Prehospital Analgesia With Intranasal Ketamine (PAIN-K): A Randomized Double-Blind Trial in Adults

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Study objective: We compare intranasal ketamine with intranasal placebo in providing pain reduction at 30 minutes when added to usual paramedic care with nitrous oxide.

Methods: This was a randomized double-blind study of out-of-hospital patients with acute pain who reported a verbal numeric rating scale (VNRS) pain score greater than or equal to 5. Exclusion criteria were younger than 18 years, known ketamine intolerance, nontraumatic chest pain, altered mental status, pregnancy, and nasal occlusion. Patients received usual paramedic care and were randomized to receive either intranasal ketamine or intranasal saline solution at 0.75 mg/kg. The primary outcome was the proportion of patients with VNRS score reduction greater than or equal to 2 at 30 minutes. Secondary outcomes were pain reduction at 15 minutes, patient-reported comfort, satisfaction scores, nitrous oxide consumption, and incidence of adverse events.

Results: One hundred twenty subjects were enrolled. Seventy-six percent of intranasal ketamine patients versus 41% of placebo patients reported a greater than or equal to 2-point VNRS reduction at 30 minutes (difference 35%; 95% confidence interval 17% to 51%). Median VNRS reduction at 15 minutes was 2.0 and 1.0 and at 30 minutes was 3.0 and 1.0 for ketamine and placebo, respectively. Improved comfort at 15 and 30 minutes was reported for 75% versus 57% and 61% versus 46% of ketamine and placebo patients, respectively. Sixty-two percent of patients (95% confidence interval 49% to 73%) versus 20% (95% confidence interval 12% to 32%) reported adverse events with ketamine and placebo, respectively. Adverse events were minor, with no patients requiring physical or medical intervention.

Conclusion: Added to nitrous oxide, intranasal ketamine provides clinically significant pain reduction and improved comfort compared with intranasal placebo, with more minor adverse events. [Ann Emerg Med. 2019;74:241-250.]

Please see page 242 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background

British Columbia Emergency Health Services is the largest emergency medical services provider in Canada. There are a total of 566 ambulances, 450 of which are staffed by primary care paramedics.[1]

The treatment of acute pain in the out-of-hospital setting in British Columbia is problematic because acute painful conditions make up a large proportion of out-of-hospital transports, yet primary care paramedics, the majority of the region's paramedics, have limited options to provide analgesia. Thus, adequate and timely pain relief is often significantly delayed.[2] The provision of out-of-hospital medications in British Columbia is determined by the Emergency Medical Assistants Licensing Board under the Medical Health Services Act. During this study, the only analgesic medication available to primary care paramedics was inhaled nitrous oxide, which is thus considered "usual care" for the paramedics because opioid analgesics and parenteral routes of administration are not available to them. The provision of opiates would instead require calling a higher-level provider (eg, advanced care paramedic) to attend the scene. Inhaled nitrous oxide is limited in its utility by its short duration of action, adverse effects such as nausea and vomiting, and the need for patient cooperation. These limitations result in dissatisfaction with its use among primary care paramedics and patients.[2] Although effective for moderate pain, its utility in severe pain is uncertain.[3,4]

Editor's Capsule Summary

What is already known on this topic

Intranasal analgesia is ideal for out-of-hospital care because it can be administered quickly and without intravenous access.

What question this study addressed

How does intranasal ketamine at 0.75 mg/kg compare with saline solution placebo for pain control in out-of-hospital adults when added to baseline nitrous oxide?

What this study adds to our knowledge

In this randomized, double-blind, clinical trial of 120 subjects, significantly more experienced clinically important reductions in pain scores at 30 minutes with ketamine than placebo (76% versus 41%). Subjects receiving ketamine had more adverse events, but none serious.

How this is relevant to clinical practice

Intranasal ketamine at 0.75 mg/kg is an effective analgesic for out-of-hospital adults, with only minor adverse events.

The intranasal route for medication delivery has been shown to provide effective, well-tolerated analgesia that can be delivered more quickly than that provided by parenteral administration.[5-7] Ketamine is a nonopioid *N*-methyl-D-aspartate receptor antagonist that is an effective analgesic with no deleterious effects on cardiorespiratory function when used in low doses.[7,8] The bioavailability through the nasal route is approximately 45%.[9,10]

Reduction in pain intensity has been shown to correspond with blood levels of ketamine, with detectable blood levels 2 minutes after intranasal administration and a mean maximum concentration 30 minutes after administration.[11] Duration of analgesia has been demonstrated for up to 3 hours.[12] Intranasal ketamine has been shown to provide rapid, well-tolerated, effective analgesia to emergency department (ED) patients with acute pain.[13-15] Current out-of-hospital experience with intranasal ketamine for analgesia is limited to small case series[16,17] and battlefield settings.[18]

To our knowledge, there have not been any published reports examining the use of intranasal ketamine in addition to usual paramedic care with nitrous oxide for acute pain in the out-of-hospital setting.

