Optimising caesarean section use 3

Interventions to reduce unnecessary caesarean sections in healthy women and babies

Ana Pilar Betrán, Marleen Temmerman, Carol Kingdon, Abdu Mohiddin, Newton Opiyo, Maria Regina Torloni, Jun Zhang, Othiniel Musana, Sikolia Z Wanyonyi, Ahmet Metin Gülmezoglu, Soo Downe

Lancet 2018; 392: 1358–68

This is the third in a Series of three papers on optimising caesarean section use

See Editorial page 1279

See Comment pages 1286, 1288, and 1290

UNDP/UNFPA/UNICEF/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction, Department of Reproductive Health and Research, World Health Organization, Geneva, Switzerland (A P Betrán PhD, A M Gülmezoglu PhD); **Centre of Excellence in Women and Child Health, Aga Khan University, Nairobi, Kenya** (Prof M Temmerman PhD, A Mohiddin FFPH, S Z Wanyonyi MRCOG); **Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium** (Prof M Temmerman); **School of Community Health and Midwifery, Faculty of Health and Wellbeing, University of Central Lancashire, Preston, UK** (C Kingdon PhD, Prof S Downe PhD); **Review Production and Quality Unit, Cochrane, London, UK** (N Opiyo PhD); **Postgraduate Program on Evidence-Based Healthcare, São Paulo Federal University, São Paulo, Brazil** (M R Torloni PhD); **MOE-Shanghai Key Laboratory of Children's Environmental Health, Xinhua Hospital, School of Medicine, Shanghai Jiao Tong University, Shanghai, China** (J Zhang PhD); **and Uganda Martyrs University, St Francis Hospital Nsambya, Kampala, Uganda** (O Musana MMed)

Optimising the use of caesarean section (CS) is of global concern. Underuse leads to maternal and perinatal mortality and morbidity. Conversely, overuse of CS has not shown benefits and can create harm. Worldwide, the frequency of CS continues to increase, and interventions to reduce unnecessary CSs have shown little success. Identifying the underlying factors for the continuing increase in CS use could improve the efficacy of interventions. In this Series paper, we describe the factors for CS use that are associated with women, families, health professionals, and health-care organisations and systems, and we examine behavioural, psychosocial, health system, and financial factors. We also outline the type and effects of interventions to reduce CS use that have been investigated. Clinical interventions, such as external cephalic version for breech delivery at term, vaginal breech delivery in appropriately selected women, and vaginal birth after CS, could reduce the frequency of CS use. Approaches such as labour companionship and midwife-led care have been associated with higher proportions of physiological births, safer outcomes, and lower health-care costs relative to control groups without these interventions, and with positive maternal experiences, in high-income countries. Such approaches need to be assessed in middle-income and low-income countries. Educational interventions for women should be complemented with meaningful dialogue with health professionals and effective emotional support for women and families. Investing in the training of health professionals, eliminating financial incentives for CS use, and reducing fear of litigation is fundamental. Safe, private, welcoming, and adequately resourced facilities are needed. At the country level, effective medical leadership is essential to ensure CS is used only when indicated. We conclude that interventions to reduce overuse must be multicomponent and locally tailored, addressing women's and health professionals' concerns, as well as health system and financial factors.

Introduction

There is no debate about the need to increase access to safe caesarean sections (CSs) where the procedure is underused. However, there is no evidence of a benefit at the population level of CS for women and babies who do not require the procedure,[1,2] and, as for any surgery, there are short-term and long-term risks to CS that have been outlined in the second paper of this Series on Optimising Caesarean Section Use.[3] Additionally, surgery overuse might constrain resources that could be used to address underuse.[4]

Consensus among the scientific and medical communities about the optimal population-level frequency of CS has not been reached.[5] Even the intent to develop a global standard is contested in the scientific literature. However, there is an almost universal consensus that, in many settings, the current frequency of CS cannot be medically justified.[2,6–8] Underuse of CS has been a focus of medical literature, research, policy, and funding efforts for decades, since increasing access to CS is a priority to reduce maternal and perinatal mortality and morbidity. Overuse, however, is a more recent and less well understood phenomenon that can even coexist with underuse in many countries.[9] There might be the potential, therefore, to redistribute resources in such countries to address underuse. This paper is the third in a Series on Optimising Caesarean Section Use,[2,3] and we focus here on interventions to reduce unnecessary CSs, which we define as CSs used in the absence of medical (including psychological) indications.[10–12]

