Supplementary data 1:**Primary studies** summary of findings table: Pain management therapies by prehospital emergency care providers: a scoping review.

Author date	Type of study	Country	Main study Therapy (additional therapies)	EMS context	Pain typology	Population and context	Aim	Main finding
NON-PHARMACOLOGICAL STUDIES								
Kober (2002)	RCT	Austria	Acupressure	Primary response - Road;	Acute trauma pain	Adults (>18)	Determine whether prehospital acupressure is effective in managing pain from minor trauma.	Acupressure resulted in significant pain reduction (VAS falling from 61.8 ± 11.8 to 34.0 ± 16.9) when compared to no acupressure or sham acupressure.
Kober (2003)	RCT	Austria	Warming	Primary response - Road;	Acute non-trauma pain	Adults (>18)	Determine whether prehospital application of warming reduces pain from cholelithiasis.	Patients who received warming showed significant reduction in pain scores on a visual analog scale (VAS), from 86.8 ± 5.5mmto 41.2±16.2 mm. compared to a group who received no warming.
Bertalanffy (2005)	RCT	Austria	Transcutaneous Electrical Nerve Stimulation (TENS)	Primary response - Road;	Back pain	Adults (>18)	Evaluate efficacy of paramedic administered TENS in acute lower back pain patients during emergency transport.	TENS reduced pain, as measured by VAS, 79 ± 6.5 mm to 48.9 ± 8.2mm Pain remained unchanged in the group which did not receive TENS (75.9 ± 16.4 and 77.1 ± 11.2)
Barker (2006)	RCT	Austria	Auricular acupressure	Primary response - Road;	Acute trauma pain	Adults (>18)	Determine if prehospital auricular acupressure reduces pain from hip fracture	Participants in the intervention group showed significantly reduced pain (VAS 65mm to approx. 39mm) at hospital arrival compared to the sham intervention group which showed no change at hospital arrival (VAS 65mm and approx. 66mm)
Barker (2006)	RCT	Hungary	Transcutaneous Electrical Nerve Stimulation (TENS)	Primary response - Road;	Acute non-trauma pain	Adults (>18)	Determine the effectiveness and ease of use of TENS in acute pelvic pain.	Patients in the intervention group showed a pain reduction from VAS72.2±10,5mm to VAS32.4 ±18.0 mm. The sham intervention group showed show3ed no change in pain score by the end of transport (VAS69.8±13.2 mm to 66.6±11.2mm)
Mora (2006)	RCT	Central Europe	Transcutaneous Electrical Nerve Stimulation (TENS)	Primary response - Road;	Acute non-trauma pain	Not reported	Determine whether prehospital TENS decreases pain in patients with urolithiasis.	Patients in the intervention group (TENS) showed significant pain reduction, from VAS85.7±10.5 to 33.3 ±16mm. Patients in the sham TESN group did not show a mean decrease in pain score (VAS85.8 ±18.0 to 82.6±14.3mm)
Lang (2007)	RCT	Austria	Transcutaneous Electrical Nerve Stimulation (TENS)	Primary response - Road;	Acute trauma pain	Adults (>18)	Determine the effectiveness of prehospital TENS for pain management in traumatic hip fracture.	The treatment group showed lower pain scores during transport (VAS 89 ±9 to 59 ± 6mm) compared to the sham TENS group, which showed smaller reductions (VAS 86 ±12 to 79 ± 11mm)
Lang (2007)	RCT	Central Europe	Acupressure	Primary response - Road;	Acute trauma pain	Adults (>18)	Determine the effectiveness of prehospital acupressure for pain relief in radius fractures. .	The intervention group showed greater reduction in pain scores at hospital arrival (VAS 47.6 ± 8.9mm reduced to 36.6 ±11) compared to the sham intervention group (VAS 51.2 ±8.7 elevated to 56.0 ± 13.3)

Irajpour (2012)	Quasi experimental	Iran	• Traction splint/simple splint • (Morphine IV)	Primary response - Road;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Compare the effectiveness of traction splints and simple splints on fractures.	Pain decreased in both groups, though traction splinting showed a greater decrease. Pain in the traction splint group reduced from NRS 6.4 (1.2) to 4.0 (1.0) at 12 hours. Pain in the simple splinting group reduced from 6.7 (1.4) immediately after splinting to 5.1 (1.2) at 12 hours. * [NRS(SD)]
PHARMACOLOGICAL THERAPIES								
First author name	Type of study	Country	• Main study Therapy (additional therapies)	EMS context	Pain typology	Population and context	Aim	Main finding
Baskett (1972)	Cohort	UK	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain Obstetric pain	Adults (>18) Paediatrics (<18)	Evaluate the effectiveness and safety of prehospital Entonox.	Marked pain relief was reported by 64% of patients, with 33% experiencing partial relief and 3.5% no relief. No serious adverse effects occurred. Minor effects included drowsiness (15%) and infrequent nausea (1%). Mask odour was poorly accepted by some patients. Most patients (96%) handled the apparatus successfully.
Wright (1972)	Cross sectional analytic	UK	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Trial the use of nitrous oxide in an ambulance service.	Entonox produced worthwhile analgesia in most cases, rated good or moderate in 89.4% by ambulance personnel and 65.9% by patients. Good relief was reported in 70.2% (staff) versus 32.4% (patients). Transient reduced consciousness occurred in 39.4%, resolving rapidly; other adverse effects were infrequent.
Wigley (1974)	Cross sectional descriptive	UK	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Describe the use of nitrous oxide in prehospital practice.	Pain improved in most patients receiving Entonox. Complete relief occurred in 17/113 cases, good relief in 54/113, fair relief in 30/113, and poor relief in 12/113. Adverse effects were infrequent, with nausea in 6/113 and vomiting in 4/113. Acceptability and feasibility findings were not reported.
Thal (1979)	Retrospective cohort	Canada	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain;	Adults (>18) Paediatrics (<18)	• Evaluate the use of nitrous oxide as a prehospital analgesic.	Pain decreased in most patients receiving self-administered Entonox. Partial or complete relief was reported in 93.6% of cases and in 97.1% of trauma patients. Drowsiness occurred in 17%, with no unconsciousness reported. The device was easy to use and transport, with normal blood gas values observed.

Amey (1981)	Cross sectional descriptive	USA	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	Evaluate Entonox as a paramedic supervised prehospital analgesic	Patients receiving nitrous oxide showed meaningful pain reduction, with 75% (54/72) reporting moderate-to-complete relief and EMTs estimating benefit in 78% (53/69). Side effects occurred in 48%, mainly light headedness and drowsiness, leading to discontinuation in 32%. No serious adverse events were reported, though acceptability and feasibility outcomes were not described.
Mckinnon (1981)	Cross sectional analytic	Canada	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18)	Pilot study describing the use of nitrous oxide for prehospital pain management.	Substantial pain reduction was reported by patients receiving nitrous oxide, with worthwhile relief reported in 96% by paramedics and 93% by patients. Marked improvement occurred in 50% and 45%, respectively. Adverse effects were mostly mild, including drowsiness and giddiness. Most patients found the apparatus easy to use and acceptable.
Donen (1982)	Cross sectional analytic	Canada	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	• Review the prehospital use of Entonox in acute pain.	Patients receiving self-administered Entonox experienced pain reduction, with complete or marked relief in 44% and partial relief in 50%, while 6.6% reported no relief. Side effects were common but mild, mainly drowsiness (40%) and dizziness (18.7%). Most patients found the technique easy to use (96.5%) and acceptable.
Stewart (1983)	Cross sectional analytic	USA	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Determine the safety and feasibility of nitrous oxide use for prehospital pain management.	The treatment group receiving patient-controlled nitrous oxide showed meaningful pain reduction, with 29.1% achieving marked to complete relief and 61.3% partial relief, while 9.6% reported no relief. Adverse effects were mostly mild, including dizziness (20%) and nausea (5.7%). The intervention was well accepted by staff and considered feasible for prehospital use.
Stene (1988)	Cross sectional analytic	USA	• Nalbuphine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain Back pain	Adults (>18) Paediatrics (<18)	Determine the safety, use and benefit of nalbuphine when administered by paramedics.	Patients receiving IV nalbuphine showed substantial pain reduction, with 89% reporting partial to complete relief and severe pain decreasing from 86% to 11% within 15 minutes. No adverse effects or haemodynamic instability were reported. Paramedics found analgesia facilitated patient management, and the intervention was feasible in the prehospital setting
Peterson (1989)	Cross sectional descriptive	USA	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Not reported	Describe the use of nitrous oxide in an emergency service.	Meaningful pain relief was experienced by the treatment group who received nitrous oxide, with 85% reporting complete or partial improvement. Adverse effects were infrequent, and no serious events were reported. Patient acceptability was moderate, with 70% willing to use Entonox again. Feasibility outcomes were not reported, though use spanned multiple pain indications
Johnson (1991)	Cohort	Australia	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate the effectiveness and safety of nitrous oxide use prehospital pain.	The therapy group receiving inhaled nitrous oxide showed partial or complete pain relief in 83% of cases, with 6% reporting complete relief and 15% no relief. Adverse effects were mild, including dizziness, nausea, and drowsiness. Most patients (80%) would use the intervention again, though some had trouble with understanding or using the device.
Bruns (1992)	Cohort	USA	• Morphine iv	Primary response - Road;	Ischaemic chest pain	Adults (>18)	Evaluate the safety of prehospital morphine use.	Patients receiving prehospital morphine for ischaemic chest pain showed safe clinical courses, with respiratory depression or hypotension occurring in 6%, often confounded by underlying pathology. Paramedic assessment was accurate in 77%, and appropriate morphine use occurred in 88%. No long-term complications were reported, though effectiveness and acceptability outcomes were not assessed.