Importance

Intranasal ketamine provides rapid, easily administered, well-tolerated, effective out-of-hospital analgesia, and may obviate the need for parenteral delivery and use of opioids that are unavailable to primary care paramedics.

Goals of This Investigation

We sought to evaluate the proportion of patients reporting moderate or severe pain (verbal numeric rating scale [VNRS] score $\geq$5) who experienced a clinically significant reduction in pain (reduction in VNRS score of 2 or more points) at 30 minutes after administration of intranasal ketamine or intranasal placebo. We additionally sought to compare VNRS score pain reduction at 15 minutes, patient-reported comfort, satisfaction scores, nitrous oxide consumption, and incidence of adverse events.

MATERIALS AND METHODS

Study Design and Setting

This was a randomized, double-blind trial and was approved by the University of British Columbia Clinical Research Ethics Board, the Fraser Health Research Ethics Board, and the Emergency Medical Assistants Licensing Board.

The study took place from November 2017 to May 2018 in a 2000-km^2 (770-mile^2) catchment area of a single station within the British Columbia Emergency Health Services organization, with an annual census of 45,000 calls. The station is staffed by 48 primary care paramedics, of whom 30 were trained in the study protocol. Training involved online review of prepared materials and an in-person educational session with the primary investigator. Competency in the study protocol was confirmed by a 10-question multiple-choice written examination that was constructed by one of the coinvestigators (S.J.) and approved by the study investigators (Appendix E1, available online at http://www.annemergmed.com).

Study materials were prepared by a clinical pharmacist according to a computer-generated block randomization schedule with block sizes of 4 (http://www.randomization.com). Ketamine was supplied as a solution at 50 mg/mL (Sandoz; Sandoz Canada Inc, Boucherville, Quebec, Canada). Pharmacists were not involved with training, recruitment, or data collection. Study materials were stored in sealed padded plastic envelopes in a centrally located biometric safe. Paramedics accessed the safe at the start of their shifts and signed out a study kit that they carried with them in the field. Each study kit contained a verbal assent form, a written consent form, a mucosal atomization device

(LMA MAD300 Nasal TM; Wolfe Tory Medical Inc., San Diego, CA), and 3 preloaded syringes of either ketamine or saline solution placebo. Syringes containing ketamine and syringes containing placebo looked identical. All study materials were labeled only with a sequence number.

Selection of Participants

Inclusion criteria were out-of-hospital patients with acute pain who reported a VNRS pain score greater than or equal to 5, and who wished to receive analgesia when queried. Exclusion criteria were younger than 18 years, known ketamine intolerance, nontraumatic chest pain, altered mental status, pregnancy, nasal occlusion, systolic blood pressure less than 90 mm Hg, or previous enrollment in the study.

To minimize the delay to analgesia provision, eligible patients were approached by the paramedic and asked for verbal assent according to a prepared script. Written informed consent was obtained before offloading of the patient at the ED.

Interventions

All patients received usual care, including nitrous oxide (50% nitrous oxide/50% oxygen mixture), based on existing paramedic protocols for its use as dictated by the Emergency Medical Assistants Licensing Board. Indications for nitrous oxide use by primary care paramedics included the relief of moderate or severe pain, with contraindications including possible pneumothorax, altered mental status, inhalation injury, or inability to comply with instructions. Nitrous oxide therapy was initiated concurrently with administration of intranasal ketamine or placebo.

Ketamine dosing was based on previous reports of intranasal ketamine use in ED patients. Because of intranasal ketamine's limited absorption by the intranasal route, subdissociative doses for analgesia in previous studies have ranged from 0.5 to 1.0 mg/kg.[13,15] The doses chosen for this study were intended to be near the midpoint of this range (0.75 mg/kg). For simplicity of administration while maintaining a weight-based protocol, ketamine dosing was based on 3 body weight categories as estimated by the paramedic in conjunction with the subject: 30 mg of intranasal ketamine for patients weighing 50 kg or less, 50 mg for those weighing 50 to 100 kg, and 75 mg for those weighing greater than 100 kg. This provided intranasal ketamine between 0.5 and 1.0 mg/kg in the treatment group, consistent with previous trials.[13-15] Nasal medications were administered into both nostrils, with half of the volume into each naris. No repeated doses of medication were provided. As per protocol, if rescue medications were required primary care paramedics would call a higher-level provider to attend the scene for the provision of rescue analgesia.

