Those differences, not clinical performance, decide whether IO reaches a county ambulance or stays in a few well-funded units. This section is deliberately brand-neutral; prices are international web and list prices from October 2026, because no Kenyan retail price for any IO device is publicly listed.[95]

## THREE FAMILIES

### DRIVER AND NEEDLE

**Powered:** Arrow EZ-IO (Teleflex), a battery drill with single-use 15, 25 and 45 mm needles and the deepest evidence base; since 2024 also a disposable tray.[96] **Manual driver:** SAM IO, battery-free and reusable, same needle lengths; every insertion succeeded in a randomised bone-model study with EMS clinicians.[97]

### SINGLE-USE SPRING DEVICES

NIO (Adult, Pediatric, Infant) and the older Bone Injection Gun: one sealed unit per insertion, no battery. Excellent in manikins, mixed in patients: 69 % first-pass for the NIO against 94 % for the powered drill; 55 % for the Bone Injection Gun against 96 %.[76,98,99]

### MANUAL NEEDLES

Jamshidi and Cook Dieckmann needles, twisted in by hand: the cheapest option, MSF's standard paediatric item and the kind most African hospitals know.[100] As good as spring and sternal devices in one helicopter-service trial, but only 43–48 % success for novices in simulation.[75,79,101,102]

| DEVICE | MECHANISM · REUSE | SITES · SIZES | INDICATIVE INTERNATIONAL PRICE | SHELF LIFE | EVIDENCE IN ONE LINE |
|---|---|---|---|---|---|
| Arrow EZ-IO | Powered drill · driver reusable, needle single-use | Prox. humerus, prox./distal tibia, distal femur (children) · 15/25/45 mm, 15 G | Driver ≈ USD 665; needle set ≈ USD 110–180 (€182 ex VAT in Germany) | Driver 10 y | 96 % field success; 94 % first-pass; strongest clinical base[98,99] |
| SAM IO | Manual rotary driver · driver reusable, needle single-use | Same sites as above, no sternum · 15/25/45 mm | Driver ≈ USD 180; needle ≈ USD 89 | n/s | All insertions successful in a randomised bone-model study with EMS clinicians, 2.8 vs 1.1 s[97] |
| NIO Adult / Pediatric / Infant | Spring-loaded · fully single-use | Tibia; humerus (adult) · 15 G adult, 18 G child, stepped infant | ≈ USD 185–235 | 5 y | 100 % in manikins; 69 % first-pass in one ED series[76,98] |
| Bone Injection Gun | Spring-loaded · single-use | Tibia; humerus · adjustable depth | ≈ USD 180; long lead times | 5 y | 55 % in a HEMS series; predecessor of the NIO[99] |

| DEVICE | MECHANISM · REUSE | SITES · SIZES | INDICATIVE INTERNATIONAL PRICE | SHELF LIFE | EVIDENCE IN ONE LINE |
|---|---|---|---|---|---|
| **Jamshidi · Cook Dieckmann** | Manual twist · single-use | Tibia (any age); 14–18 G, 2.5–4 cm | ≈ USD 48–63 (Jamshidi); ≈ USD 115 (Cook) | n/s | Equal to spring and sternal devices in a HEMS trial (80–86 % overall); 43–48 % in novice simulation; bends in a third of attempts[79,101,102] |
| **FAST1 (sternal)** | Manual, depth-controlled · single-use | Manubrium only, ≥12 y | ≈ USD 415, restricted sales | 2 y | Highest flow; slowest insertion; needs its own training[69,79] |
| **18 G hypodermic or cannula needle** | Improvised · single-use | Proximal tibia, neonates and infants | < USD 1 | — | 74 % first attempt in infants, 17 % extravasation; last resort only[103,104] |

TABLE 6.1 · DEVICES AVAILABLE IN 2026. PRICES ARE DISTRIBUTOR WEB OR LIST PRICES IN THE US, UK, EU AND AUSTRALIA, OCTOBER 2026, BEFORE SHIPPING AND KENYAN COSTS.[95] NO CREDIBLE CE-MARKED LOW-COST ALTERNATIVE FROM CHINESE OR INDIAN MANUFACTURERS WAS IDENTIFIED.

