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REVIEW ARTICLE

Post-caesarean delivery analgesia in resource-limited settings: a narrative review

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ABSTRACT

Post-caesarean pain is an important and often neglected outcome. It causes suffering, affects breastfeeding and is associated with postpartum depression and the development of chronic pain syndromes. Pain control is often difficult even in resource-rich environments; it is likely far worse in resource-limited settings, where emphasis is on reducing the high maternal mortality rate. Lack of adequate staffing, education, and postoperative monitoring severely limit the options in resource-limited settings. Resource-limited settings are further compromised by limited access to essential analgesic drugs and equipment for their administration. Solutions using affordable and accessible medications as part of a multimodal analgesic strategy are possible, supplemented by education and training programmes. More research is required, both to establish current practice and to test methods for improving maternal pain control. While government involvement is necessary to improve infrastructure and resources in individual countries, other solutions should also be sought, empowering local institutions and harnessing individual cultural characteristics.

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Introduction

Caesarean delivery (CD) represents a third of all surgical operations performed in resource-limited settings (RLS).¹ As a major focus in this context is on reducing the unacceptably high maternal mortality rates,² pain may be overlooked. There are few studies assessing post-CD pain control in RLS. In resource-rich environments women state that their highest priority is the avoidance of intra-operative and postoperative pain.³ Pain has been shown to interfere with activities of daily living in more than 80% of patients post CD.⁴ One in 10 women have persistent pain at eight weeks post CD⁴ and chronic abdominal pain is present in 10–20% of parturients within a year of delivery.^{5,6} This is associated with an up to three-fold increased risk of postpartum depression.⁴ In addition, bonding with and caring for a newborn child may be adversely affected by pain.⁷ Finally, early mobilisation is important to reduce the risk of thrombo-embolic disease.⁸ We aimed to review existing evidence regarding post-CD pain control in RLS and

to make suggestions for treatment strategies in this context. We also propose a potential research agenda.

Search strategy

To review this topic, we conducted a literature search in April 2018, with no language or date restrictions. The search was performed in the PubMed, Scopus, and Web of Science databases, using MeSH terms with variations related to post-caesarean analgesia and RLS (Appendix 1). We included literature on lower-income, and lower- and upper middle-income countries. We also included statements and policy documents from scientific societies and Departments of Health, related to post-CD analgesia. The references in each publication were individually searched for other relevant literature.

Resource-limited settings

The World Bank classifies countries into four separate groups, based on the gross national income per capita, having abandoned the terms “developed” and “developing”. Low-income countries, and many of the lower- and upper middle-income countries, are also

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Table 1 Characteristics of resource-limited settings

Limited access to appropriate medication and equipment
Lack of appropriately trained staff, with low staff-to-patient ratios
Inability to provide safe postoperative monitoring
Limited access to higher levels of care
Lack of critical care support
Poor funding
Poor infrastructure
Lack of disposal facilities
Limited educational opportunities
Limited research and quality improvement capacity
Limited internet access

often classified as RLS, although an exact definition is lacking. Specific context should dictate clinical strategies; it is possible to have a resource-rich institution in a low-income country and clinical policies should be adapted accordingly.⁹ We have listed the salient features of RLS in [Table 1](#).⁹

Applying an effective analgesia strategy in RLS, where even access to life-saving treatment is limited,¹⁰ may be viewed locally as a less important outcome. The African Surgical Outcomes Study, a large prospective cohort study in 247 hospitals in 25 African countries, confirmed a significant lack of resources and work-force deficiencies.¹¹ Further analysis of 3792 patients undergoing CD showed that one in seven CD patients suffered a complication and 1 in 200 died.¹² Post-CD pain management is likely a lesser focus in this type of environment. Anaesthesia experience was also found to be limited; in some countries, the spinal anaesthesia rate was as low as 6% prior to interventions for improvement,¹³ while as few as 6% of anaesthetists could provide safe anaesthesia for CD.¹⁴ These factors invariably have a negative impact on the delivery of effective post-CD analgesia.

The incidence and consequences of moderate to severe postoperative pain in RLS

There are few studies examining postoperative pain as a maternal outcome in RLS. A study in South Africa assessed postoperative pain for a variety of surgical procedures,¹⁵ and found that post-CD patients reported the highest incidence of moderate to severe pain (>80%). Fixed-interval intramuscular morphine was prescribed but ineffectively administered during the study period. Less than 50% of the prescribed morphine was administered and one in seven patients with at least moderate pain received none of the prescribed drug. This might reflect the situation in similar RLS worldwide but there is minimal relevant supporting literature.

Relieving post-CD pain is important for many reasons. The alleviation of human suffering is the foremost concern but the avoidance of long-term problems such

as chronic pelvic pain and postpartum depression, as well as the promotion of early breastfeeding and optimal mother-child bonding, are also key outcomes. These topics are covered elsewhere in a recent in-depth review.¹⁶ The complete elimination of pain is unlikely to be achieved and is probably not a realistic goal, since the benefits of complete analgesia should be balanced against the risks of side effects from excessive medication and delayed mobilisation.