Pain scores were assessed with a validated VNRS with a range of 0 to 10, anchored with 0 representing "no pain at all" and 10 representing "worst pain ever." Patient comfort was assessed with a 7-point scale consisting of "a lot better," "moderately better," "a little better," "the same," "a little worse," "moderately worse," and "a lot worse." These measurements were recorded every 15 minutes for 1 hour or until ED arrival. VNRS pain score, patient comfort, pulse rate, respiratory rate, blood pressure, and oxygen saturation were recorded by the paramedic before administration of study drugs and every 15 minutes thereafter until care was transferred to the ED. These data were recorded on a study data sheet by the paramedic. Patients were queried in regard to adverse events every 15 minutes in accordance with the Side Effects Rating Scale for Dissociative Anesthetics.[19] These elements included fatigue, dizziness, nausea, headache, feeling of unreality, changes in hearing, mood change, general discomfort, and hallucinations. Any interventions in response to adverse events were recorded by the paramedics on the data sheet. Paramedics rated patient and provider satisfaction, using a 10-point VNRS anchored with 0="not at all satisfied" and 10="completely satisfied." The nitrous oxide tank pressure before and after the study protocol was also recorded as a measure of nitrous oxide use.

To evaluate the effectiveness of blinding, at ED transfer paramedics recorded on the data sheet whether they believed the patient had received either ketamine or placebo. Data sheets were returned to a dedicated, secure study box at the paramedic station. Unused study kits were returned to the biometric safe for future use.

Outcome Measures

The primary outcome was the proportion of patients experiencing a reduction in VNRS pain score of 2 points or more at 30 minutes. A clinically significant reduction in pain was defined as a 2-point reduction in the score.[20]

Secondary outcomes included the proportion of patients experiencing a 2-point or more reduction in VNRS score at 15 minutes, the median reduction in the score at 15 and 30 minutes, the proportion of patients feeling "a lot better" or "moderately better" at 15 and 30 minutes, the proportion of patients feeling "a lot better," "moderately better," or "a little better" at 15 and 30 minutes, incidence of adverse events, patient and provider satisfaction, and median nitrous oxide consumption. Adverse events were considered serious if intervention was required in response to the event, including physical restraint or the necessity of calling higher-level providers to attend the scene for medication administration.

Primary Data Analysis

Because of the lack of published data comparing intranasal ketamine or placebo in addition to nitrous oxide, it was decided a priori to determine the group sizes from an internal pilot series of 40 patients (20 per group), which showed that 90% of ketamine patients compared with 60% of placebo patients showed a 2-point or more reduction in VNRS score at 30 minutes. In accordance with these data, it was determined that 49 patients per group (98 total) would be required (power 0.90; α=.05; 2-sided calculation). An extra 20% was added to this enrollment to offset potential dropouts or lost data, resulting in a total sample size of 118 patients (59 per group), rounded to 120 patients total (60 per group).

Data were entered into a spreadsheet by a single research assistant not involved in the study protocol. Data were analyzed with descriptive statistics (Microsoft Excel, version 16.13). Analysis was by intention to treat. Categoric data are presented as frequency and percentage of frequency of occurrence. Continuous data are presented as medians with ranges and interquartile ranges. Adverse effects are described as frequency of occurrence with 95% confidence