We begin with an overview of the drivers of increasing CS use. We then examine the nature and effects of both clinical and non-clinical (behavioural, educational, and psychosocial) interventions that have been tested in studies specifically designed to safely reduce the use of births by CS. We discuss the degree to which these interventions target the underlying drivers and the mechanisms of their effect that might underpin successful reduction strategies. Finally, we propose research priorities for the future.

Drivers of excessive CS use

Many decisions to use CS are driven by the clinical or psychological needs of the mother or by the clinical needs of the baby, or by both. However, where frequency of use is greater than needed, the drivers fall into three broader, interconnected, and sometimes overlapping categories. These categories relate to childbearing women, families, communities, and the broader society; health professionals; and health-care systems, financing, and organisational design and cultures.

Factors related to childbearing women, families, communities, and the broader society

The notion of maternal request for CS has been variously interpreted and widely debated.[13–15] Contrary to perceived opinion, however, most women around the world do not

Search strategy and selection criteria

We searched the Cochrane Central Register of Controlled Trials, MEDLINE, Embase, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases and two trial registries (International Clinical Trials Registry Platform and ClinicalTrials.gov) for studies published between March 29, 2010 (ie, the date of the previous version of the Cochrane review), and Aug 6, 2014. We updated our search on Feb 17, 2017, and March 8, 2018, for studies published until these dates. We searched for keywords and controlled vocabulary terms (Medical Subject Heading [MeSH]) regarding caesarean section (CS) and targeted non-clinical interventions (ie, "cesarean section", "unnecessary cesarean", "operative or surgical", "natural childbirth", "patient education", "workshop" OR "program" OR "lesson" OR "class", "psychoeducation", "decision making", "audit" OR "feedback", "opinion leader", "second opinion", "midwife" OR "nurse" OR "obstetrician"). We analysed the titles, abstracts, and MEDLINE index terms of the studies included in the previous version of the review with text analysis tools (TerMine,Voyant Tools, and Yale MeSH Analyzer) to increase the specificity of the search terms. We applied no language limitations in the searches. We also searched reference lists of trials and related reviews, websites of relevant organisations, and contacted authors for additional articles. The complete search strategy is presented in the 2018 Cochrane review (in press) on non-clinical interventions for reducing unnecessary caesarean section. We developed search strategies for electronic databases that build on preliminary scoping searches, terms used by existing quantitative reviews of interventions to reduce the number of unnecessary CSs, guidelines developed by the Cochrane Qualitative Research Methods Group, and papers that detailed strategies for optimising the identification of qualitative studies in CINAHL, MEDLINE, EMBASE, and PsycINFO. We searched CINAHL, MEDLINE, PsycINFO, Embase, Global Index Medicus, Population Information, and African Journals Online databases for eligible studies published between Jan 1, 1985, and March 22, 2017, to identify studies published since the first WHO statement on appropriate technologies for childbirth. We used no language or geographical restrictions. As standard health databases do not yet comprehensively include qualitative studies, we used backward citation chaining of the reference lists of all the included studies and existing quantitative reviews. Additionally, key articles cited by several authors (citation pearls) were checked on Google Scholar. The authors of published protocols were also contacted. Complete search strategies are presented in the individual reviews.

Correspondence to: Dr Ana Pilar Betrán, UNDP/UNFPA/UNICEF/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction, Department of Reproductive Health and Research, World Health Organization, 1211 Geneva, Switzerland
betrana@who.int

prefer a CS, in the absence of current or previous complications.[16,17] A 2011 systematic review[16] on worldwide preferences reported an overall preference for CS of 15%, which decreased to 10% when women who previously had a CS were excluded.