## WHAT AN INSERTION COSTS IN KENYA

No Kenyan distributor publishes an IO price and no IO device appears on the KEMSA or MEDS lists, so every service will import, directly or through a local agent. Needles, cannulae and infusion sets (HS 9018.31–9018.90) are VAT-exempt under the July 2026 KRA schedules, and goods of EU origin enter at preferential duty under the EU–Kenya Economic Partnership Agreement with proof of origin; the Import Declaration Fee of 2.5 % and the Railway Development Levy of 2 % apply, plus pre-shipment verification and clearing.[105,106,107] The table models the resulting landed cost at a multiplier of 1.3 (direct import) to 2.0 (through a distributor) and a rate of KSh 130 to the dollar; it is an estimate to be replaced by quotations, not a price list.

| SYSTEM | CONSUMABLE PER INSERTION, LANDED (EST.) | CAPITAL PER UNIT | VERSUS THE SHA EVACUATION TARIFF (KSH 4,500) |
|---|---|---|---|
| **EZ-IO** | KSh 19,000–47,000 | Driver KSh 112,000–173,000 (≈500 uses) | 4–10 evacuations per needle |
| **SAM IO** | KSh 15,000–23,000 | Driver KSh 30,000–47,000 | 3–5 evacuations per needle |
| **NIO** | KSh 31,000–52,000 | none | 7–12 evacuations per device |
| **Jamshidi manual** | KSh 8,000–16,000 | none | 2–4 evacuations per needle |
| **Cook Dieckmann manual** | KSh 19,000–30,000 | none | 4–7 evacuations per needle |
| **FAST1 sternal** | KSh 70,000–108,000 | none | 16–24 evacuations per device |

TABLE 6.2 · MODELLED LANDED COST PER INSERTION, KENYA, OCTOBER 2026 (INTERNATIONAL PRICES × 1.3–2.0; KSH 130/USD). LIDOCAINE, FLUSH, PRESSURE BAG AND DRESSING ADD ROUGHLY KSH 500–1,500 PER USE.[40,95]



Two things follow. First, even the cheapest purpose-made needle costs more than the public tariff for the whole ambulance journey, which is why IO will be a budgeted rescue consumable and why the protocol trigger, two failed IV attempts, matters economically as well as clinically. A French registry that priced a powered needle at €109 against €0.60 for a cannula reached the same conclusion for cardiac arrest.[81] Second, the ratio between systems is as important as the absolute number: a manual needle at a quarter to a third of the price of a powered set, or a reusable manual driver with needles at half the price, is the difference between IO on one ALS unit per county and IO on every referral ambulance and casualty department.

### WHAT FITS KENYA: A TIERED MODEL

- **Wards, level-4 casualty departments and BLS ambulances with a trained nurse or EMT:** a manual IO needle with stylet (Jamshidi or Cook type) in 15/16 G and 18 G, trained to the standard in section 9. Cheapest, no battery, tibia only, and already what the paediatric protocol envisages, replacing the improvised hypodermic needle.[8]
- **ALS and referral ambulances, county emergency departments:** a reusable driver with 15/25/45 mm needles. The powered EZ-IO has the best evidence and should be the benchmark; the SAM IO manual driver gives the same sites and needle lengths without a battery and at roughly half the consumable price, with early but favourable comparative data.[97] A service can standardise on one driver and buy whichever compatible needles its agent can register.
- **Police tactical and KDF role-1 teams:** a battery-free option that tolerates heat, dust and a year in a bag: the SAM IO or a single-use NIO, trained for the humerus; a sternal device only if doctrine and training support it.
- **Training colleges:** training needle sets and reusable bone models rather than expiring clinical stock, so that no clinical needle is drilled into a manikin.

## ANCILLARIES ON THE SAME PURCHASE ORDER

Each needle needs a primed Luer-lock extension set (included with most needle kits), a 10 mL saline flush, a 500 mL pressure infusor bag, a stabiliser dressing or firm taping, a patient wristband or label stating "IO" and the insertion time, and 2 % lidocaine without preservative or adrenaline in single-dose ampoules; multidose vials usually contain a preservative and are not suitable, and neither the Kenyan nor the WHO essential medicines list specifies the preservative-free presentation, so the product information must be checked at purchase.[13,108] Every device sold in Kenya must be registered with the Pharmacy and Poisons Board through a licensed local representative; IO needles are Class IIa in Europe and would be Class B in Kenya, for which an expedited route exists when FDA and CE evidence are in hand.[109]