Principles of effective pain treatment

Post-caesarean pain is both somatic and visceral in nature, and an effective analgesia strategy must address both components. The American Pain Society (APS), with input from the American Society of Anesthesiologists (ASA), has released Guidelines on the Management of Postoperative Pain.¹⁷ Many of the APS guidelines cannot be applied in RLS, as shown in [Table 2](#).

These recommendations form the basis of a sound peri-operative pain management strategy but require adequately trained and motivated staff, and monitoring facilities. Individualising pain management, the need for regular monitoring and the use of non-pharmacological methods, have a high work-load impact and these factors may preclude their use in RLS. Simpler approaches such as the World Health Organization (WHO) analgesic ladder (described for combating cancer pain and adopted in modified form by the World Federation of Societies of Anaesthesia [WFSA]) may be more applicable to the postoperative setting in RLS, where it can function both as a checklist and as a training aid.¹⁸

Analgesia strategies in resource-limited settings

An ideal analgesia regimen achieves maximal analgesic efficacy with minimal risks to-, or side effects for, the mother and her breastfeeding neonate. In RLS this would also imply an approach using freely-available inexpensive drugs, and one that minimises monitoring and workload impact. It should also be easily implementable by staff after minimal training.

The lack of pragmatic studies in RLS examining post-CD analgesia necessitates adaptation of existing guidelines. For example, it is common to use long-acting neuraxial opioids but this is unlikely to be feasible and safe in RLS due to stringent monitoring requirements: a minimum hourly assessment of respiratory rate, sedation and pain scores for 24 h (12 h if diamorphine is used).¹⁹ For women offered intravenous patient-controlled analgesia (PCA) with an opioid, monitoring is recommended hourly until at least two hours after discontinuation of the treatment. Additionally, preservative-free long-acting opioids and PCA infusion pumps are not consistently available in RLS. Therefore,

Table 2 Applicability of current recommendations in resource-limited settings

Possible considerations in resource-rich environment	Applicability in resource-limited settings
Individually tailored pain management plans: family centred education, pre-operative risk assessment, pain strategy based on adverse events and the ongoing assessment of pain	Staff constraints restrict applicability
Multimodal analgesic regimens, incorporating both pharmacological and non-pharmacological methods, including transcutaneous electrical nerve stimulation and cognitive behavioural modalities	Only simple analgesics available
Various drug delivery methods for opioids including patient-controlled analgesia and avoiding intramuscular administration	Limited availability
Enhanced monitoring requirements, particularly when systemic or neuraxial opioids are used	Only basic monitoring possible
Consideration for drugs such as pregabalin and gabapentin in high risk patients	Restricted drug availability
Site-specific local anaesthetic infiltration and peripheral regional analgesia including continuous peripheral regional analgesia if pain is likely to exceed the length of the block	Single-shot techniques only
A structure for developing pain management processes and guidelines, with access to pain management specialists and adequate training and education of staff	No pain management structure available, limited access to specialists

in the absence of studies specifically examining the applicability of these recommendations, guidelines require modification in a particular environment, based upon expert opinion and on the circumstances in the individual institution.

Drug availability remains a key consideration in RLS. In 2017, an amended version of the 20th WHO Model List of Essential Medicines (EML) was released. These are the most effective and safe agents for health systems and many countries use this list when considering high priority medications in the construction of individualised essential drug lists. Included agents relevant to postoperative analgesia are:

1. Local anaesthetics (bupivacaine and lidocaine)
2. Paracetamol
3. Opioids (codeine, fentanyl, morphine)
4. Nonsteroidal anti-inflammatory agents (NSAID) (ibuprofen)
5. Ketamine

A core set of drugs, based on the WHO recommendations, should be central to all strategies.

Intraoperative measures for postoperative pain

Post-CD analgesia regimens depend on intra-operative techniques employed, particularly the use of long-acting intrathecal opioids, as well as the availability of epidural analgesia for labour.

Intrathecal/epidural additives

Intrathecal long-acting opioids, particular morphine, are currently recommended as the gold standard for postoperative analgesia following spinal anaesthe-

sia.^{19,20} While intrathecal fentanyl provides good intra-operative and early postoperative analgesia, morphine provides analgesia that lasts into the second postoperative day, with superior analgesia outcomes.²¹ However, poor availability of preservative-free morphine (even in resource-rich countries), coupled with the requirements for postoperative monitoring, are challenges to the feasibility of this approach in RLS. Epidural morphine in doses up to 3 mg, administered to patients who receive labour epidural analgesia prior to CD, appears to provide better analgesia than parenteral opioids and similar analgesic efficacy to intrathecal morphine.^{22,23} However, epidural techniques are not widely used in RLS and monitoring requirements are comparable to those for intrathecal morphine.¹⁹ Ultra-low dose intrathecal morphine ($\leq 50 \mu\text{g}$) and epidural morphine ($\leq 1 \text{ mg}$) may provide safer alternatives in otherwise healthy women but safety remains to be established in the absence of adequate monitoring. There does not appear to be a consistent role for intrathecal clonidine, even in resource-rich environments.¹⁶