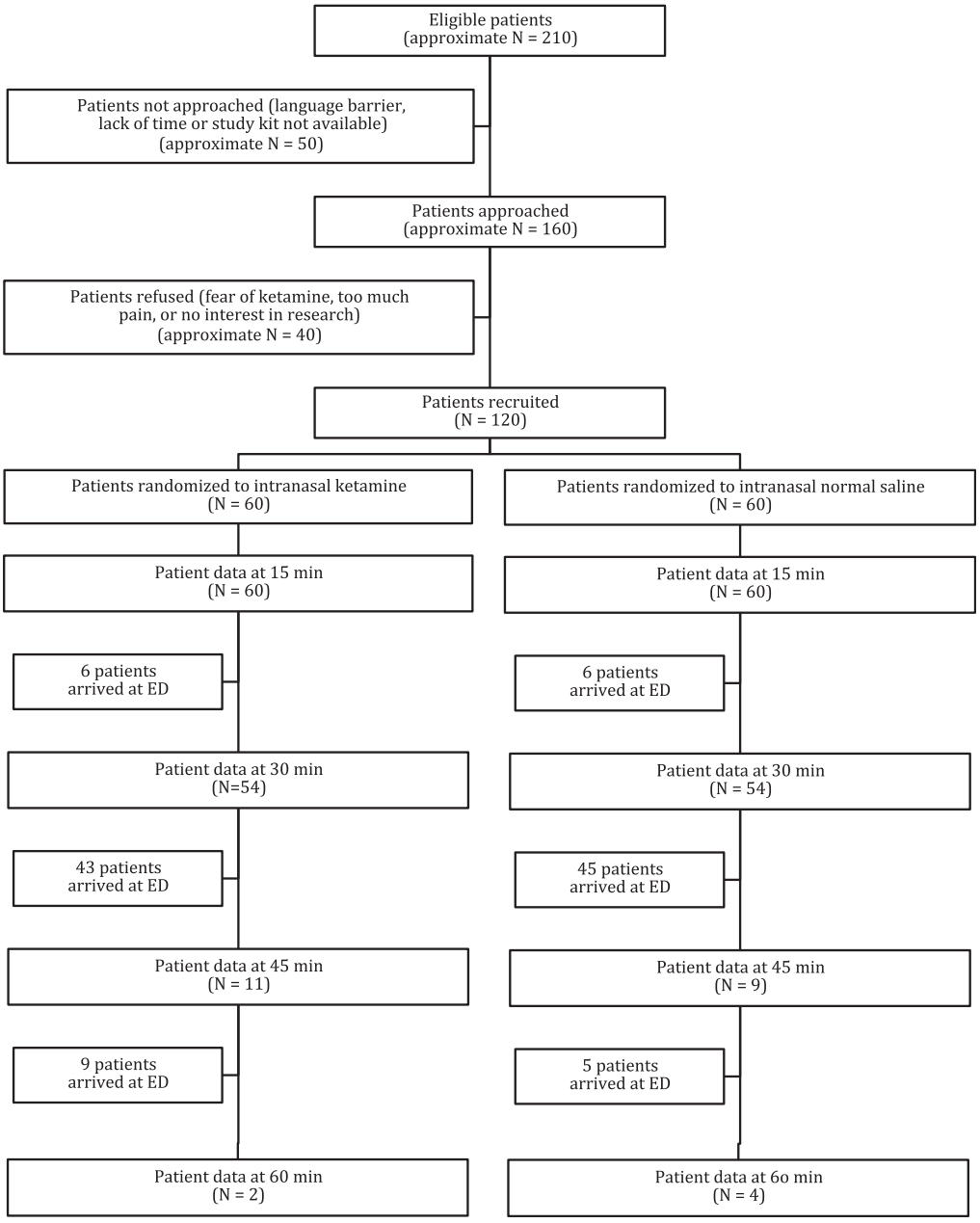

Figure 1. Flow of study subjects.

intervals. Significance testing of the primary outcome was calculated as the z ratio of the 2 proportions.[21] P=.05 was considered statistically significant.

RESULTS

Characteristics of Study Subjects

The flow of study subjects is illustrated in Figure 1. Exact data on the number of patients approached for enrollment were not available. According to correspondence with the enrolling paramedics, it is estimated that 75% of potentially eligible patients were approached for enrollment, and that of those, approximately 75% agreed to participate. Reasons for not approaching potentially eligible patients for enrollment included language barrier, lack of time to perform the consent and data collection process, and not having study kits available in the car. Reasons for eligible patients refusing enrollment included fear of ketamine as a known street drug, no interest in research, and being too much in pain to understand and agree to the study protocol.

Main Results

Patient characteristics are shown in Table 1. Age, body weight, sex distribution, comorbidities, indication for use, and initial pain score were similar between the groups. Main results are displayed in Table 2. Significantly more patients receiving ketamine had a clinically significant reduction in pain score compared with those receiving placebo (P=.002). Pain reduction and change in VNRS pain scores at 15 minutes and 30 minutes are displayed in Figures 2 and 3, respectively. Adverse events are displayed in Table 3. A greater proportion of patients receiving ketamine reported adverse effects, primarily dizziness and feeling of unreality. All adverse effects were considered minor, with no patients requiring any intervention. There were no changes in vital signs requiring any intervention or removal from the study protocol. No patients required the provision of rescue analgesia.

