Patient controlled analgesia (PCA), involving the use of on-demand analgesia (usually opioids) under patient control, is commonly used to treat acute postoperative pain. Such on-demand delivery systems offer pharmacokinetic advantages and practical advantages over ‘as required’ analgesic administration, including: steadier plasma drug concentrations increased patient autonomy and reduced nursing time [1]. Randomised controlled trials have demonstrated clinical advantages of PCA in postoperative populations with higher patient satisfaction, lower pain scores and a lower risk of pulmonary complications [2, 3]. Moreover, over recent years, evidence has emerged for the use of PCA outside of a postoperative population.

Despite a high prevalence of acute pain amongst Emergency Department (ED) patients, obstacles such as the under-use of analgesics and delays in analgesic administration, often hinder the delivery of optimal pain management [4]. Recent pressures on NHS departments and year-on-year increases in ED attendances may further compound these problems [5]. Clinical research has suggested benefits with the use of PCA in EDs indicating that PCA may result in clinically significant reductions in pain scores [6, 7], and comparable pain scores and patient satisfaction to intermittent intravenous boluses [8]. Despite these previous studies on efficacy, the costs associated with the use of PCA within an ED population are yet to be elucidated. It is, therefore, perhaps timely to investigate the cost implications of introducing PCA into routine ED practice.

In this issue of Anaesthesia, Pritchard et al. present an economic evaluation of the use of PCA in a population of patients attending ED and subsequently admitted for traumatic injuries or non-traumatic abdominal pain [9]. The clinical outcomes from these studies have been published previously [10, 11] and show comparable benefits to previous studies in similar populations [6]. In the abdominal pain population, patients receiving PCA spent less time in moderate to severe pain (mean difference 14.5%; 95%CI 5.6–23.5%), reported greater satisfaction with their analgesic regimen (very or perfectly satisfied, adjusted OR 2.56; 95%CI 1.25–5.23), but consumed more morphine (adjusted mean difference 12.3 mg; 95%CI 7.2–17.4 mg) [10]. In agreement with previous studies [8], similar, but non-statistically significant results, were found in the traumatic injuries cohort, albeit with no difference in pain scores between treatment groups [11].

**Economics**

With these clinical data, Pritchard et al. attempt to resolve existing uncertainties over costs for the use of PCA in the ED with their current economic evaluation. They present a detailed cost-effectiveness analysis using an incremental cost-effectiveness ratio of the additional cost associated with PCA of averting 1 h of moderate to severe pain (defined as > 4.4 cm on a 10 cm visual analogue scale). This outcome can be calculated from the differences in costs as the numerator and the differences in clinical effects between the groups as the denominator. This form of analysis is appropriate when we have competing choices between a number of interventions, where only one can be selected. It gives the additional cost of averting one hour of moderate to severe pain with PCA compared with usual care. In Pritchard’s analysis this varied from
£15 ($18.6; €17.6) per hour with abdominal pain to £25 ($31; €29.3) per hour with traumatic injuries, with additional costs over the 12-h study period being around £20 ($24.8; €23.4) per patient (regardless of efficacy). Most previous economic analyses in postoperative populations are now outdated, making direct comparisons problematic [12]; nevertheless, the costs quoted appear acceptable when considering introducing PCA into routine practice. It should, however, be noted that while the original clinical studies enrolled around 400 participants, the economic evaluation sampled only 20 of these patients for observation, and therefore may not accurately reflect the entire sample. Despite this limitation, the authors considered a wide variety of costs for PCA devices including purchasing, cleaning, servicing and maintenance, and were careful to consider a variety of sensitivity analyses with PCA equipment costs and staff time. However, it is unclear whether initial (and continued) nursing staff training to use the PCA equipment was factored into these calculations.

The methodology of the trials underpinning this current economic evaluation are at low risk of bias (notwithstanding the impracticalities of blinding). However, with any economic analysis, it is important to consider the clinical studies the analysis is based on and the possible limitations in these analyses. In keeping with previous research in the area, the primary economic evaluation of the study is based on time spent in moderate to severe pain (defined as > 4.4 cm) [13]. This definition may create problems when attempting to assess the clinical significance of the author’s findings in relation to costs. Specifically, dichotomising pain in this manner would categorise patients with pain of 4.6 cm in the moderate to severe category and another with 4.4 cm in the mild category. This may not reflect clinically significant differences when averaged over a group. To illustrate this problem using the author’s own data, consider the results of the trial evaluating traumatic injuries [11]. The results show similar average pain scores in the PCA and usual care groups (44 vs. 47.2, respectively on a standardised scale 0–100 area under the curve) although less time was spent in moderate to severe pain (36% vs. 44%), which did not quite reach statistical significance. Similarly, in the abdominal pain trial [10], at first glance it appears that, according to the author’s definition (> 15%), a clinically significant difference exists in pain scores between treatment groups (35 vs. 47 on 0–100 area under the curve). However, the usual care group had higher, clinically significant [7], median baseline pain scores (visual analogue scale 6.1 vs. 4.8) and, when adjusted for baseline pain score, there may not be a clinically significant reduction in pain with PCA (mean difference 6.3; 95% CI 0.7–11.9 on a 0–100 area under the curve). Furthermore, the use of area under the curve makes assessing this change for clinical significance problematic. Adjustment for baseline pain score reduces the proportion of time spent in moderate to severe pain to a less impressive 7.3%. This adjusted figure does not appear to have been used in calculations for the economic evaluation published in this issue. Such limitations make assessing the costs associated with these outcomes difficult. It should be noted, however, that participants in both trials did not receive a titrated loading dose of morphine whilst in hospital (despite median baseline pain scores in the moderate to severe category), which may have improved the clinical significance of results. Data on requested but not fulfilled early analgesic demands may help identify whether this lack of loading dose may have affected clinical significance.