For women who favour CS in the absence of medical indications, reasons include fear of labour pain (particularly where epidural analgesia is not accessible or affordable),[18–24] fear of pelvic floor damage and urinary incontinence,[25,26] and fear of negative effects on their sexuality or sexual relationships.[26–28] Contrary to scientific evidence, most women who prefer CS perceive it to be safer for the baby and for themselves.[29–32] Less commonly, women cite convenience as a reason, particularly in societies where women bear substantial work or family responsibilities[24,29] or where they can have tubal ligation at the same time as their CS.[19,26,33] In some settings, there are perceived advantages for the child to be born on a date considered to be auspicious.[18,24,28,34] Previous negative experiences of vaginal birth, including suboptimal quality of care and experiences of disrespect and abuse, also influence choice of CS birth in subsequent pregnancies.[23,35–37]

Contemporary society exposes pregnant women to a wide range of information about pregnancy and childbirth.[38–41] The media has a growing influence on the decision by women to have an elective CS.[15,41–43] Birth by elective CS tends to be presented as controllable, convenient, fashionable, and modern.[40–42] A few studies[44]

Key messages

- Optimising caesarean section (CS) use is of global concern. CS underuse leads to higher perinatal mortality and morbidity and should remain a global health priority
- High frequency of CS use has not shown confirmed benefits, can be harmful and can commit resource use unnecessarily; therefore, to reach an optimum frequency of CS use around the world, overuse also needs to be addressed.
- Few clinical interventions have been tested in randomised trials with CS as a primary outcome; although labour induction at or near term could reduce the frequency of CS use, the side-effects, costs, and acceptability of routine labour induction with no medical indication for service users and providers have not been established. Trials that include continuous labour support show similar reductions in CS use to those of labour induction.
- Trials of non-clinical health-care interventions suggest that approaches that prioritise positive human relationships, promote respectful and collaborative multidisciplinary teamwork, and address clinicians' beliefs and attitudes and women's fear of labour pain and of poor quality of care, might be effective in reducing CS use or increasing physiological labour and birth. These approaches include labour companionship, midwife-led continuity of care, midwife-led units, antenatal education, and training and implementation of evidence-based guidelines at the point of care, along with mandatory second opinion and timely feedback to staff.
- Multifaceted (clinical and non-clinical) strategies are needed to reduce CS use and to increase physiological birth for healthy women and babies; these strategies must be scientifically tested, and tailored to local determinants (beliefs, norms, and behavioural factors that influence societal norms, women, health professionals, and health-care organisations).
- Further research is needed to evaluate the effect of CS overuse on resolving concomitant underuse.

suggest that the influence of fathers' preferences is related to convenience, previous negative experience of a partner's labour or birth, or previous experience of a partner having a CS.

Factors related to health professionals

Pregnant women tend to identify health providers as the most important influence on their decision about mode of birth.[24,45,46] By contrast, health providers report women's requests as an important reason for delivering babies with non-medically indicated CS. A study[7] that surveyed 1530 obstetricians in eight European countries found compliance with a hypothetical woman's request for CS without medical indications to be lowest in Spain (15%) and highest in the UK (79%). Fear of litigation, employment in a university-affiliated hospital, and being male were factors associated with increased likelihood of an obstetrician agreeing to a woman's request to have a CS.

In many countries, legal malpractice lawsuits make providers vulnerable even if they deliver the best evidence-based care.[47] Contrary to scientific evidence, it is commonly believed that a CS is a protective procedure.[48,49] Consequently, practitioners are more likely to be sued for complications during vaginal delivery than for unnecessary CS, even if there is no evidence of error.[47,48] Being sued (even if unsuccessfully) can generate negative publicity, damage reputations and professional confidence, and destroy careers.[50–53] This situation might result in health providers delivering a CS for professional protection, rather than to benefit the mother and the baby.[54]

In some settings, most CS operations occur during working hours and during weekdays, particularly on Fridays.[55,56] This finding suggests that the decision to use CS is sometimes made for convenience. In settings where obstetricians combine public and private work, scheduling elective CSs allows for private work to be reconciled with public duties.[34,53,57]