Although inhaled nitrous oxide was offered to all patients, ultimately 27% of ketamine patients and 25% of placebo patients did not receive it. The reasons for this included concern about described adverse effects (10 in each group), unable to activate the inhalation valve (4 in each group), and nitrous oxide not available (2 ketamine, 1 placebo).

Table 1. Characteristics of subjects receiving intranasal ketamine or placebo for analgesia.

Characteristic	Ketamine (N=60)	Placebo (N=60)
Age, y		
Median (IQR)	54 (39–68)	54 (39–69)
Range	18–93	20–96
Age distribution, No. (%), y		
18–49	23 (38)	27 (45)
50–74	28 (47)	23 (38)
≥75	9 (15)	10 (17)
Men, No. (%)	32 (53)	24 (42)
Weight, kg		
Median (IQR)	76 (68–95)	76 (67–96)
Range	42–150	40–220
Baseline VNRS score (scale 1 to 10)		
Median (IQR)	9 (8–10)	9 (8–10)
Range	6–10	5–10
Subjects receiving nitrous oxide, No. (%)	44 (73)	45 (75)
Nitrous oxide consumption, psi		
Median (IQR)	163 (50–200)	205 (50–200)
Range	5–650	20–1,450
Indication for use, No. (%)		
Musculoskeletal pain	40 (67)	42 (70)
Abdominal pain	15 (25)	10 (17)
Headache	2 (3)	3 (5)
Pelvic pain	2 (3)	2 (3)
Chest pain	1 (2)	2 (3)
Burns	0	1 (2)

IQR, Interquartile range.

LIMITATIONS

This study was conducted at a single site, which may limit generalizability. Paramedics recruited subjects according to convenience sampling in the field and would likely have been prone to selection bias.

Some patients did not receive nitrous oxide, thus limiting the conclusions that can be made of ketamine's effect when added to inhaled nitrous oxide. However, this strengthens the pragmatic nature of the study because patients are often not able to receive or tolerate nitrous oxide, which is a significant contributor to paramedic dissatisfaction with inhaled nitrous oxide and patient dissatisfaction with out-of-hospital analgesia.

There was a component of unblinding because 63% of paramedics were able to correctly identify use of ketamine and 72% of paramedics were able to correctly identify use of placebo.

Finally, the sample size may not have been able to identify the incidence of rare serious adverse effects.

Table 2. Primary and secondary outcomes in subjects receiving intranasal ketamine or intranasal normal saline solution.

Results	Ketamine	Placebo	Difference, % (95% CI)
Primary outcome			
Proportion of subjects experiencing ≥2-point VNRS pain score reduction at 30 min,*,† No. (%)	41 (76)	22 (41)	35 (17 to 51)
Secondary outcomes			
Proportion of subjects experiencing ≥2-point VNRS pain score reduction at 15 min,‡ No. (%)	38 (63)	21 (35)	28 (10 to 44)
Reduction of VNRS pain score at 15 min†			
Median (IQR)	2 (0.8 to 4)	1 (0 to 2)	
Range	−1 to 10	−2 to 5	
Reduction of VNRS pain score at 30 min*			
Median (IQR)	3 (2 to 5)	1 (0 to 4)	
Range	−1 to 10	−2 to 8	
Proportion of subjects feeling "a lot better" or "moderately better" at 15 min,‡ No. (%)	26 (43)	10 (17)	27 (10 to 41)
Proportion of subjects feeling "a lot better" or "moderately better" at 30 min,* No. (%)	23 (43)	13 (24)	19 (1 to 35)
Proportion of subjects feeling "a lot better," "moderately better," or "a little better" at 15 min,‡ No. (%)	45 (75)	34 (57)	18 (1 to 34)
Proportion of subjects feeling "a lot better," "moderately better," or "a little better" at 30 min,* No. (%)	33 (61)	25 (46)	15 (−4 to 32)
Patient satisfaction (1 to 10 scale)†			
Median (IQR)	5 (2.8 to 7)	2 (0 to 6)	
Range	0 to 10	0 to 10	
Provider satisfaction (1 to 10 scale)†			
Median (IQR)	6 (3.8 to 8)	2 (0 to 5)	
Range	0 to 10	0 to 10	
Proportion of providers correctly identifying the study drug,‡ No. (%)	38 (63)	43 (72)	−8 (16 to 33)

*Ketamine N=54, placebo N=54.
†P=.002.
‡Ketamine N=60, placebo N=60.

Discussion

The addition of intranasal ketamine to usual primary paramedic care with inhaled nitrous oxide results in a significantly greater proportion of patients experiencing a clinically significant reduction in pain. There was also improved subjective comfort and satisfaction scores, but with more minor adverse events compared with intranasal placebo with inhaled nitrous oxide.