# LAND IT, FLUSH IT, SECURE IT, WRITE IT DOWN.

The procedure takes under a minute and the complications come from skipping its boring parts. What follows is a device-neutral description that matches the manufacturers' instructions for use and the Kenyan paediatric protocol; where your device's instructions differ, the instructions win.[8,13]

## WHEN TO REACH FOR IT

- Cardiac arrest, adult or child, when IV is not secured within two attempts or is obviously unobtainable.
- Shock of any cause, haemorrhage, severe dehydration, sepsis or burns, when a peripheral line fails or will clearly take longer than a minute or two.
- A child in whom IV attempts have run for five minutes, or two attempts, whichever comes first.
- Status epilepticus, hypoglycaemia, anaphylaxis or any time-critical drug without a vein.
- Tactical and mass-casualty settings in which IV is impractical: body armour, vehicles, darkness, one provider for several casualties.
- Neonates outside hospital when the crew cannot place an umbilical line.

## WHEN NOT TO

- Fracture of the target bone, or a fracture above it that would let fluid escape.
- Infection, burn or cellulitis over the site.
- An IO attempt in the same bone within the last 48 hours (the old hole leaks).
- Orthopaedic hardware, a prosthetic joint or a previous major procedure at the site.
- Landmarks that cannot be found, or soft tissue too deep for the needles you carry.
- Bone disease such as osteogenesis imperfecta or osteopetrosis (relative).
- Never in the sternum with a limb device; only with a purpose-built sternal device.

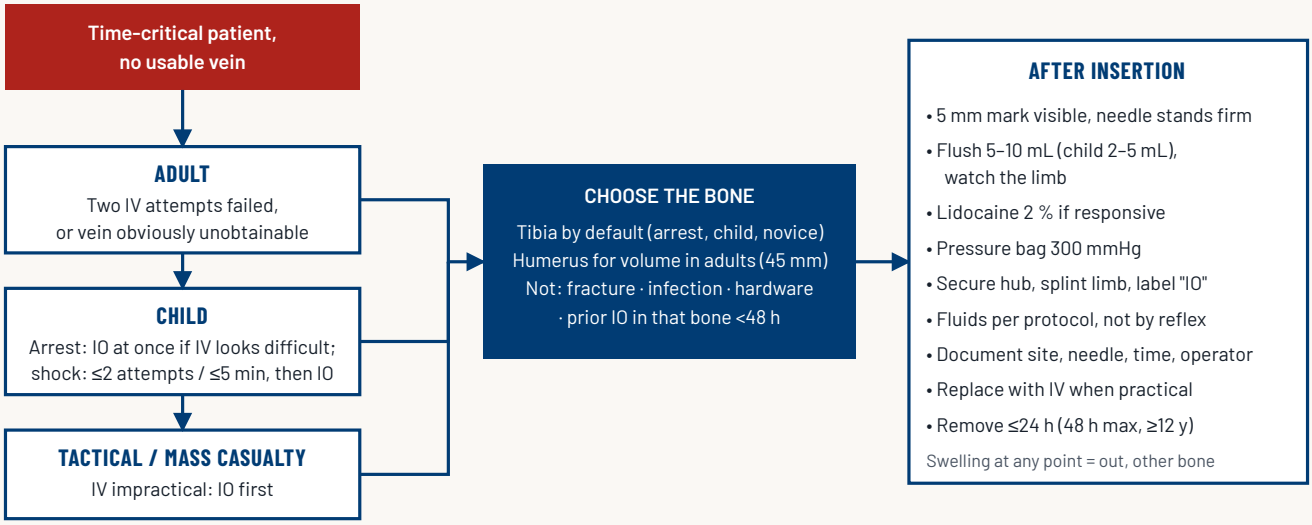


FIGURE 4 · WHEN TO GO TO THE BONE, AND WHAT MUST FOLLOW (DERIVED FROM AHA/ERC 2025, TCCC 2026, MANUFACTURERS' INSTRUCTIONS)[5,13,86,89]

## EIGHT STEPS

### 1 DECIDE AND CHOOSE THE SITE

Say it out loud: "IV failed, going IO." Proximal tibia by default. Proximal humerus in adults who need volume and have an uninjured, controllable arm. Check the exclusions above on the chosen limb.

### 2 POSITION AND EXPOSE

Leg straight, knee supported from the side or on a rolled towel; for the humerus, arm adducted, elbow bent, hand on the abdomen so the greater tubercle faces up. Cut clothing, clean the skin, gloves on. Your supporting hand holds the limb from the side, never behind the insertion point.