Chambers (1994)	Cohort	UK	• Nalbuphine IV • Nalbuphine IM	Primary response - Road;	Acute trauma pain ischaemic chest pain	Adults (>18) Paediatrics (<18)	Document the introduction of nalbuphine hydrochloride as a prehospital analgesic.	Intravenous nalbuphine showed marked pain reduction, with mean VAS decreasing from 8.0 to 3.0 and an average reduction of 5.0 cm during prehospital care. Mild adverse effects occurred in 18%, with no respiratory depression or hypotension. Paramedics found the intervention acceptable and feasible, though IV access and pain scoring posed challenges.
Thomas (1996)	Retrospective cohort	USA	• Fentanyl IV	Primary Response - Aeromedical;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate the safety of fentanyl administration for pain management during air medical transport.	No complications were documented for patients receiving intravenous fentanyl during air medical transport, with stable blood pressure and oxygenation before and after administration. No naloxone was required and no adverse physiological changes were observed. Fentanyl was primarily used for analgesia, with sedation as an additional benefit.
Gray (1997)	Case control	UK	• Nalbuphine IV	Primary response - Road;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Describe the administration of nalbuphine in severely injured patients by paramedics.	Paramedic administration of nalbuphine in major injury showed inconsistent effectiveness, with only 52–85% of administrations judged appropriate. No adverse events were reported, but documentation was poor. Concerns regarding IV access, consent, and side-effect management limited acceptability and feasibility, highlighting deficiencies in prehospital analgesia provision.
Ward (1997)	Quasi experimental	UK	• Tramadol IV • Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Establish the suitability, safety and efficacy of IV tramadol for prehospital pain management.	Patients receiving intravenous tramadol showed substantial pain reduction, with mean VAS decreasing from 8.0 (1.8) pre-treatment to 3.0 (2.4) at handover, an average reduction of 5.0 cm. Mild adverse effects occurred in 18%, with no respiratory depression or hypotension. Paramedics found the intervention acceptable and feasible, though IV access and pain scoring posed challenges
Devellis (1998)	Retrospective cohort	USA	• Fentanyl IV	Primary Response - Aeromedical;	Acute trauma pain	Paediatrics (<18)	Review the safety record of a prehospital IV fentanyl protocol.	Paediatric trauma patients receiving intravenous fentanyl during air transport showed stable physiological parameters, with no episodes of hypotension, respiratory depression, or oxygen desaturation. No naloxone was required. Fentanyl was well tolerated, with no clinically significant adverse events reported, supporting safe and feasible prehospital use in children.
Houlihan (1999)	Case series	UK	• Nalbuphine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Describe a series of cases where prehospital administration of Nalbuphine IV resulted in higher doses of opioids.	The therapy group receiving prehospital nalbuphine required substantially higher subsequent morphine doses (15–70 mg) for adequate analgesia, suggesting reduced opioid effectiveness. Adverse events were not directly reported. Acceptability and feasibility outcomes were not assessed. Findings raise concern regarding nalbuphine's antagonistic effects and potential impact on later pain management.
Woollard (2002)	Cohort	UK	• Nalbuphine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Determine the use, effectiveness, effects and outcomes of the prehospital administration of IV nalbuphine for pain management.	Low-dose nalbuphine showed modest pain reduction, with mean pain scores decreasing from 8.4 to 4.4 during prehospital care. Only 40% achieved adequate analgesia, and 60% required further hospital analgesia. Adverse events were rare (1.7% nausea). The therapy was feasible, though conservative dosing limited effectiveness.
Kotwal (2004)	Cohort	Military	• Oral Transmucosal Fentanyl citrate (OTFC)	Military/Battlefield;	Acute trauma pain	Adults (>18)	Describe the effectiveness of OTFC for pain management in soldiers in a combat environment.	Patients receiving oral transmucosal fentanyl showed marked pain reduction, with mean NRS decreasing by 5.77 points within 15 minutes and sustained analgesia for up to five hours. Minor adverse effects included pruritus and nausea; one case of hypoventilation occurred after additional opioids. The intervention was feasible and effective in the battlefield setting.

Thomas (2005)	Cross sectional analytic	USA	• Fentanyl IV	Primary Response - Aeromedical;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Report the use, safety and efficacy of fentanyl for pain management	Therapy groups receiving intravenous fentanyl during air medical transport showed stable pain management with no reported complications. Blood pressure, oxygen saturation, and heart rate remained unchanged pre- and post-administration. No naloxone was required. Fentanyl was used primarily for analgesia, with additional sedative benefit, and was feasible for routine aeromedical prehospital use.
Babl (2006)	Case series	Australia	• Methoxy flurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Paediatrics (<18)	Describe the usage patterns and effectiveness of prehospital methoxyflurane	Children receiving inhaled methoxyflurane showed rapid pain reduction, with mean scores decreasing from 7.9 to 4.5 within 5 minutes and to 3.2 at 10 minutes. No serious adverse events occurred; minor effects included drowsiness and behavioural changes. Most patients, parents, and paramedics reported high satisfaction, supporting feasible prehospital use.
Kanowitz (2006)	Retrospective cohort	USA	• Fentanyl IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain;	Adults (>18) Paediatrics (<18)	Evaluate the safety and effectiveness of IV fentanyl administration for prehospital pain management.	Intravenous fentanyl showed significant pain reduction, with mean scores decreasing from 8.4 to 3.7 during prehospital care. Adverse events were uncommon, with few transient vital-sign abnormalities and no deaths. No patients required hospital admission for complications, supporting fentanyl as a safe and feasible prehospital analgesic
Buntine (2007)	Case series	Australia	• Methoxy flurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain Back pain	Adults (>18)	Determine the efficacy, use pattern, patient satisfaction and side-effect profile of methoxyflurane in a prehospital setting.	Adults receiving inhaled methoxyflurane showed rapid pain reduction, with median VNRS decreasing from 8 at baseline to 5 at 5 minutes, 4 at 10 minutes, and 3.5 at 20 minutes. Minor adverse effects included nausea and dizziness. Most patients and paramedics reported high satisfaction, indicating feasible and acceptable prehospital use
Rickard (2007)	RCT	Australia	• Fentanyl IN • Morphine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18)	To compare IN fentanyl with IV morphine for prehospital analgesia.	The intranasal fentanyl group showed similar pain reduction to intravenous morphine at hospital arrival, with no significant difference between groups. Both treatments were clinically acceptable, though more non-serious adverse events occurred with intranasal fentanyl. Serious adverse events were rare. Intranasal administration improved feasibility by avoiding intravenous access.
Johansson (2009)	Cohort	Sweden	• Morphine IV • Ketamine IV	Primary response - Road;	Acute trauma pain	Adults (>18)	Compare the effectiveness of IV morphine and IV ketamine to IV morphine alone in prehospital patients with bone fractures.	The morphine–ketamine group showed greater pain reduction at hospital arrival than morphine alone, with NRS scores of 3.1 versus 5.4, respectively. Analgesia was achieved with lower morphine doses. Nausea and vomiting occurred more frequently with ketamine, while haemodynamic parameters remained stable. The combination was feasible but the requirement for intravenous access was a limitation.
Smith (2009)	Cross sectional descriptive	Military	• Morphine IM • Morphine transmucosal • Morphine buccal delivery • Morphine nasal atomiser	Military/Battlefield;	Acute trauma pain	Adults (>18)	Described medical personnel's experiences and perceptions of battlefield analgesia.	Battlefield analgesia was viewed as insufficient, inadequate strength and slow onset. Rapid onset and greater potency than morphine were prioritised. Non-invasive routes, including intranasal and inhaled delivery, were widely acceptable. Feasibility concerns centred on training, safety, and misuse rather than adverse events.

Fleischman (2010)	Cross sectional analytic	USA	• Morphine IV • Fentanyl IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Compare the effectiveness and safety of prehospital morphine IV and fentanyl IV.	Fentanyl and morphine groups showed similar pain reduction at hospital arrival, with mean NRS decreases of 3.1 and 2.9, respectively. Adverse effects were uncommon, including rare hypotension, hypoxia, and one naloxone use. The protocol change was acceptable and feasible, with both opioids providing comparable prehospital analgesia
Jacobs (2010)	Cohort	Australia	• Methoxyflurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Compare the adverse event rates of prehospital patient receiving methoxyflurane to those who don't	The therapy group receiving prehospital methoxyflurane showed no increased risk of cardiac, renal, hepatic disease, diabetes, cancer, or death compared with non-exposed patients. Long-term safety outcomes were comparable between groups. Effectiveness, acceptability, and feasibility were not assessed. Findings support methoxyflurane's safety profile for episodic prehospital use across adult and paediatric populations.
Middleton (2010)	Cross sectional analytic	Australia	• Morphine IV • Fentanyl IN • Methoxyflurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Compare the analgesic efficacy of IV morphine, IN fentanyl, and inhaled methoxyflurane in patients with moderate to severe pain in the prehospital environment.	Patients receiving prehospital analgesia showed pain reduction, with over 70% achieving at least a 30% decrease in pain scores. Morphine and intranasal fentanyl were more effective than methoxyflurane. Adverse events were not reported. Feasibility and acceptability varied by cost, availability, and route of administration across providers.
Bendall (2011)	Retrospective cohort	Australia	• Morphine IV • Fentanyl IN • Methoxyflurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Paediatrics (<18)	Describe the individual and comparative effectiveness of IV morphine, IN fentanyl, and inhaled methoxyflurane in paediatric patients in the prehospital setting.	Paediatric patients receiving prehospital analgesia showed effective pain reduction across all groups. Intranasal fentanyl (89.5%) and intravenous morphine (87.5%) achieved higher rates of effective analgesia than methoxyflurane (78.3%). Adverse events were not reported. Combined analgesic use had improved pain outcomes, supporting the feasibility of opioid-based strategies in children.
Garrick (2011)	Quasi experimental	USA	• Fentanyl IV • Fentanyl IM	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	Assess safety and feasibility of paramedic administration of fentanyl.	Prehospital fentanyl showed rapid pain relief, with faster onset than morphine and improved pain control within minutes. Adverse events were rare and mild and included dizziness and nausea. Training improved acceptability and appropriate use amongst staff. Feasibility was influenced by IV access challenges, patient factors such as obesity, and paramedic familiarity.
Johnston (2011)	Retrospective cohort	Australia	• Methoxyflurane • Fentanyl IN	Primary response - Road;	Acute non-trauma pain	Adults (>18) Paediatrics (<18)	Describe the effectiveness and physiologic effects of the prehospital administration of methoxyflurane and IN fentanyl for visceral pain.	Therapy groups receiving prehospital analgesia for visceral pain showed pain reduction with both methoxyflurane and intranasal fentanyl. Methoxyflurane produced greater early pain reduction, while fentanyl achieved greater reduction by hospital arrival. Hypotension was uncommon and transient. No significant respiratory or neurological adverse events were reported, supporting feasible and acceptable prehospital use of both therapies.
Jennings (2012)	RCT	Australia	• Ketamine IV • Morphine IV	Primary response - Road;	Acute trauma pain	Adults (>18)	Compare the effectiveness of an analgesic regimen of IV morphine and ketamine with IV morphine alone.	Morphine and ketamine together provided significantly greater pain reduction (−5.6 vs −3.2 (NRS)) and faster analgesia than morphine alone. Minor adverse effects were more frequent with ketamine
Wedmore (2012)	Retrospective cohort	Military	• Oral transmucosal fentanyl citrate	Military/Battlefield;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Describe the use, safety and effectiveness of OTFC for battlefield analgesia.	OTFC produced rapid, effective pain relief (mean NRS score reduction 8.0 to 3.2). Adverse events were mostly minor, predominantly nausea.