Wound infiltration

Wound infiltration at the time of CD reduces opioid consumption at 24 hours in women undergoing regional and general anaesthesia, and the addition of an NSAID may confer additional benefit.²⁴ It appears that performing both pre-incisional and post-incisional wound infiltration is superior to either technique in isolation, when the short-acting agent lidocaine is used.²⁵ Intra-operative wound infiltration is likely to be achievable in RLS and represents a simple and potentially effective method of reducing postoperative opioid consumption. Bupivacaine and lidocaine are both on the WHO EML and are thus viable options for single-shot wound

infiltration. Continuous local anaesthetic wound infiltration requires additional equipment (catheters, infusion pumps) and monitoring that preclude this technique in RLS. A recent meta-analysis also suggested that single-shot wound infiltration may be comparable to continuous infusions in obstetric patients.²⁶ Continuous infiltration of an NSAID into the wound appears more effective than a comparable dose administered systemically, but is limited by the same considerations in RLS.²⁷

Transversus abdominis plane blocks

Low-dose (<50 mg bupivacaine per side) transversus abdominis plane (TAP) blocks provide effective analgesia post CD,²⁸ potentially limiting concerns about local anaesthetic toxicity.²⁹ Bilateral TAP blocks reduce postoperative opioid consumption and nausea and vomiting, and are associated with lower postoperative pain scores, particularly in patients receiving multimodal analgesia without intrathecal morphine.^{30,31} These blocks have also been shown to be effective in RLS,^{32,33} although notably require ultrasound guidance, limiting generalisability. Transversus abdominis plane blocks are effective after abdominal surgery even without the use of ultrasonography,³⁴ however this practice has been questioned.³⁵ A study showed that less than one in four blocks achieved the correct plane for the local anaesthetic, and nearly one in five injections were inserted into the intraperitoneal cavity, even in the hands of experienced anaesthetists. This suggested that reductions in pain scores could either be due to the diffusion into the correct plane of part of the large volumes of local anaesthetic used, or to the lowering of pain scores by inadvertent peritoneal injection, as has been shown to be an effective method in other abdominal operations.³⁶ A small randomised controlled trial comparing surgeon-administered intra-operative TAP blocks with anaesthesiologist-administered transcutaneous TAP blocks showed significantly faster administration by the surgeon (2.4 vs 12.1 minutes) and decreased times in the operating theatre (55.4 vs 77.9 minutes).³⁷ Furthermore, the two groups had similar pain scores and 24-h morphine consumption. Importantly, no intrathecal morphine was used and although performed in a non-RLS setting, the surgeon-administered block may have some applicability in RLS countries, given that it obviates the need for ultrasound and improves reliability of identification of the appropriate structures.

Intravenous lidocaine

The opioid-sparing effect of intravenous lidocaine is well-established in open and laparoscopic abdominal surgery, but not as yet in CD.³⁸ Given the availability of lidocaine in RLS, this is a potential area for research, but there is currently insufficient evidence to recommend the routine use of intravenous lidocaine in the obstetric population.

Ketamine

Ketamine is cheap, widely available and included in the WHO EML. Subanaesthetic doses, given either during general or regional anaesthesia, represent a low cost and relatively low-risk intervention. One randomised trial showed no immediate postoperative benefit to low-dose ketamine (10 mg) given post-delivery in patients undergoing spinal anaesthesia that included intrathecal morphine and intravenous ketorolac.³⁹ While there were improved two-week pain scores in the ketamine group, there was also a significant increase in the incidence of psychotomimetic side-effects in this group. However, several studies in RLS settings have shown benefit for the use of low-dose ketamine in women who received spinal anaesthesia, when ketamine was given either pre-incision (0.15 mg/kg)^{40,41} or post-delivery (0.25 mg/kg).⁴² Psychotomimetic side-effects were observed only in the higher dose study. However, benefit has not been confirmed in studies that examine low-dose ketamine as part of general anaesthesia.^{43,44}

Treatment of acute postoperative pain

Non-pharmacological methods

The 2016 APS guidelines on the management of postoperative pain cite several options for non-pharmacological therapy. These include cognitive modalities such as relaxation methods (e.g. music and guided imagery) as an adjunct to pharmacological methods, and transcutaneous electrical nerve stimulation (TENS). Cognitive modalities such as music therapy have appeal in that they are low-cost, widely available and effective; there is evidence that they lower pain scores and reduce opioid consumption in the immediate postoperative period.⁴⁵ Further research is required in RLS.

