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PAin SoluTions In the Emergency Setting (PASTIES); a protocol for two open-label randomised trials of patient-controlled analgesia (PCA) versus routine care in the emergency department

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To cite: Smith JE, Rockett M, Squire R, *et al*. PAin SoluTions In the Emergency Setting (PASTIES); a protocol for two open-label randomised trials of patient-controlled analgesia (PCA) versus routine care in the emergency department. *BMJ Open* 2013;**3**:e002577. doi:10.1136/bmjopen-2013-002577

▸ Prepublication history for this paper are available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2013-002577).

Received 9 January 2013
Accepted 17 January 2013

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ABSTRACT

Introduction: Pain is the commonest reason that patients present to an emergency department (ED), but it is often not treated effectively. Patient controlled analgesia (PCA) is used in other hospital settings but there is little evidence to support its use in emergency patients. We describe two randomised trials aiming to compare PCA to nurse titrated analgesia (routine care) in adult patients who present to the ED requiring intravenous opioid analgesia for the treatment of moderate to severe pain and are subsequently admitted to hospital.

Methods and analysis: Two prospective multicentre open-label randomised trials of PCA versus routine care in emergency department patients who require intravenous opioid analgesia followed by admission to hospital; one trial involving patients with traumatic musculoskeletal injuries and the second involving patients with non-traumatic abdominal pain. In each trial, 200 participants will be randomised to receive either routine care or PCA, and followed for the first 12 h of their hospital stay. The primary outcome measure is hourly pain score recorded by the participant using a visual analogue scale (VAS) over the 12 h study period, with the primary statistical analyses based on the area under the curve of these pain scores. Secondary outcomes include total opioid use, side effects, time spent asleep, patient satisfaction, length of hospital stay and incremental cost effectiveness ratio.

Ethics and dissemination: The study is approved by the South Central—Southampton A Research Ethics Committee (REC reference 11/SC/0151). Data collection will be completed by August 2013, with statistical analyses starting after all final data queries are resolved. Dissemination plans include presentations at local, national and international scientific meetings held by relevant Colleges and societies. Publications should be ready for submission during 2014. A lay summary of the results will be available to study participants on request, and disseminated via a publically accessible website.

Registration details: The study is registered with the European Clinical Trials Database (EudraCT Number: 2011-000194-31) and is on the ISCRTN register (ISRCTN25343280).

INTRODUCTION

Pain is defined as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage'.[1] Pain is the commonest reason that patients present to the emergency department (ED), but it is often not treated effectively.[2] In a national survey of ED patients, 66% reported they were in pain.[3] The UK College of Emergency Medicine recommends that patients in severe pain should receive analgesia within 20 min of arrival in the ED, with regular reassessment and further action as required.[4] However, effective analgesia is often not achieved and almost half of patients recently surveyed thought more could be done to treat their pain in the ED.[3]

Routine care for patients in moderate or severe pain often involves the administration of intravenous morphine, which is the standard opioid used in most hospitals and has been shown to be as effective as other opioids.[5] In EDs across the UK, analgesia for patients in severe pain is currently provided by nurse-delivered intravenous morphine administered over several minutes to achieve pain relief. This technique is safe and effective in the short term but places significant

demands on nursing time, particularly when repeated doses are needed.[6]

Once a patient is admitted to a hospital ward, severe pain may be managed using strong oral opioid analgesia or advanced pain management techniques. Best practice includes multimodal analgesia using regular paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) in addition to opioids. The decision to admit a patient to the ward has been shown to delay the delivery of effective analgesia in the ED—suggesting that this group of patients are at particular risk of poor pain management.[7]

One solution may be to allow patients to deliver opioid analgesia themselves via a patient controlled analgesia (PCA) device. This device consists of a volumetric pump, which delivers a set intravenous dose of drug when a control button is pressed. The PCA system includes antisyphon and antireflux valves to minimise the risk of inadvertent drug delivery. The pump has a safety 'lockout' period when it does not deliver a further dose of opioid. A protocol commonly used throughout many UK hospitals, in settings other than the ED, uses a 1 mg bolus (1 mg morphine) and lockout period of 5 min, and is derived from a broad evidence base.[8–11] PCA has been shown to be more effective in providing pain relief when compared to standard methods of analgesia delivery in areas such as postoperative care, burns and in terminal care.[12–15] PCA is most effective in maintaining analgesia once baseline pain relief has been established.[16]