Soriya (2012)	Quasi experimental	USA	• Fentanyl IV	Primary response - Road;	Acute trauma pain	Adults (>18)	Assess the hemodynamic effect of fentanyl in the prehospital setting .	Prehospital use of IV fentanyl in traumatic pain dd not worsen shock index.
Ducasse (2013)	RCT	France	• Nitrous oxide	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Evaluate the effectiveness of prehospital Entonox in acute traumatic pain.	50% nitrous oxide (Entonox) may provide relief for moderate traumatic pain within 15 minutes of administration. Adverse events were minor and reversible.
Ellerton (2013)	Cohort	UK	• Nitrous oxide • Opioid IM • Fentanyl Lozenge • Opioid IN • Opioid IV • Oral analgesia •	Wilderness/Mountain;	Acute trauma pain	Not reported	Describe the use and effectiveness of analgesia in mountain rescue.	In mountain rescue IV opioids often prove the most effective analgesics. Use of entonox and oral agents are limited. IN opioids and oral transmucosal fentanyl lozenges may be effective alternatives.
Johansson (2013)	Case series	Sweden	• Ketamine IN • Esketamine IN	Wilderness/Mountain;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Describe the effectiveness of IN Esketamine for prehospital trauma analgesia.	In 9 trauma patients, IN esketamine produced a large and clinically important reduction in pain. Median VAS decreased from 10 to 3 rapidly. The approach was feasible in austere rescue conditions, particularly for children or in situations where IV access was delayed. Reported adverse effects were few and mild. Esketamine may be an effective analgesic strategy in prehospital environments.
Karlsen (2013)	Cohort	Denmark	• Fentanyl IN	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	Evaluate the safety and effectiveness of prehospital IN Fentanyl for pain.	IN fentanyl (50–100 µg doses) produced a median 3-point reduction in pain. 79% of cases experienced clinically meaningful analgesia. No serious adverse events were reported and there were no naloxone administrations reported. 4% of cases reported mild adverse events. IN fentanyl is a safe and effective analgesic option for prehospital care.
O'Donnell (2013)	Cross sectional analytic	USA	• Fentanyl IN	Primary response - Road;	Acute trauma pain	Paediatrics (<18)	Determine whether the introduction of a mucosal atomisation device (MAD) would increase IN fentanyl administration rates in paediatric trauma patients	Fentanyl administration rates did not significantly increase after the introduction of a MAD (30.4% pre-MAD vs. 36.7% post-MAD). Age and mechanism of injury were stronger predictors of analgesic use than the availability of the device. Younger children were less likely to receive fentanyl. Barriers to pain relief involving provider practicers and comfort persist in the prehospital environment.
Blankenstein (2015)	Cross sectional descriptive	Military	• Morphine IM	Military/Battlefield;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Describe the opinions of British army personnel on the usage and effectiveness of analgesia in the field.	A minority of respondents interviewed (30%) though battlefield analgesia was effective. Most (92%) wanted faster onset and increased potency from an analgesic in the first hour. IM morphine was mostly considered inadequate. Common concerns for IM morphine were suitability for paediatric casualties and risk of accidental self-injection from autoinjectors. Management of adverse events was a concern.

Losvik (2015)	Retrospective cohort	Iraq	• Ketamine IV • Pentazocine IV	Primary response - Road;	Acute trauma pain	Adults (>18)	Assess the effectiveness, safety and effect on physiologic indicators of paramedic administered IV ketamine and IV pentazocine for prehospital analgesia.	Prehospital pain management was associated with improved physiologic severity scores, compared to no analgesia. In patients with ISS > 8, ketamine produced a significantly greater improvement in systolic blood pressure than pentazocine, without deterioration in respiratory parameters. Ketamine was identified as a pragmatic analgesic option in prehospital care for more severely injured patients.
Friesgaard (2016)	Cohort	Denmark	• Fentanyl IV	Primary response - Road;	Acute trauma pain	Adults (>18)	Evaluate the efficacy and safety of prehospital IV fentanyl.	IV fentanyl resulted in a lowering of median NRS scores from 8 to 4, with most patients (79%) showing greater than 2-point improvement. Most patients (58% still arrived at hospital with moderate to severe pain, attributed to conservative dosing. Adverse events were rare. No naloxone was required.
Lebon (2016)	Retrospective cohort	Canada	• Fentanyl subcutaneous	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	Assess the feasibility, safety and effectiveness of SC Fentanyl by basic paramedics with online medical control assistance.	The use of SC fentanyl was feasible and resulted in 98.6% of eligible patients receiving fentanyl. Almost all injections were completed without difficulty. Most patients achieved significant pain reduction and adverse events were rare. Fentanyl SC is a safe and feasible alternative to IV and IN routes.
Murphy (2016)	Cohort	Ireland	• Fentanyl IN	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Paediatrics (<18)	Determine whether IN fentanyl is safe and effective as a prehospital analgesic for paediatrics with acute severe pain.	Fentanyl administered IN, with weight-based dosing, resulted in median NRS scores falling from 10 to 5, without reported adverse events. This included younger children. 83% of patients achieved clinically meaningful pain reduction within 10 minutes. The study found that IN fentanyl at 1.5 µg/kg is both safe and effective for prehospital management of acute severe pain in children.
Oxer (2016)	Cohort	Australia	• Methoxyflurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	To determine whether methoxyflurane had deleterious effects on respiratory and cardiovascular function when used to manage acute prehospital pain	In a large data set, no clinically significant adverse effects on systolic blood pressure, heart rate or respiratory rate were found. All vital signs remained within physiological limits and rates of abnormal vital sign decreased after methoxyflurane administration. No patients developed serios complications. Standard dose methoxyflurane is safe for use.
Weldon (2016)	RCT	Canada	• Fentanyl iv • Morphine IV	Primary response - Road;	Ischaemic chest pain	Adults (>18)	Assess whether fentanyl is an effective alternate to morphine as a first-line analgesic for ischaemic chest pain in the prehospital setting	Fentanyl and morphine provided comparable reductions in pain, with no significant differences in VAS or NRS scores. Morphine was associated with slightly higher adverse events, including a 5.1% incidence of hypotension, while no hypotensive events were recorded in the fentanyl arms. Other adverse events such as nausea, respiratory depression, and other adverse events were similar between groups. The study concluded that fentanyl was a safe and effective alternative to morphine.
Scharonow (2017)	Cross sectional analytic	Germany	• Fentanyl IV • Morphine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	Evaluate whether the administration of morphine and fentanyl by paramedics is safe and effective.	Morphine and fentanyl administered by specially trained paramedics showed a mean NRS score reduction from of 7.9 to 3.3. No major adverse events were recorded, and naloxone was not required. Morphine and fentanyl produced similar pain reduction results. The use of opioids by paramedics was effective and safe, within a defined protocol and with appropriate training.

Lyon (2018)	Cross sectional analytic	Military	• Ketamine IM	Military/Battlefield;	Acute trauma pain	Adults (>18)	Describe the effectiveness and safety of IM ketamine for pain management in tactical settings.	Ketamine IM provided rapid and significant analgesia in trauma patients in almost all tactical environments. 80% of cases experienced good pain reduction after a single dose and none required a second dose. There were no reported adverse events. Ketamine proved effective even when opioids failed.
Andolfatto (2019)	RCT	Canada	• Ketamine IN • Nitrous oxide	Primary response - Road;	Acute trauma pain	Adults (>18)	Evaluate the reduction in pain following the use of Ketamine IN, compared to placebo IN.	Ketamine IN resulted in significantly greater pain reduction compared to placebo. Ketamine produced greater median reductions in pain scores at 15 and 30 minutes compared with placebo. Ketamine showed higher incidence of minor adverse events, but none required interventions.
Bronsky (2019)	Retrospective cohort	USA	• Fentanyl IV • Ketamine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Examine low dose ketamine's effectiveness as a primary analgesic in a prehospital pain management setting.	Low-low dose IV ketamine resulted in greater mean pain score reduction than fentanyl (mean NRS score −5.5 vs −2.5) with 67% of patients achieving ≥50% pain reduction. There were no significant adverse events reported.
Friesgaard (2019)	RCT	Denmark	• Fentanyl IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Evaluate the effectiveness of a change to prehospital fentanyl protocol.	The change to a more liberal fentanyl protocol (3mcg/kg vs 2mcg/kg) resulted in more patients achieving adequate pain relief (44% vs 37%). There was no associated increase in adverse vital sign abnormalities. Unfortunately, overall analgesia remained suboptimal.
Jones (2019)	RCT	UK	• Fascia iliaca compartment block • Morphine IV • Nitrous oxide • Paracetamol (acetaminophen) IV	Primary response - Road;	Acute trauma pain	Adults (>18)	To assess the feasibility of an RCT to test the feasibility and cost effectiveness of prehospital FICB	Feasibility criteria were met. Adequate patients received the target therapy. There were high follow-up rates, balanced safety outcomes, and patients and paramedic found the procedure acceptable.
Mahshidfar (2019)	RCT	Iran	• Paracetamol (acetaminophen) IV • Ketorolac	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Compare the effectiveness of IV acetaminophen(paracetamol) and IV ketorolac in pre-hospital pain control	Both ketorolac and IV acetaminophen were similar in significantly reducing pain. ketorolac performed slightly better for severe pain while acetaminophen performed slightly better for moderate pain.
Zeitlow (2019)	Retrospective cohort	USA	• Ketamine IV	Primary Response - Aeromedical; Critical Care Retrieval - Aeromedical;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate the use of ketamine as a prehospital analgesic	Ketamine showed 98% success rate in producing effective analgesia, sedation, and procedural analgesia. Ketamine reduced pain from 9/10 to 3/10 on average. There were minimal hemodynamic or respiratory complications