Pharmacological methods

There is little evidence to inform clinicians on the safest and most effective form of oral analgesia post CD.⁴⁶

Paracetamol

Practice guidelines strongly agree that paracetamol should be employed as part of a multimodal postoperative pain management strategy,⁴⁷ however there appears to be poor adherence to the multimodal model, with as few as 4% of post-surgical patients receiving paracetamol in RLS.⁴⁸ Paracetamol has a proven cost-saving and opioid-sparing effect,⁴⁹ and has an additive effect in combination with NSAIDs.⁵⁰ Furthermore, scheduled paracetamol appears to reduce both opioid consumption and the likelihood of exceeding recommended paracetamol doses, although this finding was in a study population that received intrathecal morphine.⁵¹ Intravenous paracetamol is restricted by poor availability in RLS. Rectal paracetamol given during

CD appears effective.⁵² Importantly, paracetamol is included in the WHO EDL and is a cheap and widely available agent.

Nonsteroidal anti-inflammatory drugs

The NSAIDs are an essential component of multimodal analgesia strategies. They have a significant opioid sparing effect,⁵³ and are particularly effective in the treatment of visceral pain.²⁰ In the absence of contraindications (hypovolaemia, renal impairment, puerperal sepsis and risk of bleeding), NSAIDs are advised for routine use following CD.⁵⁴ Combined use with paracetamol appears to be particularly effective.⁵⁰ Ibuprofen is on the EML and is thus widely available. The NSAIDs have been implicated in a small number of cases of necrotising fasciitis following CD,⁵⁵ before the routine use of prophylactic antibiotics. There is, however, no evidence that NSAIDs predispose to this condition in the absence of risk factors.⁵⁶

Opioids

Little is known about current prescribing practices in RLS, with some studies suggesting that scheduled intramuscular opioid is the most common.^{48,57} Strategies employing intramuscular opioids result in an incidence of at least moderate pain of almost 70%⁵⁸ and the intravenous route is preferred if possible. Opioid use in the early postoperative phase is necessary as part of a multimodal strategy. Patient-controlled analgesia is considered to provide better pain control, with fewer adverse effects compared with intermittent boluses, whether intravenous or intramuscular.¹⁷ The cost and availability of equipment, coupled with the high volume of obstetric cases, make this unlikely to be feasible on a large scale in RLS. Disposable PCA devices have advantages in that they do not require electricity or battery usage, but remain relatively expensive compared with fixed-dose opioid prescriptions. While PCA is unlikely to be a feasible option in RLS, the use of either intravenous or intramuscular opioid remains a key part of treatment. Oral morphine represents an effective and readily available alternative, as soon as a patient can tolerate medication via this route.

Dexamethasone

A systematic review and meta-analysis in 2013 showed that a single intra-operative dose of dexamethasone reduced postoperative pain scores, opioid requirements and PACU and length of stay in the recovery room in a general surgical population.⁵⁹ However, the clinical benefits were small, and associated with a significant increase in postoperative glucose levels. A further meta-analysis examined the use of dexamethasone in patients undergoing CD and total abdominal hysterectomy under neuraxial anesthesia that included intrathecal morphine.⁶⁰ Dexamethasone reduced 24-h pain

scores and rescue analgesia requirements in this analysis. However, recent studies have not confirmed this benefit,⁶¹ so there is currently insufficient evidence to advise the routine use of intra-operative dexamethasone during CD in the absence of intrathecal morphine.

Table 3 outlines suggested analgesic strategies in RLS.

Barriers to effective pain relief

In 2007 the International Association for the Study of Pain (IASP) conducted a survey of members in RLS, revealing that, while approximately 50% of respondents had received education relating to pain management, over 90% felt that it was insufficient.⁶² Education ranks as the number one barrier to good pain management. Government policies featured second, with 74% of respondents reporting this as a major deficiency. This has led to initiatives raising the level of interest, knowledge and clinical skills in pain management.⁶³

Effective pain relief is possible using simple, inexpensive drugs; yet in low-income countries, few patients receive adequate pain relief.¹⁰ As mentioned, it is possible that pain relief is regarded as less important than other priorities (such as maternal survival) in RLS. The fact that surgery is being performed means that there is at least access to a facility able to provide anaesthesia, albeit in a resource-limited context, implying that access to basic drugs and monitoring is possible. Poor nurse-patient ratios imply that analgesia may be delivered sporadically and monitoring of potential side effects is unreliable. Furthermore, staff may develop a culture of “non-intervention”,¹⁰ and pain relief may become inconsistent and inadequate.

Availability of inexpensive and effective drugs is variable within RLS. Despite recommendations by the WHO EML, the use of opioid analgesics remains low in many RLS. While this may be related to factors already mentioned, such as deficiencies in education, it also includes issues such as international trade controls and stringent regulations in some countries, while cultural attitudes and lack of financial resources play a larger role in other areas.⁶³

Potential interventions

Training and education

Staff training in the assessment and treatment of pain represents a key intervention in improving pain-related outcomes. This could be linked to patient education and potentially the involvement of family members or the local community, depending on cultural context. Methods such as low-cost simulation, an effective intervention for the training of anaesthetists in non-technical skills, could be extended to include analgesic practice.⁶⁴ These elements could also be given greater priority in established programs such as the Safer Anaesthesia