Primary care paramedics compose the majority of paramedic staff in this out-of-hospital system. Because use of parenteral delivery methods and opiates is not available to primary care paramedics, they are limited to the use of inhaled nitrous oxide as an analgesic. This results in a significant burden of uncontrolled pain for patients and contributes to dissatisfaction of both patients and primary care paramedics. In this study, primary care paramedics were able to use intranasal ketamine analgesia effectively and with apparent safety. As expected, for patients receiving ketamine, there was less consumption of inhaled nitrous oxide compared with that for patients receiving placebo.

Some patients refused inhaled nitrous oxide or were not able to tolerate its effects, whereas others were not able to be compliant with its use. In this study, approximately a quarter of patients in each group either refused or were not able to tolerate inhaled nitrous oxide. The most common reason cited for this was adverse effects, followed by inability to activate the inhalation system. For these patients, intranasal ketamine appears to be an efficacious analgesic option.

The use of inhaled nitrous oxide is not well liked by many paramedics, who cite difficulty with patient

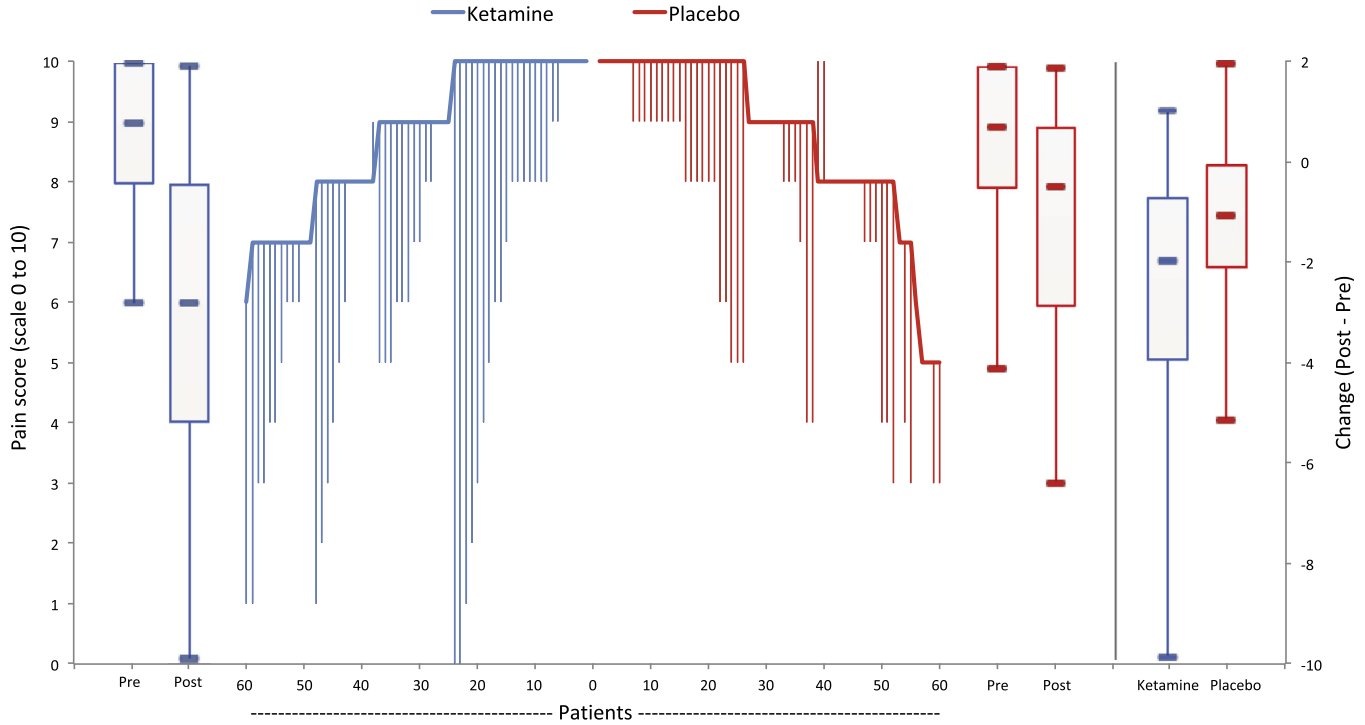

Figure 2. Pain reduction and change in pain score at 15 minutes. The boxes depict the medians and interquartile ranges, with the whiskers showing the maximum and minimum values.