Charlton (2020)	Case control	UK	• Paracetamol (acetaminophen) IV • Paracetamol (acetaminophen) oral	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Compare the effective ness of IV and oral paracetamol in acute prehospital pain.	IV paracetamol produced a greater reduction in pain scores than oral paracetamol, with 32.5% vs 20% of patients achieving clinically meaningful improvement. There were no adverse events reported.
Tanguay (2020)	Cohort	Canada	• Fentanyl IN • Fentanyl SC	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate and compare the feasibility, effectiveness and safety of IN fentanyl and SC fentanyl administration for pain management by paramedics.	IN fentanyl provided faster and more frequent pain relief than subcutaneous fentanyl, especially in older adults. Both routes of administration were effective. Both intranasal and subcutaneous fentanyl were feasible, effective and safe. No major adverse events were reported.
Bebarta (2021)	Cross sectional descriptive	MILITARY	• Ketamine IV • Ketamine IM • Ketamine IN • Ketamine IO	Military/Battlefield;	Acute trauma pain	Adults (>18)	Determine the doses of ketamine used in the combat setting.	Ketamine doses used in battlefield settings often exceeded guidelines for IV/IO routes. Battlefield casualties may require higher dosing, and current guidelines may underdose analgesia.
Bible (2021)	Cohort	USA	• Morphine IV • Fentanyl IV	Primary response - Road;	Acute trauma pain	Adults (>18)	Assess the associations between the dose of prehospital opioid (Fentanyl or morphine)and in-hospital outcomes among trauma patients.	Higher prehospital doses of fentanyl (≥200 mcg) or morphine (≥15 mg) were associated with increased emergency centre hypotension, intubation, and opioid prescription at discharge. No difference in mortality was reported.
Fernandez (2021)	Cohort	USA	• Ketamine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Describe the prehospital use of ketamine and associated outcomes.	Ketamine was used for multiple indications. There was low mortality, with occasional hypoxia and hypercapnia events. Overall, ketamine was safe.
Johansson (2021)	Cohort	Sweden	• Methoxyflurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Describe the effectiveness and safety of methoxyflurane administration for prehospital pain.	Overall, methoxyflurane lowered pain scores and was well tolerated. Some patients did not tolerate administration well and discontinued therapy. Methoxyflurane showed moderate pain relief.
Lim (2021)	RCT	Singapore	• Methoxyflurane • Tramadol IM	Primary response - Road;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Compare the efficacy of methoxyflurane and IM tramadol for managing prehospital acute pain.	Methoxyflurane provided faster and greater pain reduction than IM tramadol. Patients and paramedics were more satisfied with methoxyflurane. There were more minor adverse events with methoxyflurane, though no serios adverse events were reported.

Ozainne (2021)	Cohort	Switzerland	• Methoxyflurane	Primary response - Road;	Acute trauma pain	Adults (>18)	To describe the use and effectiveness of prehospital administration of methoxyflurane and the satisfaction of paramedics.	Methoxyflurane provided moderate analgesia in emergency care. The drug was well tolerated and patients and paramedics reported satisfaction with use. Some patients discontinued administration due to discomfort, or perceptions of no-effect.
Robinson (2021)	Cross sectional analytic	USA	• Morphine IV • Ketamine IV • Fentanyl IV • Ketamine IM • Morphine IM	Primary response - Road;	Acute non-trauma pain Acute trauma pain;	Adults (>18)	Compare ED length of stay among patients who received prehospital Ketamine, Morphine or Fentanyl.	The length of stay for patients in emergency centres for patients receiving morphine, ketamine and fentanyl were similar. The ketamine patient group showed slightly shorter stay in the emergency centre.
Goyal (2022)	Cross sectional descriptive	USA	• Ketamine IV • Ketamine IM • Ketamine IN • Ketamine IO	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Paediatrics (<18)	Describe the use, effectiveness and safety of prehospital ketamine use.	Ketamine was used mainly for analgesia and behavioral emergencies, with most paediatric patients showing clinical improvement and reduced pain. Adverse events were infrequent with prehospital ketamine administration.
Lynch (2022)	Cros sectional analytic	USA	• Fentanyl IN; Morphine IM;	Wilderness/Mountain;	Acute Trauma Pain;	Adults (>18);Paediatrics (<18);	Evaluate the effectiveness and safety of IN fentanyl in prehospital trauma pain from skiing injuries.	Intranasal fentanyl rapidly provided clinically significant pain reduction. No adverse events were reported. Fentanyl is reported to be rapidly acting, safe, and suited to austere environments.
Renza (2022)	QUASI EXPERIMENTAL	Czech Republic	• Sufentanil IV;	Primary response - Road;	Acute Trauma Pain;	Adults (>18);	Evaluate the safety and efficacy of independent administration of Sufentanil by paramedics for the management of acute traumatic pain.	Independent administration of sufentanil by trained paramedics proved safe, with no serios adverse vents reported. Nausea and vomiting were infrequent and mild. Adverse event rates were similar to physician-consulted cases. Pain scores between paramedic administered and physician administered cases both showed significant reduction. Trained paramedics can safely and effectively administer sufentanil for pain management without physician consultation.
Egger (2023)	Cross sectional analytic	Austria	• Methoxyflurane	Wilderness/Mountain;	Acute trauma pain	Adults (>18)	To investigate the efficacy and safety of prehospital methoxyflurane at moderate altitudes.	During Alpine rescue operations, methoxyflurane reduced pain by a mean of 2.9 points (NRS) within 15 minutes. There were no major adverse events or vital-signs deterioration. Minor side effects such as dizziness and light-headedness occurred in 40% of cases but were mild and self-limiting. Overall, methoxyflurane was safe and effective in an Alpine environment.
Frawley (2023)	Cross sectional analytic	USA	• Ketamine • Opioid	Primary response - Road;	Acute trauma pain	Paediatrics (<18)	Compare the effectiveness and safety of ketamine and opioids when used for prehospital analgesia in paediatrics.	Ketamine and opioids both produced substantial prehospital pain reduction in paediatric patients. Ketamine appeared more effective, with a greater mean decrease in pain scores than opioids. Adverse events were rare in both groups, with no unplanned airway placements and extremely low rates of ventilatory support required. Mild sedation occurred slightly more often with

								ketamine, but without clinically significant compromise. Overall, ketamine provided effective analgesia with a safety profile comparable to opioids.
Haske (2023)	Cross sectional descriptive	Germany	• Esketamine IN	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate patient-reported adverse effects and satisfaction in low-dose prehospital esketamine administration	Patients satisfaction rates were reported at 95% as being satisfied or highly satisfied. Adverse events were relatively low, with 78.5% of patients reporting no adverse effects. Minor adverse effects were reported by 10-20% of patients while significant adverse effects were reported by 11.3% of cases. Older adults showed more adverse effects and lower satisfaction.
Mahmood (2023)	Retrospective cohort	USA	• Ketamine • Morphine • Fentanyl	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Patients < 21	Compare the efficacy and safety of ketamine and morphine and opioids for prehospital pain management in paediatrics (<21).	Ketamine reduced pain to a greater extent than opioids (mean of 5.2 vs 2.9 points (NRS) respectively. Mild adverse events were more common with ketamine, though opioids did cause oxygen desaturation requiring intervention. Ketamine was a safe an effective alternative to opioids.
Patrick (2023)	Case series	USA	• Ketamine breath actuated nebuliser (BAN)	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Describe a series of patients who received ketamine via BAN for prehospital pain control.	Six of seven patients who received ketamine through a BAN reported meaningful pain reductions (NRS >2) there were no significant adverse effects, though mild complications such as brief dizziness and drowsiness were reported. IV cannulation was avoided in 4 patients.
Pietsch (2023)	Cohort	Switzerland	• Oral transmucosal fentanyl citrate (OTFC)	Wilderness/Mountain;	Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate the effectiveness, efficiency, safety and feasibility of the administration of OTFC for trauma pain at a ski resort.	OTFC reduced pain by a median of 3 (NRS), consistent across patient groups with only mild side effects and no major complications reported. The use of OTFC was feasible, practical and reliable.
Quinn (2023)	Case report	USA	• Ketamine breath actuated nebuliser (BAN)	Primary response - Road;	Acute trauma pain	Adults (>18)	Report the use of nebulised ketamine via BAN in the prehospital setting for the management of pain from an acute traumatic limb injury	This single patient experienced a reduction in pain from 8 to 3 (NRS) following nebulised ketamine (breath actuated nebuliser) with transient minor complications and no serious adverse events. Transport and handover occurred without need for further analgesics.
Strickmann (2023)	Cross sectional analytic	Germany	• Nalbuphine IV • Paracetamol IV • Butylscopolamine • Esketamine	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Evaluate the use and safety of nalbuphine when administered by paramedics for prehospital pain management.	Administration of Nalbuphine by paramedics, either as monotherapy or in combination with paracetamol was safe and effective. Mean pain reduction was 4.7 (alone) and 5.0 in combination with paracetamol. Neither drugs, nor combination showed any significant complications or adverse events.