Table 3 Suggested analgesia regimens in resource-limited settings

Intervention	Recommendation
Intrathecal adjuvants	Short-acting opioid <i>Fentanyl (10–25 µg)</i> Long-acting opioid <i>Morphine (50 µg), if preservative-free, and monitoring available</i> <i>Morphine (1–2 mg), if preservative-free, and monitoring available</i>
Epidural adjuvants (if labour epidural in place)	
TAP blocks/abdominal nerve blockade	Consider surgeon-administered under direct vision, if no long-acting intrathecal opioids <i>Bupivacaine 50 mg per side</i>
Wound infiltration	Routine if no TAP block given <i>20 ml 0.5% bupivacaine (100 mg)</i>
Postoperative paracetamol	Fixed interval prescription <i>Paracetamol 1 g 6 hourly PO for 5–7 days</i>
Postoperative NSAID	Fixed interval prescription <i>Ibuprofen 400 mg 8 hourly PO for 3–5 days</i>
Postoperative opioid	PRN prescriptions if resources allow; or Fixed interval prescription (any route, with option to decline if pain-free) <i>Morphine 5–10 mg IV/IM/SC 4–6 hourly for 1–2 days or</i> <i>morphine 10–20 mg PO 4–6 hourly for 1–2 days</i>
Intra-operative IV ketamine	Consider in selected cases <i>Ketamine 0.15 mg/kg pre-incision</i>

TAP: transversus abdominis plane; PO: per os; NSAID: nonsteroidal anti-inflammatory drug; IV: intravenous; IM: intramuscular; SC: subcutaneous.

From Education (SAFE)-OBS course.⁶⁵ There are also existing electronic resources, such as those provided through the e-SAFE initiative (<http://www.e-safe-anaesthesia.org/>), which include over 100 interactive e-learning sessions and video tutorials that do not require internet access. Collaboration and connection between low-income country Departments of Anaesthesia and their counterparts in high-income countries should be encouraged.

Routine assessment of pain

The routine assessment of pain is a strategy that the APS has long supported as the first step in improving pain management.⁶⁶ However, routine pain scores do not necessarily improve pain control,^{67,68} and in some areas, the treatment of pain as a “fifth vital sign” is being abandoned, due to its potential link to opioid addiction.⁶⁹ Regardless, pain scores assessments alone do not result in an improved patient experience unless coupled with active intervention. Context-sensitive pain scores, employing various methods of pain assessment dependent upon the specific culture in which the assessment is performed, are imperative in establishing effective treatment. Patient education, as well as staff training, represent integral features of such a strategy.

Government involvement

Improvements in infrastructure and increasing access to pain relief medications remain areas that require local government involvement. It is important to link adequate pain control to existing programs targeting an

improvement in maternal outcomes, and both local and international support is often required. The elimination of barriers to accessing opioid medication is an example of a field that cannot be adequately addressed only at a local institutional level.

Research

There is a lack of evidence from RLS to provide adequate direction toward post-CD analgesia strategies. Large observational studies are required to establish the existing standards of pain control and the incidence of chronic pain. Interventional studies employing practicable, context-sensitive strategies should follow this work. Guidelines in RLS remain informed largely by expert opinion and are based on studies performed in resource-rich environments. This is certainly a reasonable approach, but improvements are more likely to be practicable with strategies designed specifically for local contexts. Collaboration between high-resource research units and RLS is essential in order to achieve this objective. A proposed research agenda is outlined in Table 4.

Conclusions

Post-CD analgesia is an important and often neglected maternal outcome in RLS. Maternal pain control is challenging even in resource-rich environments and is likely far worse in RLS. Simple multimodal analgesic strategies remain possible, incorporating both non-pharmacological and pharmacological treatment, but inadequate monitoring and poor availability often ham-

Table 4 Potential research agenda*Prospective observational studies assessing current practice*

Assessment of current analgesic regimens: efficacy, efficiency and patient satisfaction
 Long term follow-up (chronic pain syndromes, depression, functional status)

Analysis of contributors to deficiencies in pain management

Infrastructure
 Drug availability
 Systems inadequacies
 Staffing numbers and capacity

Evaluation of context-sensitive interventions in RLS

Administration of analgesics prior to discharge to the ward, before regression of spinal block
 Family-assisted analgesia
 Intra-operative partner/family support and effect on postoperative outcomes
 Routine pain assessments and risk-prediction scores
 Placement of problem cases in proximity to nursing station
 Use of non-pharmacological methods (such as music)

*Validation of techniques in RLS: TAP blocks, wound infiltration**Educational interventions*

Video/social media/internet based
 Simulation and training programs

RLS: resource-limited settings; TAP: transversus abdominis plane.

per the feasibility of the use of long-acting spinal or epidural opioids. Improved training and education could significantly enhance this area of postoperative care. Global challenges such as restricted access to opioid analgesia remain barriers to adequate pain relief and require concerted collaborative interventions.

Declaration of Competing Interest

None.