compliance, patient inability to activate the inhalation system, and limited analgesic efficacy as primary justifications for this stance. The intranasal route is ideal for use by primary care paramedics in relatively austere conditions because it requires no specialized skills and can be provided quickly. Opioid analgesia is unavailable to primary care paramedics; in addition, respiratory depression and concerns of oversedation have been cited as primary justifications for withholding opioids.[22] Ketamine is well known to preserve cardiorespiratory function and thus is well suited for use in austere out-of-hospital settings.[23]

Ketamine appeared to provide rapid pain reduction when given in addition to nitrous oxide, with a greater proportion of patients reporting a significant reduction in pain score at 15 and 30 minutes. Subjective comfort was improved at all points but was most pronounced at 15 minutes. This is consistent with findings in previous studies that noted the rapid onset of pain reduction with the use of ketamine analgesia.[24,25]

Adverse effects were minor and more commonly reported for patients receiving ketamine. As has been reported previously, the majority of patients reported dizziness, feeling of unreality, and nausea. Despite this, satisfaction scores in the ketamine group were higher, a finding consistent with those of previous comparative studies.[13] The trend to higher satisfaction scores despite a higher incidence of reported adverse effects supports the premise that adverse effects with low-dose ketamine analgesia are minor. This is further supported by the fact that no adverse effects required any treatment, consistent with previous reports on low-dose ketamine analgesia.[13,15,24-27]

The incidence of adverse effects with the use of ketamine in subdissociative doses appears to be inversely related to the dose used[26] and to the speed of delivery.[27] Analgesic efficacy is preserved with slower delivery rate of ketamine,[27] whereas use of lower doses of ketamine shows a trend to lesser analgesic efficacy and a substantial reduction in the incidence of adverse effects.[26] Further study of the intranasal route could include the use of differing doses to examine the balance between analgesic efficacy and the incidence of adverse effects.

Blinding of paramedics to ketamine use was moderately effective in this study. Many of the known effects of ketamine, such as nystagmus, are not present when ketamine is used in low analgesic doses; thus, paramedics would not be able to use this finding to identify the study drug used. Many of the known adverse effects of ketamine are related to its dissociative effects. At low doses, effects such as dizziness and feeling of unreality are most common. It is possible that the concomitant use of inhaled nitrous oxide obscured the detection of these