Tohira (2023)	Cohort	Australia	• Ketamine wafer sublingual • Methoxyflurane • Paracetamol oral	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain	Adults (>18) Paediatrics (<18)	Describe the use, effectiveness and safety of ketamine wafers for prehospital pain management by volunteer paramedics.	Rural volunteer paramedics easily, and safely administered ketamine wafers, without major adverse events. Use was predominantly in trauma cases, long transport times and severe pain. Ketamine wafers provided meaningful pain reduction, and was considered similar to methoxyflurane. Nalbuphine, and nalbuphine + paracetamol are more effective than paracetamol alone. No complications were observed in either drug, or combinations.
Wihlborg (2023)	Mixed method	Sweden	• Methoxyflurane	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Describe how ambulance nurses experience the administration of methoxyflurane during emergency care.	Nurses mostly experienced methoxyflurane as safe, rapid in onset and easy to use with overall high satisfaction. Experiences were mixed, with negative perceptions stemming from varied effectiveness and differences in patients' comprehension. Nurses frequently encountered mild adverse events, and were concerned about the pungent odour, which sometimes led to discontinuation. Patient control was viewed as beneficial though this required coaching.
Benz (2024)	Cross sectional analytic	Switzerland	• Methoxyflurane	Wilderness/Mountain;	Acute Trauma Pain;	Adults (>18);	To analyse whether methoxyflurane is effective in skiing accidents in an Alpine environment.	Methoxyflurane in the hands of trained ski-patrol members produced safe and effective analgesia in 2/3 of cases. Paramedics found methoxyflurane to be easy to use in the Alpine environment.
Deslandes (2024)	Cross sectional analytic	Germany	• Nalbuphine + paracetamol IV • Morphine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	To compare the effectiveness and safety of nalbuphine + paracetamol to morphine IV in the prehospital setting.	Nalbuphine + paracetamol produced lower NRS scores than morphine and patients had a higher change of achieving an NRS<4. Overall complications were rare, though morphine did produce more adverse events. was more effective than morphine. Adverse effects were mild, with no serious complications reported.
McArthur (2024)	Cross sectional analytic	USA	• Ketorolac; • Paracetamol IV;	Primary response - Road;	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);	Compare the efficacy of prehospital parenteral ketorolac and IV acetaminophen (paracetamol) in managing acute pain.	Overall, paracetamol and ketorolac produce clinically meaningful reductions in pain score, tough there was no statistically significant differences between the drugs after adjustment for confounders.
McMullan (2024)	RCT	USA	• Ketamine IN • Fentanyl IN	Primary response - Road;	Acute trauma pain	Adults (>18)	Evaluate the effectiveness of adding fixed dose IN ketamine or placebo to standard IN fentanyl dose for prehospital pain management..	Adding 50mg of ketamine IN to fentanyl analgesia did not show better pain outcomes than
Scharonow (2024)	Cross sectional analytic	Germany	• Fentanyl • Morphine • Metamizole • Butylscopolamine	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain Back pain	Adults (>18) Paediatrics (<18)	Investigate the safety and effectiveness of fentanyl and morphine for prehospital pain management by paramedics.	A reduction of pain by a score of 4 or more on NRS was achieved in approximately ¾ of patients (mean NRS reduction from 8.4-3.5) for both drugs. Adverse events were rare, without any respiratory depression or desaturation recorded. No cases required naloxone. Vital signs remained stable.

Wennberg (2024)	Cross sectional descriptive	Sweden	• Alfentanil IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Evaluate the safety and effect of IV alfentanil administered by ambulance nurses in prehospital emergency care.	Overall, IV alfentanil administered by ambulance nurses showed low rates of adverse events(2.5%) and very low (0.01%) rates of serious adverse events. Pain scores measure don VAS showed a median reduction in pain score from 8 – 4. Over 17 000 administrations in 11 years practice remained stable with no predictors of adverse events found.
Johnston (2025)	Cross Sectional Descriptive	Canada	• Ketamine IN	Primary response - Road;	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);Paediatrics (<18);	Describe the patient safety implications of expanding paramedic scope to include the use of prehospital IN ketamine. .	Data showed a weight-based dosing error rate of 11.2% and in a quarter of encounters, patients did not meet CPG criteria for ketamine. 14% of cases did not contact mandatory clinical support prior to administration. In terms of documentation, 25% of audited PCRs were non-compliant. No instances of patient harm were recorded.
Lohman (2025)	Cross sectional analytic	Germany	• Paracetamol IV • Nalbuphine IV • Piritramide IV	Primary response - Road;	Acute Trauma Pain;	Adults (>18);	Evaluate the efficacy and safety of IV nalbuphine + paracetamol, piritramide and paracetamol for prehospital trauma pain.	Efficacy: Nalbuphine + paracetamol was more effective than piritramide or paracetamol in achieving pain reductions of greater than 4 (NRS). Safety: Overall complication rates were low, though nalbuphine + paracetamol showed more nausea and vomiting requiring antiemetics.
McArthur (2025)	Cross sectional analytic	USA	• Ketamine -breath actuated nebuliser (BAN) • Fentanyl (BAN) • Fentanyl IV • Fentanyl IO	Primary response - Road;	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);	Compare the analgesic efficacy of ketamine administered by BAN with fentanyl administered by BAN.	Ketamine and fentanyl delivered by breath actuated nebulises showed no statistically significant differences in overall pain reduction. For traumatic pain, patients in the ketamine group showed greater reduction in pain than fentanyl ,though there was no difference in the non-trauma group.
McWilliams (2025)	Cross sectional analytic	USA	• Sufentanil SL;	Primary response - Road;	Acute Trauma Pain;	Adults (>18);	Evaluate the efficacy and safety of prehospital SL Sufentanil for pain management.	A clinically meaningful reduction in pain (2.6 points on NRS score) occurred after sub lingual sufentanil use. There were statistically significant reductions in in heart rate and systolic blood pressure though these did not reach clinical significance. No safety concerns were reported.
Smyth UK (2025)	RCT	UK	• Ketamine IV; • Morphine IV;	Primary response - Road;	Acute Trauma Pain;	Adults (>16)	Assess whether ketamine is more effective than morphine for acute severe traumatic pain when used by paramedics	No significant difference in efficacy between ketamine and morphine for overall analgesia. (SPID* ketamine 3.5 vs morphine 3.4 = no significant difference). The onset of action was faster and duration of action shorter for ketamine. Other outcomes were similar, including the proportion of achieving pain <4 and global improvement. No differences were found in chronic pain at 3 or 6 months. Ketamine showed slightly higher, non-clinically significant BP and SPO2 readings, but other physiological indicators were similar. Serious adverse events were low and comparable between groups. Ketamine was associated with more behavioural adverse effects and morphine with more desaturation and hypotension. *Sum of Pain Intensity Difference. The difference in pain intensity over the assessment period.

Sykora (2025)	QUASI EXPERIMENTAL	Czech Republic	• Sufentanil IV; Paracetamol IV;	Primary response - Road;	Acute Trauma Pain;	Adults (>18);	Investigate the effectiveness and safety of independently administered IV Sufentanil for the management of acute traumatic pain by paramedics.	Paramedics who independently administered IV achieved similar reductions in pain scores to paramedics who consulted physicians. Complete NRS documentation was lower in the consultation group. Total sufentanil dose was slightly higher in the independent group. There were some adverse events — including respiratory depression, hypotension, nausea, vomiting, and need for oxygen-, but they were infrequent and occurred similarly between groups. The independent group administered anti-emetics more often. The independent group was associated with a small decrease in diastolic blood pressure. Other vital signs were stable across groups. Non-opioid adjunct analgesia was less frequent in the consultation group, and on-scene time was similar between independent and consultation groups.
PROCEDURES								
First author name	Type of study	Country	Main study Therapy (additional therapies)	EMS context	Pain typology	Population and context	Aim	Main finding
Simpson (2012)	Case report	Australia	• Digital nerve block	Primary response - Road;	Acute trauma pain	Adults (>18)	Describe a case of paramedic performed digital nerve block.	Digital nerve block was fond to be effective (allowing reduction) and feasible.
Dochez (2014)	Quasi experimental	the Netherlands	• Fascia iliaca compartment block (FICB) • (Lidocaine with adrenaline)	Primary response - Road;	Acute trauma pain	Adults (>18)	Examine whether ambulance nurses can effectively perform FICB	EMS nurses performed block in 108 patients. The block was effective in 96 patients, reducing the mean pain score from NRS6/10 to 3/10 at 30 minutes. There were no noted complications and patient satisfaction was categorised as high. Properly trained EMS nurses can effectively perform FICB.
McRae (2015)	RCT	Australia	• Fascia iliaca compar	Primary response - Road;	Acute trauma pain	Adults (>18)	Compare the efficacy and feasibility of paramedic performed FICB for pain management in suspected hip	The intervention group (FICB) showed a larger early pain reduction than those receiving standard care (morphine) (50% vs. 22%, p = 0.025). Median pain scores fell by 5 points with FICB and 2 points with standard care. FICB did not prolong scene time, and no

			tment block • (Morphine IV)				or femur fractures with standard care of morphine aliquots.	immediate adverse events were observed among the 11 patients who received it. Paramedic administered FICB is effective and feasible.
Brokmann (2016)	Quasi experimental	Germany	• Telemedicine • (Esketamine • Piritramide • Metamizol • Morphine IV • Fentanyl IV)	Primary response - Road;	Acute non-trauma pain Acute trauma pain Ischaemic chest pain Back pain	Adults (>18)	Compare the effectiveness and safety of analgesia telemedically delegated to paramedics with standard physician administered analgesic practice.	In both the intervention group (telemedicine) and control group (physician administered analgesia) adequate analgesia was achieved. Minor adverse events occurred with equal frequency in both groups. Documentation was better in the intervention group. Telemedically supported paramedics can deliver safe and effective analgesia.
Lenssen (2017)	Retrospective cohort	Germany	• Telemedicine • Piritramide • Metamizol • N-butylscopolamine • Dimenhydrinate • Morphine IV • Ketamine IV	Primary response - Road;	Acute non-trauma pain Acute trauma pain	Adults (>18)	Evaluate the effectiveness and safety of analgesia administered by telemedically supported paramedics.	Pain reduction was comparable between intervention (telemedicine) and historical control (physician) groups (4.94 ± 2.01 vs. 4.84 ± 2.28; $p = 0.5379$), resulting in similar arrival NRS scores (3.1 ± 1.7 vs. 3.3 ± 1.9; $p = 0.5229$).Complete NRS documentation was more frequent with telemedicine (140/149 vs. 130/199, $p < 0.0001$). No severe adverse events occurred. Both approaches achieved clinically significant pain reduction. Telemedically delegated analgesia is safe and effective compared to physician administered analgesia.
Evans (2019)	Qualitative	UK	• Fascia iliaca compartment block	Primary response - Road;	Acute trauma pain	Adults (>18)	Describe paramedic experiences of the use of FICB.	Paramedics viewed FICB as appropriate and feasible, though initially time-consuming and anxiety-provoking due to unfamiliarity. Training was praised, confidence grew with experience, and no major safety concerns emerged. Challenges stemmed from the emergency context, including long waits, severe patient pain on movement, and treating patients in front of family members.