References

- Weiser TG, Haynes AB, Molina G, et al. Size and distribution of the global volume of surgery in 2012. *Bull World Health Organ* 2016;**94**:201–9.
- Alkema L, Chou D, Hogan D, et al. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. *Lancet* 2016;**387**:462–74.
- Carvalho B, Cohen SE, Lipman SS, Fuller A, Mathusamy AD, Macario A. Patient preferences for anesthesia outcomes associated with cesarean delivery. *Anesth Analg* 2005;**101**:1182–7.
- Eisenach JC, Pan PH, Smiley R, Lavand'homme P, Landau R, Houle TT. Severity of acute pain after childbirth, but not type of delivery, predicts persistent pain and postpartum depression. *Pain* 2008;**140**:87–94.
- Niklasson B, Georgsson Ohman S, Segerdahl M, Blanck A. Risk factors for persistent pain and its influence on maternal wellbeing after cesarean section. *Acta Obstet Gynecol Scand* 2015;**94**:622–8.
- Li WY, Liabsuetrakul T, Stray-Pedersen B, Li YJ, Guo LJ, Qin WZ. The effects of mode of delivery and time since birth on chronic pelvic pain and health-related quality of life. *Int J Gynaecol Obstet* 2014;**124**:139–42.
- Gamez BH, Habib AS. Predicting severity of acute pain after cesarean delivery: a narrative review. *Anesth Analg* 2018;**126**:1606–14.
- James AH, Jamison MG, Brancazio LR, Myers ER. Venous thromboembolism during pregnancy and the postpartum period: incidence, risk factors, and mortality. *Am J Obstet Gynecol* 2006;**194**:1311–5.
- Bishop DG, Rodseth RN, Dyer RA. Recipes for obstetric spinal hypotension: the clinical context counts. *S Afr Med J* 2016;**106**:861–4.
- Size M, Soyannwo OA, Justins DM. Pain management in developing countries. *Anaesthesia* 2007;**62**(Suppl 1):38–43.
- Biccard BM, Madiba TE, Kluyts HL, et al. Perioperative patient outcomes in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *Lancet* 2018;**391**:1589–98.
- Bishop D, Dyer RA, Maswime S, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *Lancet Glob Health* 2019;**7**:e513–22.
- Olufolabi AJ, Atito-Narh E, Eshun M, Ross VH, Muir HA, Owen MD. Teaching neuraxial anesthesia techniques for obstetric care in a Ghanaian referral hospital: achievements and obstacles. *Anesth Analg* 2015;**120**:1317–22.
- Hodges SC, Mijumbi C, Okello M, McCormick BA, Walker IA, Wilson IH. Anaesthesia services in developing countries: defining the problems. *Anaesthesia* 2007;**62**:4–11.
- Murray AA, Retief FW. Acute postoperative pain in 1 231 patients at a developing country referral hospital: incidence and risk factors. *South Afr J Anaesth Analg* 2015;**22**:19–24.
- Carvalho B, Butwick AJ. Postcesarean delivery analgesia. *Best Pract Res Clin Anaesthesiol* 2017;**31**:69–79.
- Chou R, Gordon DB, de Leon-Casasola OA, et al. Management of Postoperative Pain: A Clinical Practice Guideline From the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. *J Pain* 2016;**17**:131–57.
- World Health Organization. Cancer pain relief: with a guide to opioid availability. 2nd ed. Geneva: WHO; 1996. p. 13–36.
- Practice Guidelines for Obstetric Anesthesia: An Updated Report by the American Society of Anesthesiologists Task Force on Obstetric Anesthesia and the Society for Obstetric Anesthesia and Perinatology. *Anesthesiology* 2016;**124**:270–300
- Sutton CD, Carvalho B. Optimal pain management after cesarean delivery. *Anesthesiology Clin* 2017;**35**:107–24.
- Sultan P, Halpern SH, Pushpanathan E, Patel S, Carvalho B. The effect of intrathecal morphine dose on outcomes after elective cesarean delivery: a meta-analysis. *Anesth Analg* 2016;**123**:154–64.
- Bonnet MP, Mignon A, Mazoit JX, Ozier Y, Marret E. Analgesic efficacy and adverse effects of epidural morphine compared to parenteral opioids after elective caesarean section: a systematic review. *Eur J Pain* 2010;**14**(894):e1–9.
- Ng K, Parsons J, Cyna AM, Middleton P. Spinal versus epidural anaesthesia for caesarean section. *Cochrane Database Syst Rev* 2004;**2**:CD003765.
- Bamigboye AA, Hofmeyr GJ. Local anaesthetic wound infiltration and abdominal nerves block during caesarean section for postoperative pain relief. *Cochrane Database Syst Rev* 2009;**3**:CD006954.
- Fouladi RF, Navali N, Abbasi A. Pre-incisional, post-incisional and combined pre- and post-incisional local wound infiltrations with lidocaine in elective caesarean section delivery: a randomised clinical trial. *J Obstet Gynaecol* 2013;**33**:54–9.
- Adesope O, Ituk U, Habib AS. Local anaesthetic wound infiltration for postcaesarean section analgesia: a systematic review and meta-analysis. *Eur J Anaesthesiol* 2016;**33**:731–42.