Factors related to health-care systems, financial reimbursements, and organisational design and cultures

In many but not all settings, the frequency of CS births is higher in the private sector.[58] In Brazil, for example, 80–90% of all babies in the private sector are born by CS, compared with 30–40% in the public sector.[59,60] In some settings, private maternity care sustains the finances for whole hospitals. If CSs can generate greater revenue than vaginal births, there are financial incentives to persuade women that a CS is the best delivery option for them selves and their baby.[57]

Inexperience or inadequate skills in performing an assisted vaginal delivery have been associated with a greater frequency of CS use,[53] especially in settings where there is little training and supervision, and young physicians are afraid of showing signs of incompetency or of asking senior staff for support.[53] In many settings, young obstetricians have become experts in CS, but are losing confidence in undertaking vaginal assisted deliveries and breech deliveries.[61,62]

Women's experiences of poor-quality antenatal environments, equipment, interaction with health professionals, and deliveries are associated with a mistrust in the system and staff. This mistrust can trigger a decision to undergo a CS to avoid anticipated poor-quality labour and birth care.[24,37] In some low-resource settings, the frequent use of CS in tertiary hospitals has been attributed to unskilled primary-care professionals, who delay referral because they do not detect danger signs. The transferred woman arrives late and in a critical condition and an emergency CS is the only solution.[53]

A schematic representation of the clinical (eg, presentation, number of fetuses, and previous CS) and non-clinical factors that affect the frequency of CS births is also shown in the figure.[64,65] The non-clinical factors are represented in the three outer rings, whereas the clinical factors are represented at the center, according to the Robson classification. The figure is intended to visually represent the layers of complexity of the factors involved.

Interventions to reduce unnecessary caesareans

Interventions to reduce unnecessary CSs can be broadly conceptualised as clinical and non-clinical, although there is overlap between the two. Clinical interventions tend to target a specific clinical practice for an individual woman (eg, vaginal birth after CS [VBAC]). Such interventions might only slightly reduce CS use because CS for clinical indications represents a shrinking proportion of the overall increasing use of this operation, as reported in the first paper in this Series.[2] Non-clinical interventions address one or more aspects of the design and delivery of the system of care and are often multifactorial. WHO has issued guidelines[66,67] on antenatal and intrapartum care, which include recommendations on some of the clinical interventions that reduce CS use and improve other outcomes for mothers and babies. We next summarise the clinical interventions to reduce overuse of CS, and we provide a more in-depth analysis of non-clinical interventions, based on the 2018 WHO recommendations.[68]

Clinical interventions

Only two clinical interventions for healthy women and babies with no complications have been tested in randomised controlled trials, which have had a primary outcome of intrapartum CS; these trials tested the effectiveness of routine induction of labour at or near term[69] and active management of labour.[70–72] The routine induction trials either found no difference in the frequency of CS use[69] or reduced its use.[70–72] The latest Cochrane review[73] on this topic did not have mode of birth as a primary outcome, but did show a reduction in CS use overall, as did the recently completed ARRIVE trial[74] of over 6000 low-risk primigravid women who were randomly allocated to groups at or around 39 weeks'

gestation (relative risk [RR] 0·84, 95% CI 0·76–0·93). However, induction of labour might result in other complications during delivery such as increased frequency of instrumental birth.[70–72] Additionally, women's views and experiences on labour and birth in the context of these trials are rarely reported in studies. Furthermore, recruitment to these trials was poor (ie, the proportion of approached eligible women who agreed to participate was low); for example, only about a third of eligible women agreed to participate in a randomised controlled trial assigning primigravid women aged 35 years or older to labour induction at 39 weeks or to expectant management,[69] and only 25% of those who were eligible agreed to take part in the ARRIVE trial.[75] This poor recruitment raises questions about women's willingness to undergo labour induction and, consequently, about the generalisability of the findings.