Evans (2019)	Qualitative	UK	• Fascia iliaca compartment block	Primary response - Road;	Acute trauma pain	Adults (>18)	Describe the experiences of patients of paramedic performed FICB.	Patients trusted paramedics and felt reassured by their calm, supportive communication, even though most had little memory of being offered or receiving FICB. They mainly recalled severe pain, long waits, and the relief of compassionate care. Paramedic attitude—not the procedure—shaped their experience. Hip fractures had a major impact on independence and well-being, and after hospital treatment patients focused on regaining mobility and returning to their previous quality of life
Wennberg (2021)	Case control	Sweden	• Fascia iliaca compartment block (FICB) • (Morphine • Alfentanil • Ketamine • S-ketamine • Midazolam • Diazepam • Chirocain)	Primary response - Road;	Acute trauma pain	Adults (>18)	Compare FICB to standard treatment (morphine) for the management of prehospital pain.	FICB produced greater pain reduction than standard care: static pain improved in 56% vs. 30% of patients and dynamic pain in 85% vs. 59% ($p < 0.01$). NRS and BRS scores showed significantly larger reductions with FICB, and fewer patients required morphine (26% vs. 86%). No side-effects were reported, and even patients receiving FICB alone showed strong pain relief (89% improved).
Watchorn (2023)	Cohort	Canada	• Patient controlled analgesia (PCA)	Critical Care Retrieval - road	Acute non-trauma pain Acute trauma pain	Adults (>18) Paediatrics (<18)	Determine the feasibility, efficacy as well as patient and paramedic satisfaction with the use of PCA for pain management.	Ambulance-based PCA was feasible and safe across 84 transfers, with no serious adverse events. Only 3.6% experienced mild desaturation managed with low-flow oxygen, and no cases required naloxone or stopping PCA. Pain scores remained stable (4/10 to 4/10), morphine use averaged 18 mg, and satisfaction was high for both patients (4.6/5) and paramedics (4.7/5). The study shows PCA can be safely used during long rural inter-facility transfers.

Supplementary data 2:Secondary studies summary of findings table: Pain management therapies by prehospital emergency care providers: a scoping review.

Author date	Which therapies are addressed	Main Aim/ primary question	In which Pain context/typology is the study conducted?	Population	In which EMS mode is the study conducted?	Summary of main findings
SYSTEMATIC REVIEWS WITH METANALYSIS						
Simpson (2014)	TENS;	investigate the effectiveness of TENS, compared with 'sham' (i.e. placebo) TENS, for relieving acute pain and anxiety.	Acute non-trauma pain Acute Trauma Pain;	Adults (>18);	Primary response - Road.	None of the studies included reported detailed data on adverse effects or complications arising from TENS, and none defined what type of adverse effects or complications, if any, were monitored for. No adverse or harmful effects were described in any study. Statistically significant reductions in heart rate were reported across all studies, for those who received TENS. Nonsignificant differences in blood pressure following TENS were reported across all studies.
Slade (2023)	Fascia Iliaca Compartment Block;	To assess the effectiveness and	• Acute Trauma Pain;	Adults (>18);	• Mixed Prehospital context;	FICB provides effective prehospital analgesia for adults with proximal femoral fractures and is associated with pain

		implementability of FICB in routine prehospital care for proximal femoral injuries.				reduction. FICB shows high success rates and is safe, effective and feasible prehospital.
SYSTEMATIC REVIEWS						
Park (2010)	Morphine IV Fentanyl IV Fentanyl IN Tramadol IV Fascia Iliaca Compartment Block Nitrous Oxide Methoxyflurane Ketamine IV OTFC Alfentanil IV;	to investigate current evidence for analgesics in the pre-hospital environment.	Acute non-trauma pain Acute Trauma Pain;	Adults (>18);	Military/Battlefield Primary response - Road;	This review concluded that there was a lack of sufficiently detailed evidence for prehospital analgesia. Evidence often showed analgesic failure, though studies often required upwards of 30 minutes to reach maximum pain reduction. Evidence did not show differences In effectiveness of opioids, but data was limited. Evidence for analgesics rarely showed severe or critical adverse events, though minor adverse events were often reported. Fascia iliaca blocks did show efficacy with low levels of failure of pain relief, though the method may be limited to use in femur fractures. Inhaled analgesics (nitrous oxide and methoxyflurane) showed good pain relief by arrival at hospital, though there was evidence for a high failure rate for nitrous oxide, which may have also required continuous application. Despite its broad uptake, there was an absence of efficacy data for ketamine. There was a lack of evidence for the use of NSAIDS and cyclooxygenase-2-inhibitors. There was also no evidence investigating the use of prehospital paracetamol. Multimodal analgesia was also not studied.
Jennings (2011)	Ketamine IV Morphine IV	aims to identify studies relevant to the use of ketamine as an analgesic agent in the pre-hospital environment.	Acute non-trauma pain Acute Trauma Pain	Adults (>18);Paediatrics (<18);	Primary response - Road;	Ketamine is effective as an analgesic and reduces the dose of morphine required for pain relief. Ketamine does not result in lower VAS scores than morphine, though acts faster. Patients treated with ketamine may present with more mild adverse events than those treated with morphine.
Lee (2011)	Acupressure;	To review the findings of randomized controlled trials (RCTs) that tested the efficacy of	Acute non-trauma pain Acute Trauma Pain	Adults (>18);	Mixed Prehospital context;	Two prehospital RCTs examined the efficacy of acupressure for pain related to trauma. Acupressure for three minutes in patients being transported by ambulance following minor trauma reduced pain, anxiety, and heart rate compared with control and sham acupressure groups. In a study of patients with radius fracture, acupressure significantly reduced pain

		acupressure for symptom reduction.				and anxiety when compared with a placebo group that received acupressure at an inappropriate location.
Hansen (2013)	Fentanyl IN Morphine IV Methoxyflurane	To evaluate the current evidence for the use of IN fentanyl as an analgesic in the emergency department (ED) and prehospital setting.	Acute Trauma Pain Ischaemic Chest Pain	Adults (>18);Paediatrics (<18);	Primary response - Road;	Two studies demonstrated no significant differences between IN-fentanyl and IV morphine treatment to reduce acute pain. Another study demonstrated IV morphine to be superior to IN fentanyl in treatment of acute pain. A comparison of methoxyflurane and IN fentanyl in visceral pain and showed faster pain score reduction with methoxyflurane,], though IN fentanyl showed greater reduction on arrival at hospital.
Dijkstra (2014)	Morphine IV; Fentanyl IV; Ketamine IV; Nitrous Oxide; Paracetamol (Acetaminophen) IV; Other; Tramadol IV ;Ibuprofen (oral);	To identify effective and safe initial pharmacological pain interventions, available in the Netherlands, for trauma patients with acute pain in the chain of emergency care.	Acute non-trauma pain; Acute Trauma Pain;	Adults (>18);Paediatrics (<18);	Mixed Prehospital context;	Paracetamol and IV opioids (morphine, fentanyl) are consistently safe and effective for prehospital trauma analgesia, while NSAIDs show mixed safety and efficacy and are not recommended for ambulance or HEMS use. S-ketamine's effectiveness remains unclear. Paracetamol and opioids remain the most reliable options, and innovative routes such as intranasal fentanyl warrant further study
Samuel (2015)	Morphine IV; Fentanyl IV; Methoxyflurane; Ibuprofen (oral);Ketamine IV; Nitrous Oxide;	To analyze the available evidence in prehospital pain management of injured children.	Acute Non-trauma pain; Acute Trauma Pain;	Paediatrics (<18);	Mixed Prehospital context;	Limited evidence suggests fentanyl 1–3 µg/kg is effective for paediatric prehospital analgesia, with no major adverse events reported, though safety data remain weak. Overall analgesic use in children is low, likely due to underassessment, limited training, and fear of complications. Small children appear undertreated, and current evidence shows paediatric prehospital pain management is suboptimal.
Hards (2018)	Fascia Iliaca Compartment Block;	to collate and analyze current evidence of the prehospital use of FICB in patients of any age suffering fractures to the femoral bone; in particular, to assess	Acute Trauma Pain;	Adults (>18);Paediatrics (<18);	Primary response - Road;	Across studies, prehospital FICB consistently reduced pain. Success rates were high—about 90% overall—whether defined by full or partial sensory loss. Adverse events were rare, with only one transient reaction reported. Patient satisfaction was high across studies, with no meaningful differences compared to opioid-based care. Scene times were not prolonged. Overall, evidence supports FICB as a safe, effective, high-success prehospital analgesic option for femoral

		whether FICB provides effective prehospital analgesia in this group of patients and is a feasible analgesic technique. The reported success rates and adverse effects of FICB performed in a prehospital setting are investigated along with any data on patient satisfaction and scene time delays.				fractures, though further research comparing it directly with systemic opioids is needed.
Porter (2018)	Nitrous Oxide Methoxyflurane;	hypothesis testing - Entonox would improve tolerance to TCP	Acute Trauma Pain;	Adults (>18);	Primary response - Road;	Low-dose methoxyflurane and 50% nitrous oxide both provide rapid, well-tolerated analgesia for trauma pain in emergency settings, with no significant difference in pain relief at 5–15 minutes. Methoxyflurane was easier to administer and more portable, while both treatments were safe with mostly mild, transient side effects. Evidence supports both agents as effective options, though more direct comparisons are needed.
de Rocquigny (2019)	Ketamine IV; Ketamine IM;	analyse content and quality of published data on the use of ketamine for prehospital pain management in a military setting	Acute Trauma Pain;	Adults (>18);	Military/Battlefield;	A review of 8 studies, this paper shows 50-100mg of IV ketamine reduced moderate to severe battlefield pain, after a single dose. Ketamine use increased after the introduction of enabling guidelines. Ketamine is used in more severe injuries, though it has the lowest use in suspected brain injurie lower blood pressures. Most frequently used in extremity injuries and most often during evacuation, not at point of injury. Ketamine is associated with slight improvements in heart rate, slight reductions in SBP, and lower GCS scores. Ketamine provided effective pain relief during tactical operations.