Despite the high prevalence of pain in ED patients there is very limited evidence relating to the use of PCA in this setting. Prior to starting the PASTIES trial, only one small randomised trial of 86 adult patients with pain due to trauma presenting to the ED had been published,[17] which concluded that PCA was as effective as standard nurse titrated analgesia. However, the trial data were collected during the patients' ED stay only, and did not continue to follow them after admission to a hospital ward. Having contacted the corresponding author of this paper, it would appear that the main issue with this study was that the duration of active participation did not extend beyond 3 h (Clancy M, personal communication, 2009).

Three further relevant studies have been reported since the current study started, although all three studies were limited to a 2 h period in the ED. The largest,[18] a study done in North America, randomised 211 emergency patients with abdominal pain to one of three groups; standard care, PCA standard dose (1 mg) bolus or PCA higher dose (1.5 mg) bolus. It found that there was a significant reduction in pain in both PCA groups compared to standard care. A smaller study from Malaysia included patients presenting with pain of traumatic origin;[19] 96 patients in two centres were randomised to either standard care or PCA (1 mg boluses), with a significant reduction reported in pain scores in the PCA group compared to the standard care group. The same two authors reported another smaller study of 47 patients with traumatic injury.[20] Patients were again randomised to receive either standard care or PCA (1 mg boluses). This study found similar reductions in pain scores in the PCA group compared to standard care. These three recent studies provide further limited evidence of the short-term utility of PCA in emergency patients, but do not address the management of pain over the subsequent hours following hospital admission.

Cost analyses of the use of PCA versus standard analgesia have been carried out in a postoperative setting and suggest that PCA costs may be higher.[21] However, in the ED the heavy demands on nursing time of providing intravenous analgesia may offset the initial high setup costs of PCA analgesia; this current study will therefore determine the UK cost implications of PCA use in the emergency setting over the first 12 h of hospital care. No previous or current studies have been identified that combine ED care with ongoing ward care to assess quality of pain relief beyond 4 h, and no detailed analysis of the cost-effectiveness of PCA in this setting has previously been reported.

The aim of our study is therefore to compare PCA morphine to routine care (nurse titrated intravenous morphine in the ED and oral or parenteral morphine on the wards) in adult emergency patients who present in moderate or severe pain due to traumatic injuries or non-traumatic abdominal pain, and are then admitted to an inpatient ward.

METHODS AND ANALYSIS

Study design

The study comprises two contemporaneous multi-centre open-label randomised trials of PCA versus routine care in the ED. Patients presenting to the ED requiring intavenous analgesia and admission to hospital, with either traumatic musculoskeletal injury or non-traumatic abdominal pain, are potentially eligible for inclusion. Key outcome measures will be collected at baseline and then hourly for 12 h. While two separate trials are running (one of patients presenting with traumatic musculoskeletal injuries, the other with non-traumatic abdominal pain), both are based on the same protocol, which is outlined below. Nevertheless, they are considered as two separate trials since they are powered separately.

Participants

Eligible patients are adults presenting to the ED with either traumatic injury or non-traumatic abdominal pain requiring intravenous opioid analgesia and hospital admission for at least 12 h from the time of enrolment. Exclusion criteria are listed in table 1. Study participants include patients who meet the screening criteria and are willing and able to give informed consent.

Table 1 Exclusion criteria

Criteria	Rationale
Patients over 75 years	Altered plasma levels of opioid in this age group for a given standard dose of PCA
Patients with a reduced conscious level (Glasgow Coma Score <15)	Will not be able to give informed consent
Inability to operate a PCA device	Will not be able to complete the intervention
Patients who cannot understand the study information	For example due to pre-existing dementia, learning difficulties or intoxication. Will not be able to give informed consent
Patients with chronic pain	Altered pain processing or opioid tolerance
Patients who are opioid tolerant or have active opioid addiction	Abnormal response to opioids or potential opioid misuse
Patients with a history of renal failure	Accumulation of active opioid metabolites
Allergy or other contraindication to morphine	
Hypotension (systolic blood pressure <90 mmHg)	Morphine may exacerbate hypotension
Patients in police custody, or prisoners	
Inability to gain intravenous access	Will not be able to receive intravenous morphine
Patients who are likely to be definitively treated in the ED and discharged, or who are likely to require transfer for surgery direct from the ED	Will not be able to complete 12 h of VAS scoring
Patients who are pregnant or breast-feeding	Altered drug metabolism and fetal/infant opioid effects
Patients on other predetermined analgesia pathway	eg, regional anaesthesia
Previous participation in this study	
Current participation in another CTIMP	