The latest Cochrane review[76] of active management of labour (ie, strict diagnosis of labour, routine amniotomy, oxytocin for slow progress, and one-to-one support in labour) showed no significant difference in the frequency of CS use between women at low-risk who received a predefined package of care (ie, active management) and women receiving routine care. However, when the authors excluded one low-quality study, the results showed a significant reduction in frequency of CS use (RR 0·77, 95% CI 0·63–0·94). It has been suggested that one-to-one support could be the primary mechanism affecting the frequency of CS use.[76] This hypothesis is strengthened by the latest Cochrane review[77] of continuous labour support, which found that the frequency of CS use is reduced when this intervention is used relative to when it is not used (0·75, 0·64–0·88), although CS was measured as a secondary outcome.

Although external cephalic version is used to reduce CS in breech presentation, it does not appear to do so in trial conditions.[78,79] CS use for breech presentation increased to almost 100% in many settings, after the publication of the results of the Term Breech Trial,[78,80] but the authors of the 2-year trial follow-up noted that "planned caesarean delivery is not associated with a reduction in risk of death or neurodevelopmental delay in children at 2 years of age".[81] Some centres are now offering carefully screened women the option of trying for a vaginal breech birth, with generally good outcomes.[82]

Women with a previous CS who have no complications in a subsequent pregnancy are often offered a trial of labour with a view to achieving VBAC. The only trial of VBAC[83,84] in the relevant Cochrane review[85] includes data for mode of birth for only 22 women, with no significant difference in CS frequency. A large European trial[86] of this approach is due to report soon. The influence of medical opinion leaders might increase the use of VBAC and, consequently, reduce CS use.[87] Despite the scarce trial evidence on mode of birth, both external cephalic version and VBAC are part of usual clinical practice in many settings.[88,89]

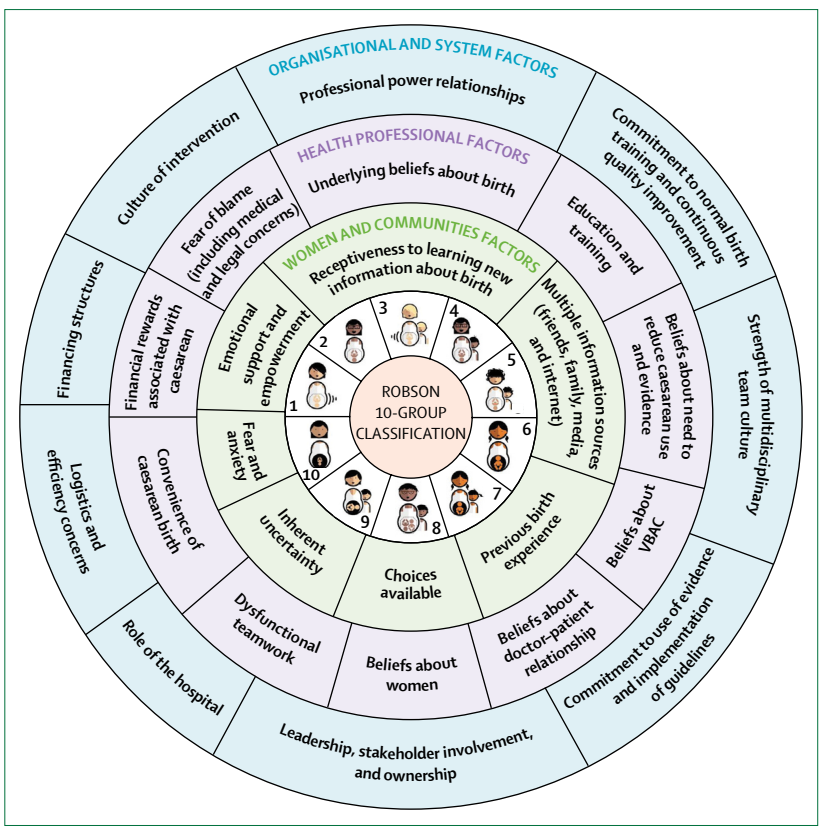

Figure: **Schematic representation of factors related to women, society, health providers, and health-care organisations that affect the frequency of caesarean section use at the local level; these factors surround the obstetric and clinical factors that also affect the frequency of births by caesarean section, which are represented in the middle by the Robson 10-group classification[63]**
VBAC=vaginal birth after caesarean section.