### 3 PICK THE NEEDLE BY DEPTH, NOT WEIGHT

Push the needle through the skin until the tip rests on bone. At least one 5 mm black mark must still be visible above the skin; if not, the needle is too short. Weight bands (15 mm: 3–39 kg; 25 mm: from 3 kg; 45 mm: from 40 kg) are a starting point only; the humerus almost always needs 45 mm in adults.[13,67]

### 4 INSERT

Tibia and femur at 90° to the bone; humerus at about 45°, aimed at the opposite hip. Powered: drill with gentle pressure and release the trigger the moment you feel the "give" into the marrow. Manual: steady twisting pressure, stop at the give. Spring-loaded: fire, then withdraw the trocar. The needle should stand unsupported.

### 5 CONFIRM, ASPIRATE, FLUSH

Remove the stylet, attach a primed extension set. Aspirate marrow if you can (optional, and a dry tap does not mean failure; a sample now is usable for glucose and lactate). Flush 5–10 mL saline in adults, 2–5 mL in children, with your eyes on the calf or upper arm. Swelling means extravasation: stop, remove, choose another bone.

### 6 TREAT THE PAIN IN THE CONSCIOUS PATIENT

Before the flush: 2 % preservative-free lidocaine, 40 mg in adults or 0.5 mg/kg (maximum 40 mg) in children, through the hub over two minutes, wait one minute, then flush and give half the dose again if infusion still hurts. Systemic analgesia if that fails.[13]

### 7 RUN IT UNDER PRESSURE, SECURE IT

Fluids need a 300 mmHg pressure bag or syringe push; gravity gives a few millilitres a minute. Apply the stabiliser dressing or tape the hub firmly, splint the limb, and strap a humeral arm across the abdomen; it must not be abducted beyond 90°, and raising it dislodges the needle. Label the line "IO" with the time.

### 8 DOCUMENT, HAND OVER, REMOVE IN TIME

Record site, needle length, time, number of attempts, flush, lidocaine and who inserted it. Tell the receiving team the line is IO and when it went in. Replace with IV as soon as practical; remove within 24 hours (48 hours only in patients aged 12 years and older with no alternative).[110] To remove: syringe on the hub, rotate clockwise, pull straight out, sharps bin, dress the site.

## CHILDREN AND INFANTS

The proximal tibia is the site of choice at every age; the distal femur is a good second site in infants, whose tibial surface is small. Landmarks are 1 cm medial to the tuberosity, or 1–2 cm below the patella and 1 cm medial when the tuberosity cannot be felt. Hold the leg from the side with a towel roll under the knee, never with your hand behind it. Insert gently: a powered driver can go straight through a small bone if the trigger is held after the give. Flush 2–5 mL and watch the calf; children extravasate more often than adults, and a pressure bag on a misplaced paediatric needle is the classic route to compartment syndrome.[64,65] In neonates, do not aspirate, use the smallest needle the device offers and expect a higher failure and complication rate.[66,84]




FIGURE 5

**PROXIMAL HUMERAL ACCESS DURING TRANSPORT**

Elbow flexed, hand resting on the abdomen so that the greater tubercle faces upward. A 45 mm needle is inserted at about 45° towards the opposite hip, then the arm is secured across the abdomen. The humerus gives roughly twice the tibial flow.

## FLUIDS AND DRUGS THROUGH THE LINE

Dose every drug as you would intravenously, follow each with a 5–10 mL flush (2–5 mL in children), and expect adrenaline from a tibial needle to peak a little later than from a vein. Tranexamic acid, antibiotics, dextrose, anticonvulsants, uterotonics, blood and blood products are all appropriate; hypertonic and very viscous solutions run slowly and need pressure. Blood through a humeral needle under a pressure bag runs at 65–80 mL/min; a second site roughly doubles that, and push-pull with a 60 mL syringe adds about a third.[61,62] In children, the volume and rate are set by the Basic Paediatric Protocols, not by the capacity of the line.[8]

## THE IMPROVISED NEEDLE

Kenya's paediatric protocol permits a 16–21 G hypodermic needle when no IO needle is available.[8] That is a statement about scarcity, not a recommendation. A hypodermic needle has no stylet, clogs with cortical bone, bends, cannot be secured and extravasates easily; it belongs to the last resort in a ward with nothing else, not to an ambulance kit. A manual IO needle with a stylet costs a small fraction of a powered set and removes every one of those problems (section 6).