CTIMP, clinical trial of an investigational medicinal product; ED, emergency department; PCA, patient controlled analgesia, VAS, visual analogue scale.

Study recruitment

Patients are screened by a research nurse on arrival at the ED. Following an initial assessment and pain management, patients are approached by a research nurse and given a patient information sheet detailing the study. If they are happy to discuss the study further, any questions are answered at this stage. Patients are then fully assessed against the inclusion and exclusion criteria before written informed consent is obtained from the patients willing and able to participate. Patients who decline to take part are not obliged to give a reason for declining but reasons are recorded by the research nurse if given.

Study procedures

After informed consent is obtained, the first visual analogue scale (VAS) pain score is recorded, and the patient randomised (using a secure web-based randomisation system) to receive either PCA or routine care (see figure 1).

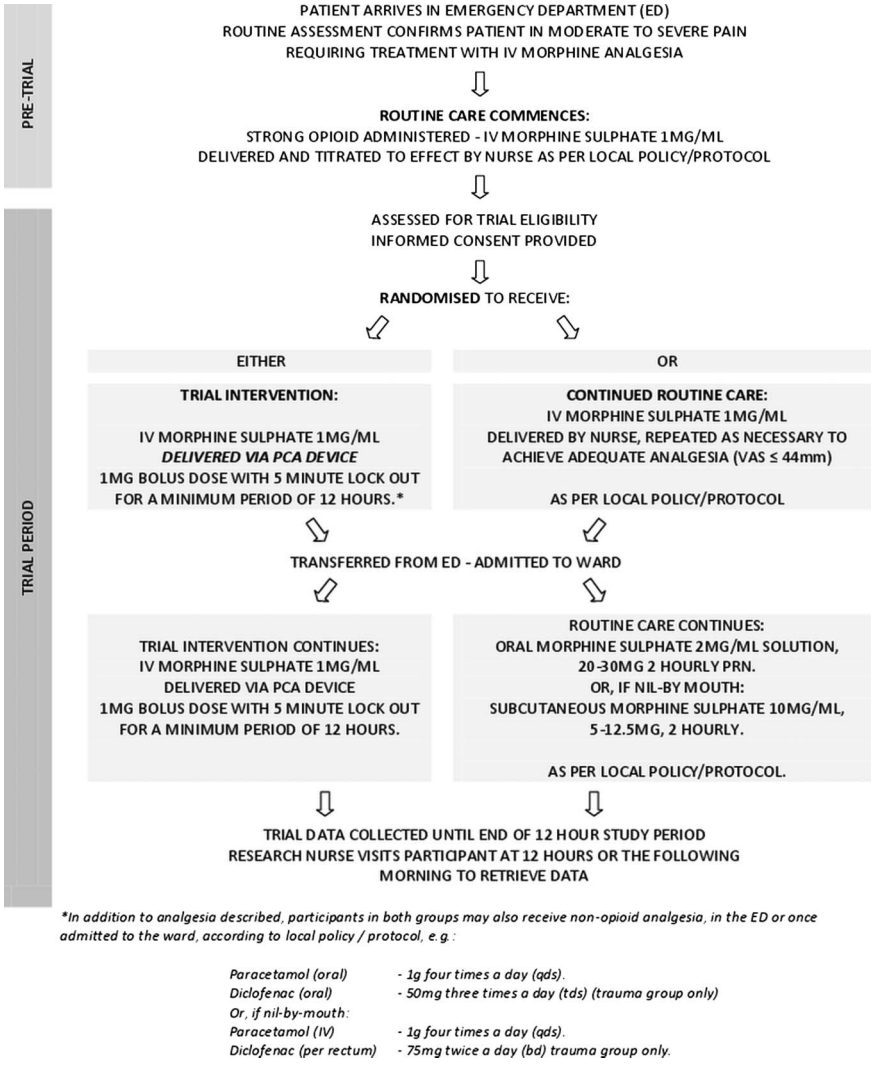
Participants in both groups then receive instructions on how to complete the VAS scores, which are entered into a mini flipchart. The participant turns the page of the flipchart after an entry is made, and the previous score is therefore not visible for comparison the next time a VAS score is recorded. Participants in the trauma group are instructed to record their pain scores on movement, while those in the abdominal group are asked to record their pain scores upon deep breathing. Electronic timers (Casio F-91W digital watches) issue a bleep every hour as a reminder to the participant to complete the hourly score, but this bleep is not usually loud enough to wake the participant from sleep. Participants are also instructed how to record periods asleep on the booklet, using a tick box on each page.