27. Lavand'homme PM, Roelants F, Waterloos H, De Kock MF. Postoperative analgesic effects of continuous wound infiltration with diclofenac after elective cesarean delivery. *Anesthesiology* 2007;**106**:1220–5.
28. Ng SC, Habib AS, Sodha S, Carvalho B, Sultan P. High-dose versus low-dose local anaesthetic for transversus abdominis plane block post-Caesarean delivery analgesia: a meta-analysis. *Br J Anaesth* 2018;**120**:252–63.
29. Griffiths JD, Le NV, Grant S, Bjorksten A, Hebbard P, Royse C. Symptomatic local anaesthetic toxicity and plasma ropivacaine concentrations after transversus abdominis plane block for Caesarean section. *Br J Anaesth* 2013;**110**:996–1000.
30. Abdallah FW, Halpern SH, Margarido CB. Transversus abdominis plane block for postoperative analgesia after Caesarean delivery performed under spinal anaesthesia? A systematic review and meta-analysis. *Br J Anaesth* 2012;**109**:679–87.
31. Mishriky BM, George RB, Habib AS. Transversus abdominis plane block for analgesia after Caesarean delivery: a systematic review and meta-analysis. *Can J Anaesth* 2012;**59**:766–78.
32. Kagwa S, Hoeft MA, Firth PG, Ttendo S, Modest VE. Ultrasound guided transversus abdominis plane versus sham blocks after caesarean section in an Ugandan village hospital: a prospective, randomised, double-blinded, single-centre study. *Lancet* 2015;**385**:S36.
33. Moyo N, Madzimbamuto FD, Shumbairerwa S. Adding a transversus abdominis plane block to parenteral opioid for postoperative analgesia following trans-abdominal hysterectomy in a low resource setting: a prospective, randomised, double blind, controlled study. *BMC Res Notes* 2016;**9**:50.
34. McDonnell JG, O'Donnell B, Curley G, Heffernan A, Power C, Laffey JG. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. *Anesth Analg* 2007;**104**:193–7.
35. McDermott G, Korba E, Mata U, et al. Should we stop doing blind transversus abdominis plane blocks? *Br J Anaesth* 2012;**108**:499–502.
36. Boddy AP, Mehta S, Rhodes M. The effect of intraperitoneal local anesthesia in laparoscopic cholecystectomy: a systematic review and meta-analysis. *Anesth Analg* 2006;**103**:682–8.
37. Narasimhulu DM, Scharfman L, Minkoff H, George B, Homel P, Tyagaraj K. A randomized trial comparing surgeon-administered intraoperative transversus abdominis plane block with anesthesiologist-administered transcutaneous block. *Int J Obstet Anesth* 2018;**35**:26–32.
38. Dunn LK, Durieux ME. Perioperative use of intravenous lidocaine. *Anesthesiology* 2017;**126**:729–37.
39. Bauchat JR, Higgins N, Wojciechowski KG, McCarthy RJ, Toledo P, Wong CA. Low-dose ketamine with multimodal postcesarean delivery analgesia: a randomized controlled trial. *Int J Obstet Anesth* 2011;**20**:3–9.
40. Menkiti ID, Desalu I, Kushimo OT. Low-dose intravenous ketamine improves postoperative analgesia after caesarean delivery with spinal bupivacaine in African parturients. *Int J Obstet Anesth* 2012;**21**:217–21.
41. Sen S, Ozmert G, Aydin ON, Baran N, Calskan E. The persisting analgesic effect of low-dose intravenous ketamine after spinal anaesthesia for Caesarean section. *Eur J Anaesthesiol* 2005;**22**:518–23.
42. Rahmanian M, Leysi M, Hemmati AA, Mirmohammadkhani M. The effect of low-dose intravenous ketamine on postoperative pain following cesarean section with spinal anesthesia: a randomized clinical trial. *Oman Med J* 2015;**30**:11–6.
43. Bilgen S, Koner O, Ture H, Menda F, Ficioglu C, Aykac B. Effect of three different doses of ketamine prior to general anaesthesia on postoperative pain following Caesarean delivery: a prospective randomized study. *Minerva Anestesiol* 2012;**78**:442–9.
44. Reza FM, Zahra F, Esmaeel F, Hossein A. Preemptive analgesic effect of ketamine in patients undergoing elective cesarean section. *Clin J Pain* 2010;**26**:223–6.
45. Hole J, Hirsch M, Ball E, Meads C. Music as an aid for postoperative recovery in adults: a systematic review and meta-analysis. *Lancet* 2015;**386**:1659–71.
46. Mkontwana N, Novikova N. Oral analgesia for relieving post-caesarean pain. *Cochrane Database Syst Rev* 2015;**29**(3). <https://doi.org/10.1002/14651858.CD010450.pub2> CD010450.
47. American Society of Anesthesiologists Task Force on Acute Pain M. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. *Anesthesiology* 2012;**116**:248–73.
48. Ogboli-Nwasor E, Sule ST, Yusufu LM. Pattern of postoperative pain management among adult surgical patients in a low-resource setting. *J Pain Res* 2012;**5**:117–20.
49. Altenau B, Crisp CC, Devaiah CG, Lambers DS. Randomized controlled trial of intravenous acetaminophen for postcesarean delivery pain control. *Am J Obstet Gynecol* 2017;**217**(362):e1–6.
50. Ong CK, Seymour RA, Lirk P, Merry AF. Combining paracetamol (acetaminophen) with nonsteroidal antiinflammatory drugs: a qualitative systematic review of analgesic efficacy for acute postoperative pain. *Anesth Analg* 2010;**110**:1170–9.
51. Valentine AR, Carvalho B, Lazo TA, Riley ET. Scheduled acetaminophen with as-needed opioids compared to as-needed acetaminophen plus opioids for post-cesarean pain management. *Int J Obstet Anesth* 2015;**24**:210–6.
52. Mahajan L, Mittal V, Gupta R, Chhabra H, Vidhan J, Kaur A. Study to compare the effect of oral, rectal, and intravenous infusion of paracetamol for postoperative analgesia in women undergoing cesarean section under spinal anesthesia. *Anesth Essays Res* 2017;**11**:594–8.
53. Pavy TJ, Paech MJ, Evans SF. The effect of intravenous ketorolac on opioid requirement and pain after cesarean delivery. *Anesth Analg* 2001;**92**:1010–4.
54. Wilder-Smith CH, Hill L, Dyer RA, Torr G, Coetzee A. Postoperative sensitization and pain after cesarean delivery and the effects of single IM doses of tramadol and diclofenac alone and in combination. *Anesth Analg* 2003;**97**:526–33.
55. Van Ammers PM, Moore PJ, Sacho H. Necrotizing fasciitis after cesarean section-association with non-steroidal anti-inflammatory drugs. A report of 3 cases. *S Afr Med J* 1991;**80**:203–4.
56. Aronoff DM, Bloch KC. Assessing the relationship between the use of nonsteroidal antiinflammatory drugs and necrotizing fasciitis caused by group A streptococcus. *Medicine (Baltimore)* 2003;**82**:225–35.
57. Faponle AF, Soyannwo OA. Post-operative pain therapy: prescription patterns in two Nigerian teaching hospitals. *Niger J Med* 2002;**11**:180–2.
58. Dolin SJ, Cashman JN, Bland JM. Effectiveness of acute postoperative pain management: I. Evidence from published data. *Br J Anaesth* 2002;**89**:409–23.
59. Waldron NH, Jones CA, Gan TJ, Allen TK, Habib AS. Impact of perioperative dexamethasone on postoperative analgesia and side-effects: systematic review and meta-analysis. *Br J Anaesth* 2013;**110**:191–200.
60. Allen TK, Jones CA, Habib AS. Dexamethasone for the prophylaxis of postoperative nausea and vomiting associated with neuraxial morphine administration: a systematic review and meta-analysis. *Anesth Analg* 2012;**114**:813–22.
61. Ituk U, Thenuwara K. The effect of a single intraoperative dose of intravenous dexamethasone 8mg on post-cesarean delivery analgesia: a randomized controlled trial. *Int J Obstet Anesth* 2018;**35**:57–63.
62. Bond M. A decade of improvement in pain education and clinical practice in developing countries: IASP initiatives. *Br J Pain* 2012;**6**:81–4.