Hartshorn (2019)	Methoxyflurane;	The aim of this review was to examine the potential utility of inhaled methoxyflurane in this setting.	Acute Non-trauma pain; Acute Trauma Pain;	Paediatrics (<18);	Mixed Prehospital context;	Across six paediatric studies, low-dose inhaled methoxyflurane consistently produced rapid, clinically significant pain reduction within 2–10 minutes, with 71–87% achieving adequate analgesia and very low rescue-medication use. Adverse effects were mostly mild and transient (drowsiness, euphoria, cough), with brief deep sedation mainly in children <5 years and no renal or hepatic toxicity reported. Patient, parent and provider satisfaction was high. Evidence supports methoxyflurane as a fast-acting, well-tolerated, needle-free option for acute moderate-to-severe paediatric pain
Williams (2019)	Fascia Iliaca Compartment Block; Morphine IV;	To determine the need for FICB in the prehospital setting. Compare FICB with morphine for pain relief in femoral factures, and to establish if FICB can feasibly and safely be performed in the prehospital environment; to identify the adverse effects associated with prehospital FICB	Acute Trauma Pain;	Adults (>18);Paediatrics (<18);	Mixed Prehospital context;	Prehospital FICB is feasible, safe, and highly successful for pain in femoral fractures. Pain reduction was consistent, and adverse effects were rare and mild, especially compared with IV morphine. There is a suggestion that FICB may provide superior analgesia to morphine, though overall comparative data remain limited. FICB can be performed effectively by trained paramedics, and appears suitable for diverse prehospital settings.
Bansal (2020)	Ketamine IV Ketamine IM Ketamine IN **<u>Other</u>** Morphine IV Fentanyl IV Pentazocine IV	Does ketamine result in satisfactory pain relief compared to other agents in patients requiring analgesia?	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);	Mixed Prehospital context;	There is low grade evidence to show that ketamine as effective and safe as analgesic. There is low grade evidence to show that ketamine is as effective as opioids.
Sandberg (2020)	Ketamine IV; Morphine IV; Fentanyl IV; Ketamine IN; Nitrous Oxide; Pentazocine IV;	to explore the benefit and harm of ketamine compared with other analgesic	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);	Primary response - Road;	Ketamine is an effective prehospital analgesic that which may provide pain relief equal to or better than opioids. There is less nausea and vomiting than with opioids, but a higher risk of agitation. Studies are small and heterogeneous, but overall

		drugs (or no drug) in prehospital patients with acute pain.				ketamine appears safe when used in low analgesic doses by trained providers.
Wongtongkam (2020)	Ketamine IV; Ketamine IM; Ketamine IN; Pentazocine IV;	investigate the triple therapeutic effects of ketamine in prehospital setting (analgesia, sedation and intubation)	Acute Trauma Pain;	Adults (>18);Paediatrics (<18);	Mixed Prehospital context;	Ketamine often demonstrated superior pain reduction compared, achieving greater than 50% pain reduction more often than fentanyl and outperforming morphine when used alone or in combination. Usually administered for moderate to severe pain. Physiological responses commonly included elevated blood pressure and heart rate, with up to half of patients developing tachycardia, and compared with other analgesics, ketamine recipients often showed higher heart rates, lower blood pressure, and lower GCS scores. In terms of adverse events, nausea and vomiting were more frequent with morphine, and ketamine was more associated with hypersalivation and occasional emergence phenomena.
Abebe (2021)	Morphine IV; Fentanyl IV; Ketamine IV; Ketamine IM; Fentanyl IN; Methoxyflurane;	Examine the preferable drugs for prehospital pain relief in paediatric patients with acute pain, irrespective of aetiology	Acute Non-trauma pain; Acute Trauma Pain;	Paediatrics (<18);	Primary response - Road;	IN fentanyl alone is effective for pain reduction. IN Fentanyl + Paracetamol/Ibuprofen/Nitrous Oxide as multimodal therapy is effective. Morphine is as effective as fentanyl. Methoxyflurane as a single drug effectively reduces pain, with few adverse events. No additional risk of disease following methoxyflurane use. Methoxyflurane is less potent than morphine and fentanyl, or multimodal analgesic approaches, though it may have better odds of achieving pain reduction than morphine and fentanyl. Multimodal analgesia with combination morphine, fentanyl and methoxyflurane is effective for pain relief. No statistical evidence proving a combination of drugs is better than morphine or fentanyl alone.
Davis (2021)	Acupressure; TENS ;Other; Fascia Iliaca Compartment Block;	To determine the effectiveness of interventions by examining patient-related outcomes	Acute Trauma Pain;	NOT REPORTED	Primary response - Road;	There may be an underutilization of pain therapies, including pharmacological therapies. Many pharmacological studies do not report on pain outcomes. Traction splint studies do not report effectiveness of pain management, though traction

	Morphine IV; Fentanyl IV; Nitrous Oxide; Methoxyflurane; Traction splinting;	such as pain reduction, procedural success rates, and any adverse effects that occur afterward, and explore emerging prehospital pain management practices. .				splints appear to be underutilized. do not seem to result in immediate sequelae. FICB successfully reduces pain. TENS shows statistically significant reductions in pain. Auricular acupressure shows statistically significant reduction in pain.
Friesgaard (2022)	Morphine IV; Fentanyl IV; Tramadol IV;	The aim of this systematic review was to explore the efficacy and safety of opioid analgesics in the pre-hospital setting and to assess potential alternative therapies.	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);	Mixed Prehospital context;	Opioid analgesics show broadly comparable effectiveness. There is moderate quality evidence showing that intravenous morphine and synthetic opioids provide similar pain relief. Low quality evidence suggests intranasal fentanyl is similarly effective to intravenous morphine, though it may require more rescue analgesia and is associated with more adverse events. There does not appear to be a difference in analgesic effect treatment by physicians and paramedics.
Hyldmo (2023)	Methoxyflurane; Nitrous Oxide;	. we evaluated the additional demand for painkillers after the initial use of methoxyflurane	Acute Non-trauma pain; Acute Trauma Pain;	Adults (>18);	Mixed Prehospital context;	Inhaled methoxyflurane and nitrous oxide appear to be safe and potentially useful options for prehospital pain management. The overall quality of evidence is low. Nitrous oxide provides moderate pain relief and outperforms placebo, but is less effective than morphine and methoxyflurane, and may pose occupational exposure risks to EMS personnel. Methoxyflurane shows faster onset and stronger analgesic effects than paracetamol, ketoprofen, tramadol and fentanyl, though morphine remains more potent. Nitrous oxide and methoxyflurane are associated with mild adverse events, and no serious harms Methoxyflurane shows the most consistent benefit, particularly as a short-acting analgesic or bridge to IV therapy.
RAPID REVIEWS						
Whitley (2019)	Fentanyl IN; Ketamine IN;	To review prehospital	Acute Trauma Pain;	Paediatrics (<18);	Primary response - Road;	Intranasal fentanyl appears effective and safe for reducing pain in children in the prehospital setting. There were consistently

		evidence on the safety and effectiveness of intranasal analgesics for children in pain.				high rates of clinically meaningful pain reduction reported with no serious adverse events. Evidence for intranasal ketamine and S-ketamine is limited though both seem effective in small, low-quality studies. No interventional studies exist, and overall evidence quality is low, with uncertainties regarding the correct administration rates and safety for agents which are not fentanyl .
Yeung (2018)	Methoxyflurane	To evaluate the clinical effectiveness, cost-effectiveness, and evidence-based guidelines for the use of low-dose methoxyflurane for the management of moderate to severe pain associated with trauma or procedures in the pre-hospital setting.	Acute non-trauma pain; Acute Trauma Pain;	Adults (>18);	Primary response - Road; Critical Care Retrieval - Aeromedical;	Inhaled methoxyflurane provides some analgesic benefit for pain reduction in prehospital trauma care but appears less effective than intravenous morphine and intranasal fentanyl. Evidence is limited and low in quality, with only retrospective studies and systematic reviews lacking pooled estimates. Methoxyflurane produced mainly mild adverse effects and did not appear to show any serious harm in any of the included studies. no signal for serious harm. There were no cost-effectiveness studies or evidence-based guidelines for the management of prehospital trauma pain or procedural analgesia in the prehospital setting. Given the overall low quality of evidence the review concluded that its overall effectiveness in this setting remains uncertain
NARRATIVE REVIEWS						
Author date	**Which therapies are addressed**	**Main Aim/ primary question**	**In which Pain context/typology is the study conducted?**	**Population**		**Summary of main findings**
Borland (2002).	Nalbuphine IV Morphine IV Fentanyl IV Nitrous Oxide Tramadol IV;	To evaluate the literature on current prehospital analgesia practices and highlight potential areas for improvement.	Acute non-trauma pain Acute Trauma Pain;	Adults (>18)	Primary response - Road	The review concluded Nitrous Oxide to be effective, but with usage limitations on very young, very old, entrapped patients, and patients with impaired consciousness. Nalbuphine may be effective, but risks elevation of narcotic use in the emergency centre. Tramadol may be more effective than nitrous oxide, but had not been compared with nalbuphine or other opiates in an RCT. The use of morphine and fentanyl is effective for relieving pain, but IV administration requires specialist skills. The options for prehospital analgesia have improved, but implementation takes time.
Mclennan (2007).	Methoxyflurane	Review the safety and efficacy of methoxyflurane and	Acute Trauma Pain	Adults (>18)	Military/Battlefield	The review opines that methoxyflurane should be evaluated as a potential alternative to IM morphine for battlefield pain relief.

		assess whether it could be used to replace morphine as the primary analgesic in the pre-hospital environment.				The review finds that methoxyflurane is an effective analgesic, however safety information is incomplete, though only minor adverse events have been reported. For the military specifically, methoxyflurane has not been tested in military environments, and handling issues, and effects of methoxyflurane may not be conducive to the military environment.
Thomas (2008).	Morphine IV Fentanyl IV Nalbuphine IV Tramadol IV Ketamine IV Ketorolac;	To improve provision of pain relief by identifying and offering solutions to barrier to analgesia.	Acute Trauma Pain	Adults (>18)	Primary response - Road	Barriers include appropriate pain assessment, concerns for masking of findings, fear of adverse events, restrictive medical control, and obtaining IV access. Effective strategies to improve analgesia administration include structured pain assessment tools, education on analgesic safety and pharmacology, protocol driven analgesia and diversifying analgesic options and routes of administration.
Grindlay (2009).	Methoxyflurane	Review the use of methoxyflurane in prehospital and emergency care and possible future applications.	Acute non-trauma pain Acute Trauma Pain	NOT REPORTED	Mixed Prehospital context	Methoxyflurane delivered via inhaler provides rapid and clinically significant analgesia in both adults and children. Patients and paramedics are both satisfied with methoxyflurane as an analgesic. Only minor adverse effects were reported: drowsiness, dizziness, cough, headache, vomiting, confusion, and hallucinations, which were self-limiting. There were differences in application between services, with some advocating concurrent oxygen supplementation and others advising against it. Operational considerations include variation in oxygen-use guidance (NSW advising against concurrent oxygen.. Paramedics were advised to provide no more than 2 administrations per shift to limit exposure to fumes. There were further safety concerns related to teratogenicity, substance abuse. Methoxyflurane appears to be an effective and accepted option for prehospital use with potential for expanded application.
Marland (2013).	Ketamine IV Ketamine IM Ketamine IN;	Review the prehospital use of ketamine.	Acute non-trauma pain; Acute Trauma Pain	Adults (>18) Paediatrics (<18)	Mixed Prehospital context	Ketamine is used in prehospital care for anaesthesia induction, analgesia, and procedural sedation, and offers rapid, reliable dissociative anesthesia. It may preserve airway reflexes and cardiovascular stability . It is versatile and can be used for combative patients, where IM ketamine can control combative patients prior to RSI, in extrication where it can provide prolonged and safe analgesia. Multiple routes of administration make it especially useful in paediatrics. It has proven effective