Interventions

The participants allocated to receive routine care are prescribed intravenous morphine while in the ED and oral morphine (or subcutaneous/intramuscular for those nil by mouth) when transferred to the hospital ward. The participants randomised to the PCA group receive instruction from the research nurse on how to operate the PCA device, which is set up by the ED nurses, and initiated with a 1 mg morphine bolus and a 5 min lockout. PCA is continued for a minimum period of 12 h; in practice ongoing requirement for PCA is reviewed the following morning by the clinical team. Participants in both the groups are prescribed multimodal analgesia in addition, including paracetamol and a NSAID unless contraindicated, and are also prescribed antiemetics as required. Most outcome data are collected for 12 h from the point at which the first pain score is completed. Length of hospital stay and final diagnosis at discharge are collected retrospectively.

Where possible, at the end of the 12 h study period (or the following morning as appropriate), participants in both groups are visited by a research nurse to facilitate study data collection. The final page of the data collection booklet includes a five-point patient pain

Figure 1 Trial schematic.



management satisfaction score ranging from 'perfectly satisfied' to 'not satisfied at all'. There is also a final pain VAS score, collected the following morning, which may be used to guide analysis of missing final data points.

Primary outcome measure

The primary outcome measure is the total pain experienced over the 12 h study period, as captured by hourly completion of a VAS. The VAS is presented as a 100 mm horizontal line with verbal anchors at each end of 'no pain' and 'worst pain possible'. The study participant selects the point along the line (and marks this point with a pen) that reflects their current pain perception. Participants record VAS scores at 60 min intervals over a 12 h period. Periods of sleep are also recorded retrospectively by the participant.

Secondary outcome measures

Secondary outcome measures include total opioid dose, opioid side effects, patient satisfaction with pain management, proportion of study period with VAS >44 mm, proportion of study period spent sleeping, length of hospital stay and incremental cost effectiveness ratio (ICER).

Total opioid dose is recorded from the prescribed medication administered as recorded on the patient's drug chart during the study period. Study observation charts are utilised for all study participants and are based on the standard hospital charts: these are completed as part of routine care by ED nurses in the ED, and then by ward nurses after inpatient ward admission. Observations follow the standard of care in each centre. Typically, this involves observations 1 hourly for 4 hours, 2 hourly for 8 hours and 4 hourly thereafter. In practice, this will mean hourly vital signs in the ED and 2 h vital signs for the rest of the study period. Observations include heart rate, blood pressure, respiratory rate, oxygen saturations, oxygen flow rate, sedation score (AVPU) and nausea score (0–2). A research nurse reviews the observation charts after the 12 h study period and transcribes out-of-range results into the study case report form (CRF). Following the participant's discharge, the length of stay in hospital and final diagnosis at discharge are obtained from the patient

administration system (or equivalent) by the research nurse and recorded in the CRF.

Randomisation and blinding

Randomisation to either PCA or standard care is undertaken via a secure web-based randomisation system. Research team members accessing the randomisation website do not know the allocation for an individual patient until the relevant details are entered and recruitment confirmed.