## COMMON FAILURES AND THEIR FIXES

| PROBLEM | USUAL CAUSE AND FIX |
|---|---|
| No flow, needle firm | Marrow in the needle: flush harder with a 10 mL syringe, then pressure bag |
| Swelling around site | Through-and-through or too short: remove, other bone, never the same bone |
| Needle wobbles | Not in cortex or dislodged: remove; secure the next one and splint |
| Pain on infusion | No or too little lidocaine: repeat half dose through the hub; slow the rate |
| Humeral line stops | Arm raised or abducted: bring it back across the abdomen, re-secure |
| Needle breaks on removal | Rocked or bent: always syringe on hub, rotate, pull straight |

# UNDER BODY ARMOUR, INSIDE A VEHICLE, IN THE DARK.

Tactical medicine has used intraosseous access longer and more routinely than civilian EMS. The reasons are practical: a casualty in a plate carrier has no accessible forearm, a medic working by red light cannot see a vein, a vehicle hit by an IED produces four casualties for one provider, and the nearest surgeon may be hours away. Kenya's security forces face all four.



FIGURE 6

**TACTICAL TRAINING: HUMERAL ACCESS WITH BODY ARMOUR IN PLACE**

The proximal humerus stays accessible below the shoulder strap of a plate carrier, so armour need not be removed. Intraosseous access belongs to the medic and paramedic tier of TCCC and TECC training, rehearsed with the multi-casualty drill.

## WHAT TCCC AND TECC SAY

The Committee on Tactical Combat Casualty Care's 2026 guidelines place vascular access in the Tactical Field Care phase, after haemorrhage control and airway: IV or IO access is indicated for haemorrhagic shock, significant risk of shock, or any need for non-oral drugs; an 18-gauge cannula or saline lock is preferred, and if IV access is not quickly obtainable the medic goes to IO.[89] Tranexamic acid, 2 g by slow IV or IO push as soon as possible and within three hours, cold-stored low-titre O whole blood as the first resuscitation fluid, calcium after the first unit, and warmed fluids are all written for either route. Site and device training belongs to the Combat Medic and Paramedic curricula that accompany the guideline.[89] The civilian and law-enforcement adaptation, TECC, carries the same logic into indirect-threat care and, in its paediatric appendix, suggests IO as the primary route in children.[90] Nothing in either guideline puts a needle into a casualty during care under fire: there, the tourniquet is the only intervention.

## WHY THE HUMERUS AND THE STERNUM

Body armour, webbing and gloves cover the forearm; the proximal humerus sits just below the shoulder strap and the sternum lies under the front plate, which lifts away. Both sites give the highest flow rates for blood and the fastest drug delivery, which is why they lead the military literature.[47,48] The sternal device needs its own training and cannot be used with chest compressions; the humeral site needs a 45 mm needle and an arm that is then strapped down. The tibia stays the fallback in a vehicle where only the legs are reachable. Israeli field data from 172 patients show the reality of point-of-injury access: first-pass success 67 %, cumulative 81 %, and every failed IV attempt beforehand lowered the odds of IO success.[58] The British Afghanistan series, with 1,014 devices and over 5,000 blood and fluid infusions without a major complication, shows the safety ceiling in trained hands.[50]

## THE KENYAN PICTURE

The Kenya Defence Forces have run Tactical Combat Casualty Care courses with partner nations since at least 2016, including a month-long course for 100 KDF and Somali personnel at Dhobley in 2023 and further training at Manda Bay in 2024, and the Army commissioned an advanced life support ambulance fleet in November 2025.[111,112] Published accounts of the 2024 training list tourniquets, wound packing, needle decompression and airway adjuncts; IO access is not mentioned, which suggests it has not yet been trained at scale.[112] Some 1,410 Kenyan troops serve in the African

Union mission in Somalia, where IED and gunshot casualties are evacuated to the Defence Forces Memorial Hospital in Nairobi. The National Police Service's Border Patrol Unit, General Service Unit, Rapid Deployment Unit and Special Operations Group take repeated IED casualties in Mandera, Garissa and Lamu: seven officers injured in one strike in July 2025, eight in an armoured vehicle in August 2025, further casualties in February and August 2026.[33] Kenyan police in Haiti depended on a single Level-2 facility and cross-border airlift for their wounded.[113] In every one of those scenarios the casualty is in armour, in or near a vehicle, with one medic and a long evacuation, and the drugs that matter, tranexamic acid, blood, antibiotics and analgesia, need a line.