63. Berterame S, Erthal J, Thomas J, et al. Use of and barriers to access to opioid analgesics: a worldwide, regional, and national study. *Lancet* 2016;**387**:1644–56.
64. Skelton T, Nshimyumuremyi I, Mukwesi C, Whynot S, Zolpys L, Livingston P. Low-cost simulation to teach anaesthetists' non-technical skills in Rwanda. *Anesth Analg* 2016;**123**:474–80.
65. Enright A, Grady K, Evans F. A new approach to teaching obstetric anaesthesia in low-resource areas. *J Obstet Gynaecol Can* 2015;**37**:880–4.
66. Quality improvement guidelines for the treatment of acute pain and cancer pain. American Pain Society Quality of Care Committee. *JAMA* 1995;**274**:1874–80.
67. Mularski RA, White-Chu F, Overbay D, Miller L, Asch SM, Ganzini L. Measuring pain as the 5th vital sign does not improve quality of pain management. *J Gen Intern Med* 2006;**21**:607–12.
68. Narasimhaswamy S, Vedi C, Xavier Y, Tseng CH, Shine D. Effect of implementing pain management standards. *J Gen Intern Med* 2006;**21**:689–93.
69. Levy N, Sturgess J, Mills P. “Pain as the fifth vital sign” and dependence on the “numerical pain scale” is being abandoned in the US: Why? *Br J Anaesth* 2018;**120**:435–8.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijoa.2019.05.009>.