As pain experience over subsequent hours may be affected by the time of day of recruitment (those included later in the day will be scoring their pain during night hours when they may spend a greater proportion of time asleep), randomisation is stratified by morning/afternoon admission, as well as by recruitment centre. Blinding is not possible for this study due to the nature of the intervention.

Sample size

The main objective of this study is to assess the magnitude of any difference in total pain scores between the PCA and standard care groups, for each population. Primary outcome data are being collected in terms of self-reported pain scores over time, with VAS measurements completed hourly over the 12 h study period. Data will be conceptualised as a graph of VAS pain against time and used to produce an area under the curve (AUC) for each patient. This is a measure of overall pain experienced during the study period.[22]

Very few studies have addressed the question of what reduction in AUC might be a clinically significant analgesic effect. One study by Camu *et al*[23] demonstrated that a 20% reduction in the AUC for pain on movement was associated with a 26% absolute increase in the proportion of patients reporting their global rating of pain relief as very good or excellent (p=0.01). Conservatively, therefore, a difference in AUC of 15% between PCA and standard care groups was chosen to be of clinical significance. On a standardised AUC (scoring between 0 and 100) the standard care group is expected to have an average score of about 40 units, so 15% equates to a six-point reduction. A SD can be estimated from the research conducted by Camu *et al*[23] as about 15 units. Based on these assumptions, and using a two-tailed two sample t test, with a type I error rate of 0.05, a sample size of 100 patients per group provides sufficient power (80%) to detect a between-group difference of 15%.

Statistical analyses

The primary analyses are all pre-specified and a detailed statistical analysis plan will be completed and signed-off by the data monitoring committee prior to starting the analyses. Data will be reported and presented according to the CONSORT statement.[24] In the primary analyses the data will be pooled across all participating recruitment centres, with adjustment for centre in all comparative analyses, and with adjustment for time of recruitment. 95% CI will be calculated and presented where possible.

The primary statistical analysis will follow an intention-to-treat approach, with the intent-to-treat population defined as all participants in the trial who completed the baseline and at least one other pain VAS. The primary outcome measure of total pain experienced will be captured using the area under the curve approach and will be compared between PCA and standard care groups using analysis of covariance, which will include the two stratification variables as covariates, both being considered as fixed effects, with a suitable transformation of the AUC considered if necessary. The estimate of the difference in mean AUC will be presented, together with a 95% CI for the difference.

Continuous secondary outcomes will be compared between the two groups using analysis of covariance, with adjustment for stratification variables and a suitable transformation of each variable considered if necessary. For each of the side effects, binary logistic regression will be used to estimate the OR and 95% CI for the group effect.

For the analysis of the participant's satisfaction with pain management, it is likely that the five-point scale (ranging from 'perfectly satisfied' to 'not at all satisfied') will need to be recoded into fewer categories. Depending on how many recoded categories there are, either binary or ordinal logistic regression will be used to determine the OR and 95% CI for the group effect.

Missing data

It was anticipated prior to starting the study that there would be some missing VAS scores and the original protocol specified how both missing data and periods when a participant indicated she/he was asleep should be handled within the analysis. However, inspection of the incoming combined primary outcome data suggests that there may be a relatively high proportion of participants with one or more missing pain VAS scores—in particular, indications of being asleep. As part of the development of the statistical analysis plan, more detailed rules for handling the missing pain VAS scores have been developed for each missing data scenario (sleep, spoilt, score missing but participant remained in trial and score missing because participant withdrawn from trial). In brief, this involves linear interpolation where the absent pain score(s) falls between two valid VAS scores, and last observation carried forward where the absent score(s) extends to the final 12 h time point. The one exception to the latter is when it makes more sense to impute zero for the remaining scores, in particular if the patient is discharged because the pain has resolved; any other such potentially ambiguous situations will be judged on an individual basis, blinded to group allocation. Furthermore, a number of sensitivity analyses are also planned, such as treating all sleep periods as zero. The strategies have been discussed and agreed

with the data monitoring committee and will be incorporated into the statistical analysis plan.