| SCENARIO | WHY IV FAILS | IO ANSWER |
|---|---|---|
| **IED strike on a patrol vehicle, three to eight casualties** | Casualties pinned, armour on, limbs crushed, one medic | Humeral or sternal IO in the two most critical, 45 seconds each; tranexamic acid and blood started before extraction |
| **Gunshot casualty, night operation, no light discipline for IV** | Veins invisible, hands cold, gloves | Landmarks are palpable; a powered or manual IO needs no vision of a vein |
| **Officer in haemorrhagic shock, four-hour road evacuation** | Collapsed veins, repeated failed cannulation delays departure | IO in under a minute, pressure-bag fluids and drugs en route, replaced at the receiving hospital |
| **Mass-casualty terror attack, civilians and officers** | Dozens of casualties for a handful of ALS providers | IO lets a single provider secure access on several patients while others control bleeding |
| **Protest injury, gunshot, crowd scene** | Scene time must be seconds; IV in a moving stretcher fails | Tibial IO on the stretcher, drugs on the move |

### WHAT A TACTICAL IO PROGRAMME NEEDS

- **Doctrine first.** IO sits in the TCCC Combat Medic/Paramedic tier, not in Combat Lifesaver or All-Service-Member training; the Kenyan equivalent is the unit medic and the police medical officer, not every officer.
- **A device that survives the kit.** Heat, dust and months in a bag punish batteries and packaging; single-use spring or push devices and manual needles have no battery; powered drivers need a charging and inspection routine.
- **Sites trained for armour.** Humerus and, where a sternal device is procured, the sternum; the tibia as fallback.
- **Drugs to match.** Tranexamic acid, calcium, antibiotics and ketamine analgesia are the point of the line; whole blood is the aspiration.
- **Handover discipline.** Every IO must be labelled and reported at the Role-2 or hospital handover with its insertion time, and removed within 24 hours.

# FROM A BOX IN THE PROTOCOL TO A KIT ON THE VEHICLE.

Kenya does not need to invent anything: the evidence, the guidance, the paediatric protocol and the devices exist. What is missing is a scope of practice that names the skill, an equipment standard that lists the device, a training standard and a governance loop. This section proposes each.

## 9.1 REGULATION: FOUR SENTENCES THAT WOULD CLOSE THE GAP

| INSTRUMENT | CURRENT POSITION | PROPOSED WORDING |
|---|---|---|
| **KMPDC EMS scope of practice (in preparation)** | No published scope; the application form recognises Ambulance Operator, EMT and Paramedic without listing procedures.[39] | "Intraosseous vascular access (proximal tibia, distal tibia, distal femur in children; proximal humerus for paramedics) is within the scope of practice of paramedics and of EMTs and registered nurses who have completed an accredited IO competency module, under the clinical protocols of their licensed service." |
| **KMPDC ambulance inspection checklist** | Requires IV catheters and infusion sets for BLS and ACLS ambulances; lists no IO device.[18] | Add to section E for ACLS ambulances: "Intraosseous access device with adult and paediatric needles, extension set, stabiliser and pressure infusor." Optional for BLS ambulances with a trained provider. |
| **KEBS KS 2429:2019 ground-ambulance standard** | Equipment schedules by ambulance category; IO device not confirmed in the current text.[114] | At revision, include an IO device in the advanced life support equipment schedule. |
| **MoH Basic Paediatric Protocols** | Describes IO when IV fails; silent on who may perform it, when to switch and prehospital use.[8] | Add: "Any clinician trained in the procedure may insert an IO line. In a child with shock, do not spend more than five minutes or two attempts on peripheral IV access before IO. In ambulances, IO is the first alternative to IV." List IO needles on the Kenya Essential Medical Supplies List. |

None of these requires legislation: KMPDC, the National EMC Steering Committee and the Ministry's child health division can act within existing mandates, whatever the outcome of the county dispute over inspections.[38]