Outcomes

Selecting outcomes on which to measure reductions in pain is also controversial. Debate exists on the use of traditional methods such as visual analogue scales and whether these are treated as ratio or ordinal data [14]. Therefore, some researchers in the field advocate similar measures to those used in this study, such as no worse than mild pain [13]. However, a more appropriate measure may be the proportion of time patients experience a 50% reduction from baseline pain. This avoids the problem of differences in baseline scores between groups, which can confound dichotomous pain end-points. Intuitively, groups with a lower baseline pain score should have more participants spending less time in the moderate to severe pain category even without intervention. Despite these concerns over clinical significance, patient satisfaction was
higher in the PCA group, which may reflect differences in pain or perhaps patients welcoming the independence of being able to immediately administer analgesia rather than waiting for nurse-initiated analgesia [4, 5]. Such patient-centred outcomes may have additional clinical relevance and if significant improvements can be demonstrated, this represents another benefit supporting the introduction of PCA into EDs.

One important strength of Pritchard’s economic evaluation pertinent to EDs, is the detailed breakdown of both staff costs and time spent administering each intervention. Theoretically, PCA offers lower staff time requirements in administering repeated analgesic boluses in postoperative populations [12]; this may provide an additional benefit in a busy ED. Conversely, PCA can take time to set up, and increase staff commitments, including documentation of pain scores and regular observations [15]. In Pritchard’s study, PCA took a mean time of around 38 min to set up, whereas usual care took around 25 min. This may offer an additional barrier to adoption, particular the 20 min (on average) PCA set up and instruction time. Unfortunately, pain management strategies do not occur in a vacuum, with any investment by EDs limiting resources for other areas. For comparison, an hour of work from an agency registrar in Emergency Medicine (£26.8; €33.2; $31.4) [16] or GP consultation (£32; €39.7; $37.4) may represent more of a priority to departments struggling with staff numbers rather than investing in pain management strategies with potentially only modest clinical benefits. Before PCA is routinely adopted in EDs, the possible opportunity costs should also be considered.

Safety
An important concern of anaesthetists and acute pain staff may be the move of PCA devices from the postoperative setting into EDs, where staff may lack experience of such equipment. In the study of abdominal pain, 209 participants (of 363 potentially eligible) were enrolled over a 2-year period [10]. With such numbers it is unclear if exposure to PCA would be sufficient to maintain staff competencies. Furthermore, in both trials, morphine consumption was higher in the PCA group (mean differences in each study 12.6 mg and 17.1 mg) [10, 11]. Differences of this magnitude in morphine consumption can increase adverse events [17], raising in-patient costs [18]. Indeed, although the trials were not powered to detect differences in adverse events, patients in the PCA group were more likely to suffer from nausea [10, 11]. The most concerning opioid-associated adverse event is respiratory depression, and while the incidence is low (~ 1.9%) [19], postoperative clinical staff are experienced in recognising and managing this. It is unclear whether EDs and especially receiving ward staff outside of the research environment have sufficient experience to monitor this complication, especially in periods of high patient demand. One of the clinical trials reported a serious adverse event attributed to respiratory depression in the PCA group [11], suggesting larger data-sets are required to identify potentially significant increases in respiratory depression within an ED population. Indeed, a previous study that used continuous pulse oximeter recordings has suggested a high incidence of desaturation episodes with opioid PCA and similar studies in an ED population would be welcomed [20].

Conclusion
Pritchard et al. present a thought-provoking series of studies exploring the role of PCA in the ED. Questions remain regarding the assessment and management of opioid-related adverse events in ED with PCA, its impact on ED discharge, patient outcomes and the associated added costs. Qualitative studies may also help identify the attitudes of acute pain and ED staff to the introduction of PCA into routine ED practice. The detailed economic assessment from Pritchard et al. in this issue is, however, a significant step towards assessing the relative merits of introducing a common and frequently effective intervention into routine ED practice.

Competing interests
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