Economic evaluation

The trial will include a cost-effectiveness study from an NHS perspective. For the economic evaluation, the relative effectiveness of the intervention will be measured in terms of hours in moderate or severe pain averted. Details of the volume of resources used for pain management using the PCA or in usual management will be collected, ignoring resource use that is common to both study arms. Resource use will be costed using standard NHS costs. The main drivers of marginal cost in this study are likely to be medical and nursing time, but the evaluation will include the costs of medication, equipment and disposables and costs associated with length of stay. As part of the economic evaluation, an opportunistic sample of up to 20 patients in each arm of the trial will be observed by a research nurse and the time required for pain management by healthcare staff will be recorded. The results of the economic evaluation will be reported as ICERs defined as the additional cost per hour in moderate or severe pain averted. Uncertainty around the estimates of the ICER will be explored using probabilistic and deterministic sensitivity analysis.

ETHICS AND DISSEMINATION

Ethical considerations

The protocol is designed to conform to the principles of the Declaration of Helsinki and has been approved by the South Central—Southampton A Research Ethics Committee (REC reference 11/SC/0151). A clinical trial authorisation has been obtained from the Medicines and Healthcare products Regulatory Agency (MHRA) and the study runs in compliance with the Medicines for Human Use (Clinical Trials) Regulations 2004 and subsequent amendments, the principles of GCP, the Research Governance Framework for Health and Social Care (Second edition, 2005) and the Data Protection Act 1998. The study has been adopted by the NIHR Clinical Research Network (CRN).

The study is sponsored by Plymouth Hospitals NHS Trust and approved by the participating trust's research and development departments at investigator sites. The study is managed by the UKCRC-registered Peninsula Clinical Trials Unit at Plymouth University (Registration No: 31).

A trial management team meets regularly to discuss the progress of the trial, and address any issues that arise. A Trial Steering Committee (TSC), with an independent chair, meets approximately every 6 months to oversee the conduct and safety of the trial. A Data Monitoring Committee (DMC), comprising two independent clinicians and one independent statistician, meets approximately every 6 months to oversee the data management and any issues relating to patient safety. The DMC provides recommendations to the TSC following each meeting.

The main ethical consideration is that emergency patients in pain are being asked to participate in a research study. However, all the patients are initially treated according to their needs, and only once the patient has received appropriate initial analgesia and made more comfortable, are they approached regarding the study.

Timelines and dissemination plans

Approval from a NHS Research Ethics Committee was obtained in May 2011. Recruitment and training of staff involved in the project occurred in June 2011, and recruitment of participants started in July 2011. Additional trial centres were added, to improve recruitment, during 2012.

Patient recruitment will complete in July 2013. Statistical analyses will start once final data collection and monitoring has concluded, and it is anticipated that the first publications will be ready for submission by early 2014.

As well as the submission of research articles to appropriate peer-reviewed journals, research findings will be submitted for presentation at local, national and international scientific meetings held by, for example, the College of Emergency Medicine, Faculty of Pain Medicine and Royal College of Anaesthetists. In particular, effective dissemination of research findings throughout the Emergency Medicine community within the UK and overseas is anticipated with one of the study authors (JRB) currently chairing the UK Clinical Effectiveness Committee of the College of Emergency Medicine. A lay summary of the results will be available to study participants on request, and disseminated via a publically accessible website.

CONCLUSIONS

The lack of evidence regarding the effectiveness of PCA to manage pain in patients presenting to emergency departments indicates the need for well-designed clinical trials to investigate this subject. This study, comprising two trials in different populations of patients in pain presenting to the ED, has been designed to investigate whether PCA is more effective than standard care in managing pain in the ED and during the following hours of hospital admission. This is the first study to follow-up participants from emergency admission to the hospital ward, and will therefore give a pragmatic answer to the question of whether PCA should be used in these patients.

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Contributors JS, MR and RS conceived the idea of the study and JS, MR, RS, PE, AB, and CP were responsible for the initial study design. CJH, SC and JRB further contributed to the final study design. SC and PE designed the plan for data analysis with input from all other authors. All authors contributed to the planning of the study, have critically revised successive drafts of the manuscript, and have approved the final version.

Funding This work is supported by the NIHR Research for Patient Benefit (RfPB) Programme, grant reference number PB-PG-0909–20048.

Competing interests None.

Ethics approval South Central—Southampton A Research Ethics Committee.

Provenance and peer review Not commissioned; internally peer reviewed.

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