## 9.2 PROCUREMENT: WHAT TO BUY, PER UNIT

| UNIT | KIT | INDICATIVE LANDED COST (EST.) |
|---|---|---|
| **Paediatric ward or level-4 casualty department** | 4 manual IO needles (2 × 15/16 G, 2 × 18 G), pressure bag, lidocaine 2 % PF ampoules, flushes, dressing | KSh 40,000–90,000 |
| **BLS ambulance with trained nurse or EMT** | 2 manual IO needles (adult and child), pressure bag, ancillaries | KSh 20,000–45,000 |
| **ALS or referral ambulance** | Reusable driver (powered or manual) with 1 × 15 mm, 2 × 25 mm, 1 × 45 mm needles, 2 stabilisers, pressure bag, ancillaries | KSh 120,000–300,000 initial; KSh 15,000–47,000 per use thereafter |
| **Police tactical or KDF role-1 team** | Battery-free driver or 2 single-use devices, 45 mm needles, tranexamic acid, pressure bag | KSh 60,000–150,000 |
| **Training college, per skills station** | Training driver, training needle sets, reusable bone model or manikin leg, paediatric model | KSh 150,000–400,000 once |

TABLE 9.2 · INDICATIVE KITS AND COSTS, FROM THE MODEL IN SECTION 6; TO BE REPLACED BY SUPPLIER QUOTATIONS AFTER PPB REGISTRATION IS CONFIRMED.[95,109]

Three procurement rules. **Register before you buy:** check the Pharmacy and Poisons Board register for the device and its local representative; if none is listed, the importer completes Class B registration first.[109] **Buy the system, not the needle:** one driver per county pools needle stock, training models and refreshers. **Budget replacement, not stock:** a needle used is a needle gone.

## 9.3 A TRAINING STANDARD

Sahara EMS College proposes this competency module as the minimum for any provider inserting IO lines in Kenya, based on the training studies in section 4.8.

| | |
|---|---|
| Duration | 4 hours, of which 2.5 hands-on |
| Entry | EMT, AEMT, paramedic, nurse, clinical officer, medical officer |
| Theory (60 min) | Physiology, indications and triggers, contraindications, sites and landmarks, needle selection, complications, pain, fluids per protocol, documentation |
| Skills (150 min) | Proximal tibia adult and child, distal femur child, proximal humerus adult; every device the service stocks; flush and extravasation drill; lidocaine; securing; removal |
| Assessment | 30 min: structured checklist on a bone model: landmark, needle choice, insertion, confirmation, flush, secure, document; pass requires every critical step |
| Refresher | Hands-on every 6–12 months; every insertion in the field logged and reviewed |

Two design choices matter. Paediatric landmarks and the flush-and-watch drill are taught to everyone, because the shocked child is the Kenyan IO patient. And the module is device-specific: the ward nurse practises the manual twist, the paramedic the 5 mm mark and the humerus. A single short session produces competence; whether it lasts without practice is unproven, so the refresher and field log are part of the standard.[74,77,80]

The module is part of Sahara's AEMT programme and runs as a stand-alone half day for ambulance services, hospitals, police and military medical units, with a tactical variant.

## 9.4 CLINICAL GOVERNANCE: THE LOOP THAT MAKES IT SAFE

Every insertion generates a one-line record on the patient care or handover form: indication and failed IV attempts; site, device and needle length; time and operator; flush and extravasation check; lidocaine; what was infused; removal or handover time. A quarterly one-page audit reports first-attempt success, decision-to-flush time, extravasation, dislodgement and dwell over 24 hours; every compartment syndrome, infection or fracture is reviewed case by case. Suggested first-year targets: first-attempt success at least 85 %, decision-to-flush under two minutes, extravasation under 5 %, all lines documented and removed within 24 hours.[11,64] As no Kenyan IO data exist, Sahara EMS College will collate and publish anonymised audit data from partner services.

## 9.5 A TWELVE-MONTH ROADMAP FOR A COUNTY OR AN AMBULANCE OPERATOR

**1 MONTHS 1–2 · DECIDE AND WRITE**
Adopt the trigger ("two failed IV attempts, five minutes in a child") in the clinical protocol; choose the tier model and the device family; add IO to the handover form and equipment checklist.

**2 MONTHS 2–4 · REGISTER AND PROCURE**
Confirm PPB registration and a local representative; obtain quotations and a KRA tariff ruling for the driver; order kits and training sets; secure preservative-free lidocaine.

**3 MONTHS 3–6 · TRAIN**
Run the 4-hour module for every ALS crew and casualty-department nurse first, then BLS crews with a nurse or EMT; certify by assessment; appoint a lead per station.