						in disaster medicine. Ketamine has several adverse events, such as emergence phenomena, hypersalivation and transient apnoea. Psychogenic reactions are dose related.
Canadian Agency for Drugs and Technologies (CADTH) (2014).	Patient Controlled Analgesia (PCA)	Review the evidence of the clinical effectiveness and guidelines regarding PCA for patients with acute injury during transfer to a higher level of care.	Acute Trauma Pain	Adults (>18)	Primary response - Road	There were no clinical studies or evidence-based guidelines for the effectiveness or safety or recommended use of PCA.
Ellerton (2014).	Morphine IV Fentanyl IV/ IN Paracetamol (Acetaminophen) IV Ketamine IV/ IN/ IM Methoxyflurane Nitrous Oxide Ketorolac Acetaminophen Oral Femoral Nerve block Fascia Iliaca Compartment Block Methoxyflurane Tramadol IV Splinting;	Describe evidence-based options for prehospital analgesia in mountain rescue.	Acute Trauma Pain	NOT REPORTED	Wilderness/Mountain	No single analgesic appears ideal for mountain rescue and services should adopt a multimodal approach. IV opioid have a strong evidence base and are safe and effective in prehospital mountain environments. When IV access is not feasible alternate routes should be used. Nerve blocks may be feasible if used by trained providers. Nonpharmacological therapies remain essential adjuncts.
Pak (2015).	Acupressure TENS Warming	Review the current evidence of nonpharmacological interventions for pain management in the paramedic practice setting.	Acute non-trauma pain Acute Trauma Pain	Adults (>18)	Primary response - Road	There is limited evidence for non-pharmacological interventions, though interventions seem effective when compared with sham interventions or placebo. TENS, warming and acupressure are effective for pain reduction. All interventions were tolerable and safe.
Blair (2016).	Methoxyflurane	Review the efficacy and tolerability of methoxyflurane in patients with trauma pain.	Acute non-trauma pain Acute Trauma Pain	Adults (>18) Paediatrics (<18)	Mixed Prehospital context	In prehospital studies methoxyflurane was more effective for pain relief than IM tramadol. Methoxyflurane showed minor sedating effects but were transient and mild. Linkage data with large data sets showed no increase in risk of renal or hepatic disease from prehospital administration.

Griffiths (2017).	Methoxyflurane	Review effectiveness and safety of methoxyflurane for use in helicopter search and rescue in the UK.	Acute Trauma Pain	Adults (>18)	Primary Response – Aeromedical Wilderness/Mountain	Methoxyflurane could be effective in helicopter search-and-rescue as it rapidly acting and is effective at reducing acute trauma pain. It may improve patient comfort during extrication and winching. It is safe for use.
Wedmore (2017).	Oral transmucosal Fentanyl Citrate [Morphine IV; Fentanyl IV Fentanyl IN Ketamine IM Ketamine IN Ketamine IV]	Analyse the use, effectiveness and safety of OTFC in the battlefield environment.	Acute Trauma Pain	Adults (>18) Paediatrics (<18)	Military/Battlefield	OTFC was shown to be effective on the battlefield as a non-invasive analgesic in moderate to severe pain. It does not require IV access and maintains haemodynamic stability. Adverse effects are midland major complications are rare.
Porter (2018).	Methoxyflurane	Review the safety, efficacy, satisfaction and clinical usage clinical usage of methoxyflurane as an analgesic in prehospital trauma pain and medical procedures	Acute Trauma Pain	Adults (>18) Paediatrics (<18)	Mixed Prehospital context	Across large data sets methoxyflurane consistently provides effective analgesia to both adults and children, though less effective than opioids. It is generally safe to use. Methoxyflurane use is associated with shorter prehospital times than opioids.
Cohen (2020).	Methoxyflurane	Review Penthrox inhaler for military medical care.	Acute non-trauma pain Acute Trauma Pain	Adults (>18)	Military/Battlefield	Methoxyflurane offers effective, portable and rapidly acting analgesia suitable for combat environments. It can be used by combat medical technicians for bridging analgesia between oral agents and opioids. It has administrative and logistical advantages over opioids. Further work is required for its use in extreme climates and conditions and to mitigate for a small risk of abuse.
Kitch (2020).	Ketamine IV Ketamine IM Ketamine IN	Review the use of ketamine in prehospital care.	Acute Trauma Pain	Adults (>18) Paediatrics (<18)	Mixed Prehospital context	Ketamine is used out-of-hospital for airway management, chemical restraint, analgesia and emerging indications. Low-dose ketamine provides comparative analgesia to opioids, reduces opioid requirements and shows minimal complications.
Williams (2020).	Methoxyflurane	Assess the efficacy of Methoxyflurane for procedural analgesia in the pre-	Acute non-trauma pain Acute Trauma Pain Back Pain	Adults (>18) Paediatrics (<18)	Mixed Prehospital context	Prehospital evidence shows that methoxyflurane is safe and effective for pain management. Methoxyflurane is less potent for pain relief than opioids

		hospital environment.				
Critchley (2022).	Ketamine IV	Discuss whether IV ketamine safe and effective for use by paramedics in the UK?	Acute Trauma Pain	Adults (>18)	Primary response - Road	IV ketamine provides comparable analgesia to morphine and may provide faster pain relief when used alone or in combination with opioids. Minor adverse events were common with ketamine and vital signs changes were small. Ketamine appears safe for us by UK paramedics.
de Grunt (2024).	Methoxyflurane Nitrous Oxide Fentanyl IN /Buccal/ Nebulised Oral Transmucosal Fentanyl Citrate (OTFC) Ketamine IN / Nebulised Sufentanil IN/ SL	Summarise the evidence for commonly used analgesics and alternative routes of administration other than IV as well as identify research gaps.	Acute Trauma Pain;	Adults (>18);	Mixed Prehospital context;	The evidence shows that inhalation, intranasal (IN), and oromucosal are effective routes of administration when IV access is delayed. The evidence evaluated methoxyflurane, fentanyl, ketamine, nitrous oxide, and sufentanil . Methoxyflurane demonstrated consistent pain reduction and high patient/provider satisfaction. IN ketamine and IN sufentanil may offer analgesia comparable to IV opioids but with higher rates of mild adverse effects and limited high-quality evidence . There was insufficient or weak evidence supporting IN or nebulised fentanyl, IN esketamine, nebulised ketamine, and nitrous oxide. and oromucosal fentanyl. Future research should compare IN and oromucosal administration with standard care.
Pawley (2024).	Ketamine IN	Review IN ketamine use by non-physician prehospital clinicians	Acute non-trauma pain	Adults (>18) Paediatrics (<18)	Mixed Prehospital context;	Ketamine delivered IN provides a rapid, non-invasive analgesic option for non-physician prehospital clinicians. It is useful when IV/IO access is difficult or distressing and reduces pain effectively in both adult and paediatric populations. Low quality data show doses of 1-1.5mg/kg produce effective relief. It is safe for use by non-physicians, and IN delivery reduces delays, avoids needle related distress and is feasible. Ketamine requires higher dosing due to lower bioavailability and is associated with adverse events. There is limited prehospital data.

Supplementary data 3:Secondary studies summary of findings table: Pain management therapies by prehospital emergency care providers: a scoping review.

Author date	Which therapies are addressed	Main Aim/ primary question	In which Pain context/typology is the study conducted?	Population	In which EMS mode is the study conducted?	Summary of main findings
SCOPING REVIEWS						
Lourens (2019)	Ketamine IV; Morphine IV; Paracetamol Oral; Fentanyl IV; Nitrous Oxide; splinting and immobilisation;	Provide insight into existing prehospital acute pain assessment and management practice and research in Africa;	Acute Trauma Pain, Acute non-trauma pain.	Adults (>18);Paediatrics (<18);	Mixed Prehospital context;	Only six studies on acute prehospital pain care in Africa were identified. These showed consistently poor or absent pain assessment and generally inadequate pain care which didn't appear to be evidence based. Morphine was the most commonly used analgesic, often at low doses, with very limited use of alternative agents. Non-pharmacological therapies were inconsistently applied. Practitioners frequently relied on subjective cues and personal judgement rather than objective pain scales for the assessment of pain. Paramedics still seem to base their decisions on personal beliefs rather than evidence and patient self-report. Overall, the review highlights major gaps in evidence, inconsistent practice, and the need for improved education, clinical guidelines, and research on acute pain assessment and management in African EMS systems.
Mota (2021)	Acupressure; TENS	Map non-pharmacological interventions in the pre-hospital, emergency department, and trauma-centre settings where they have been implemented and evaluated to reduce acute pain in adult victims of trauma [Only findings related to the prehospital setting]	Acute trauma pain	Adults (>18);	Primary response - Road;	The nonpharmacological interventions identified as being used in the prehospital setting were acupressure, auricular acupressure/acupuncture, and TENS. Small, randomized trials showed that these techniques can reduce pain, anxiety, and heart rate compared with sham treatments, but evidence was limited to minor. Other measures such as immobilisation, ice, compression, elevation, and bandaging were also used by emergency medical services, but they were not studied in respect of pain management. thus, their effectiveness was not evaluated. Prehospital evidence was sparse, low-quality, and insufficient to determine effectiveness, especially for moderate or major trauma.
Anderson (2024)	Fascia Iliaca Compartment Block	Review the use of regional anesthesia in the prehospital environment, evaluating which regional Anesthetic procedure was performed for various indications, their efficacy, and the type of healthcare provider delivering the Anesthetic	Acute trauma pain	Adults (>18);Paediatrics (<18);	Mixed Prehospital context	Regional blocks were shown in multiple studies to be more effective than intravenous analgesia alone, defined by reductions in pain scores. Paramedics utilizing a FICB in addition to morphine had a greater reduction in VNPS of 50% versus a 20% reduction when utilizing morphine alone.8 Peripheral nerve blocks have been demonstrated to be more efficacious than the use of systemic analgesia and sedation in facilitating joint relocation in the out-of-hospital setting.