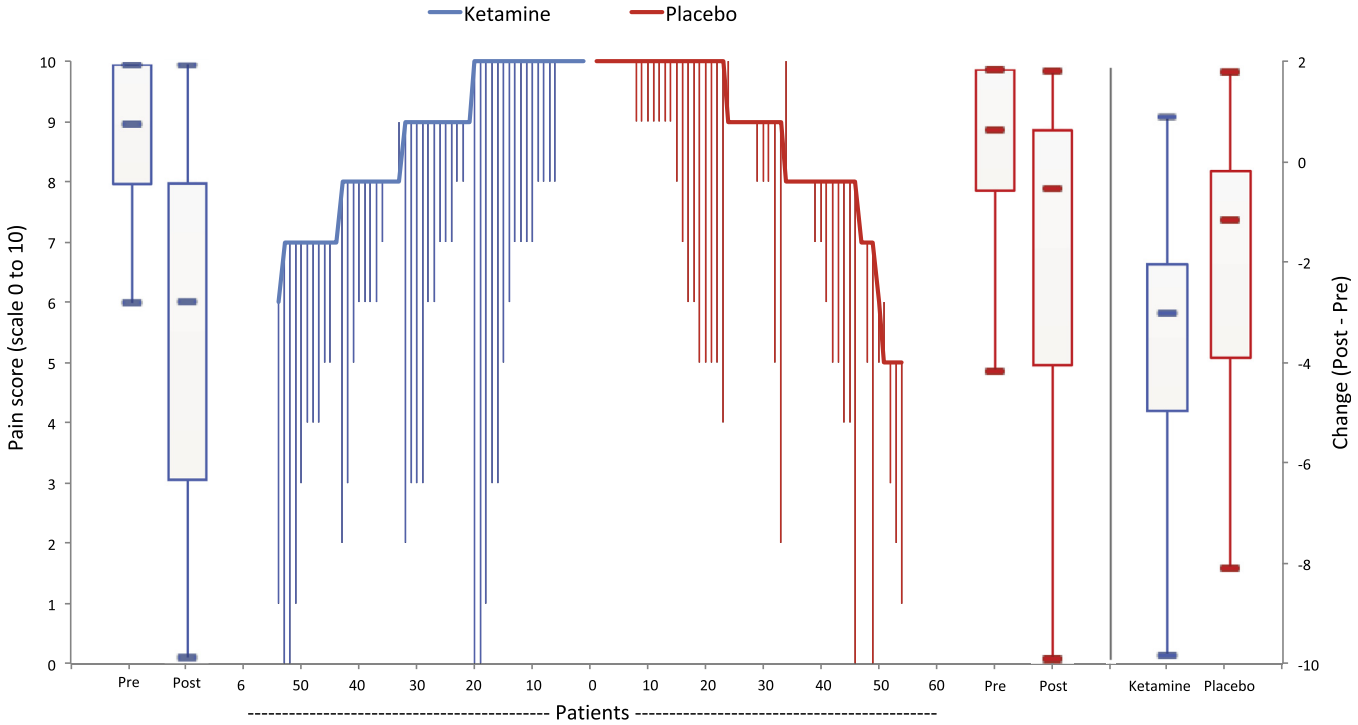

Figure 3. Pain reduction and change in pain score at 30 minutes. The boxes depict the medians and interquartile ranges, with the whiskers showing the maximum and minimum values.

ketamine-related effects, thus improving the blinding in patients receiving both ketamine and nitrous oxide. For patients not receiving nitrous oxide, the effect of ketamine was likely to be much more apparent, thus inhibiting blinding.

In summary, compared with placebo, the addition of intranasal ketamine to usual care with nitrous oxide results in a greater proportion of patients reporting a clinically significant reduction in VNRS pain score within 30 minutes and improved subjective comfort. Ketamine was

Table 3. Subject-reported adverse effects in subjects receiving intranasal ketamine (N=60) or placebo (N=60).

Results	Ketamine	Placebo	Difference, % (95% CI)
Adverse effects			
Subjects experiencing adverse effects, No. (%) [95% CI]	37 (62) [49 to 73]	12 (20) [12 to 32]	42 (24 to 56)
No. of adverse effects experienced*	52	14	
Adverse effects, No. (%) [95% CI]			
Feeling of unreality	16 (27) [17 to 39]	1 (2) [0.3 to 9]	25 (13 to 37)
Dizziness	12 (20) [12 to 32]	6 (10) [5 to 20]	10 (–3 to 23)
Nausea	10 (17) [9 to 28]	3 (5) [2 to 14]	12 (0.3 to 24)
Fatigue	6 (10) [5 to 20]	1 (2) [0.3 to 9]	8 (–1 to 19)
General discomfort	3 (5) [2 to 14]	3 (5) [2 to 14]	0 (–9 to 9)
Mood change	3 (5) [2 to 14]	1 (2) [0.3 to 9]	3 (–5 to 12)
Hallucination	1 (2) [0.3 to 9]	1 (2) [0.3 to 9]	0 (–7 to 7)
Change in hearing	1 (2) [0.3 to 9]	0	2 (–5 to 9)
Headache	0	1 (2) [0.3 to 9]	2 (–5 to 9)

*Some subjects experienced more than one adverse effect.

associated with more minor adverse effects not requiring treatment and greater overall satisfaction scores. The use of intranasal ketamine in the out-of-hospital setting is effective and appears safe in the hands of primary care paramedics.

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Author contributions: GA and EW conceived the study. GA obtained research funding. All authors designed the trial. EW and RS provided statistical expertise on study design. GA, WD, SJ, and GB supervised paramedic training, patient recruitment, and data collection. EW analyzed the data. GA drafted the article, and all authors contributed to its revision and approval. GA takes responsibility for the paper as a whole.

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DIAGNOSIS:

Testicular torsion. Bedside ultrasonography of the patient revealed absent color Doppler flow of the left testis. The emergency physician immediately performed manual detorsion at the bedside, and ultrasonography showed partial reperfusion of blood flow (Figure 2, Video E2, available online at http://www.annemergmed.com). The patient underwent bilateral orchiopexy to prevent the recurrence of torsion and was discharged uneventfully after 2 days.

Testicular torsion is a common urologic emergency among adolescent boys and young men. Rotation of the testis and twisting of the spermatic cord rapidly leads to ischemia, resulting in a loss of germ cells.[1] Potential examination findings include no pain relief with testicular elevation (Prehn's sign), retraction of the scrotal skin (Ger's sign), and high-riding testis (Brunzel's sign).[2] Color Doppler ultrasonography is a useful and rapid tool for imaging the acute scrotum, with an absence of testicular flow diagnostic for ischemia.[3] If surgery is not readily available, immediate manual detorsion is warranted; orchiopexy is likely warranted to prevent recurrence.[4]

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