**4 MONTHS 6–12 · USE, AUDIT, REFRESH**
Go live with the record and the quarterly audit; review every complication; hold a refresher at month 12; report to the county health committee and to KMPDC.

# WHAT WE ASK OF WHOM.

Nothing here requires new evidence, new law or a large budget: only that providers, operators, counties, the regulator and the uniformed services each take the step that is theirs.

## PROVIDERS: EMTS, PARAMEDICS, NURSES, CLINICAL OFFICERS

01 Treat two failed IV attempts in a time-critical adult, or two attempts or five minutes in a child, as the trigger to go to the bone.

02 Learn the proximal tibia until it is boring; add the humerus once the tibia is reliable.

03 Pick the needle by the visible 5 mm mark, flush with your eyes on the limb, give lidocaine to the conscious patient, secure the limb, label the line.

04 Give children the fluids the protocol prescribes, through whatever line you have, and nothing more.

05 Document every insertion and every complication; the national picture will be built from your charts.

## AMBULANCE OPERATORS AND HOSPITALS

01 Put IO on every ALS and referral ambulance now, and on BLS units as soon as a nurse or EMT trained to the section 9 standard is on the crew.

02 Choose the system by total cost per access and robustness in your fleet; a reusable driver or a manual system brings IO within reach of the SHA tariff.

03 Write IO into your clinical protocols, your handover form and your equipment checklist, with a 24-hour removal rule and a complication log.

04 Audit quarterly: indications, first-attempt success, time to access, extravasation, dwell time.

## COUNTY GOVERNMENTS AND THE REGULATOR

01 **KMPDC:** name IO in the forthcoming EMS scope of practice for paramedics, EMTs and ambulance nurses, with a training and refresher standard, and add an IO device to the ACLS-ambulance checklist.

02 **KEBS:** include an IO device in the ALS equipment list of KS 2429 at its next revision.

03 **Ministry of Health:** add a prehospital section and a who-may-perform statement to the IO box of the Basic Paediatric Protocols; list IO needles on the Essential Medical Supplies List.

04 **Counties:** fund one IO kit per level-4 casualty department and county ambulance as part of 922 Lifeline readiness.

05 **SHA:** recognise IO access within the emergency tariff so that operators are not penalised for using it.

## NATIONAL POLICE SERVICE AND KENYA DEFENCE FORCES

01 Add IO to the medic and paramedic tier of TCCC/TECC training, with the humerus (and the sternum, where a sternal device is procured) as primary sites.

02 Equip Border Patrol, GSU, RDU and SOG medical elements and KDF role-1 teams with a battery-free IO option and tranexamic acid; rehearse the IED multi-casualty drill with it.

03 Report IO use and outcomes through police and defence medical services, so that Kenya produces its first tactical IO data.

### OUR COMMITMENT

Sahara EMS College will teach intraosseous access to the standard set out in section 9 in its AEMT programme and its own clinical, trauma and tactical courses, and will reinforce it wherever vascular access is practised in the AHA ACLS and AHA PALS courses it delivers as an AHA Training Site, will keep this paper under annual review as the evidence and the Kenyan regulatory landscape change, and will share its training and audit data with any Kenyan service that wants to build on it. Write to us.

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ABOUT SAHARA EMS COLLEGE

# WHERE KENYA'S EMERGENCY CARE PROFESSIONALS TRAIN.

Sahara EMS College has trained emergency medical technicians, nurses, doctors and workplace first-aiders since 2020, at campuses in Nakuru and Kisumu and in the field. More than 500 participants a year complete our courses, from the Advanced EMT programme that is our core, through AHA BLS, AHA ACLS and AHA PALS as an official American Heart Association Training Site, to trauma, airway and critical-care courses for clinicians. We train with medical simulation, audio-video debriefing and the equipment our graduates will meet on the road, and we write papers like this one because a young profession deserves its own evidence base.

**Clinical Governance.** This whitepaper was prepared by the Clinical Governance team of Sahara EMS College. Version 1.0, November 2026. It will be reviewed annually or when the guidelines it rests on change.

This document is educational. It summarises published evidence, international guidelines and Kenyan protocols as of October 2026 and does not replace device instructions for use, local medical direction or the scope of practice of the reader's licensing body. Intraosseous access should be performed only by providers trained and authorised to do so. Sahara EMS College accepts no liability for clinical decisions made on the basis of this document. Product names are used for identification only; Sahara EMS College has no commercial relationship with any device manufacturer named.


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