Apart from studies with a primary outcome of reducing CS use, randomised trial evidence suggests that limiting the cascade of interventions that women and babies are sometimes exposed to can increase the frequency of spontaneous vaginal birth.[90] This outcome could be achieved by midwifery-led continuity of care,[91] by planning labour in birth centres (in settings where there is access to rapid transfer), by use of intermittent auscultation rather than electronic fetal monitoring,[92] and by offering continuous labour support.[77]

The evidence considered in the context of the drivers that we have discussed suggests that meaningful reductions in CS use cannot be achieved by clinical interventions alone. Non-clinical interventions are more likely to address behavioural and psychosocial drivers.

Non-clinical interventions

Acknowledging that there is no clear division between clinical and non-clinical interventions, we defined non-clinical interventions as those that are applied independently of a clinical encounter between a specific health-care provider and a particular service user.[68] New WHO recommendations[68] on non-clinical interventions drew on an updated Cochrane review[12] (29 included

studies), and three qualitative evidence syntheses (including Kingdon et al, unpublished)[45,93] on women's and providers' views, values, beliefs, and perceptions about CS, and factors related to health-care organisations, facilities, and systems (collectively, 49 studies reported in 52 papers). We next present a summary of the findings of these reviews.

Interventions targeted at women, families and communities

Fear, concerns about safety, convenience, misinformation, and wider society or peer-group norms are all relevant factors in decision making about mode of birth for women and their families. The efficacy evidence for interventions in this area is derived from 12 randomised controlled trials, which all compared specific education, support programmes, and birth preparation classes with usual practices, and mostly addressed knowledge, anxiety, and fear.[12] Three interventions (appendix), which were tested in small studies with fewer than 200 participants each, reduced the proportion of births by CS; these interventions included a nurse-led applied relaxation training programme (Iran),[94] a psychosocial couple-based prevention programme (USA),[95] and a childbirth training workshop (Iran).[96] In addition, one Finnish study[97] of 371 women with fear of childbirth reported no significant effect of psychoeducation on the overall frequency of CS use but a 33% increase in spontaneous vaginal births. All were low-quality, single-site studies.

See Online for appendix

Three studies[98–100] assessed different formats of educational intervention in women with a previous CS; these studies used role play education versus lectures in nulliparous women (Iran),[98] interactive decision aids versus educational brochures (USA),[99] and individualised prenatal education and support versus written information pamphlets (Canada).[100] None of these three studies showed significant differences between formats in frequency of CS or VBAC use.[12]

A qualitative evidence synthesis,[45] which was based on 12 studies published between 2001 and 2016, in Australia, Brazil, Canada, Norway, Taiwan, the UK, and the USA, mainly in urban settings, was undertaken. The studies enrolled both highly motivated women who expressed an intense desire for engagement and women who wanted the provider to make the relevant decisions. Across all groups, pregnant women welcomed educational interventions. Most reported that new knowledge could be empowering and inform more meaningful dialogue with providers, provided that the content and format did not provoke anxiety. Most women in the study were said to welcome online and digital information, but many still wanted printed copies to reflect on and to revisit with family and friends.[101]

Face-to-face dialogue with health professionals was reported by most women to be a strong influence on decisions about birth mode, especially when clinicians recognised childbirth as an emotional experience, rather than just a clinical process. Frustration and mistrust resulted when women felt they were not listened to or that advice provided was inconsistent.[45]

Interventions targeted at health professionals

Concerns about litigation, organisational and peer group norms, financial benefits, and convenience are drivers of health professional use of CS. Interventions directed at health professionals to optimise CS use have included educational packages to improve adherence to evidence-based clinical practice, second-opinion policies, audit and feedback, and peer-review of CS indications.[12] Two interventions slightly reduced CS use with high-certainty evidence (appendix): implementation of evidence-based guidelines combined with structured, mandatory second opinion (sites in Argentina, Brazil, Cuba, Guatemala, and Mexico)[102] and implementation of evidence-based guidelines combined with CS audits and timely feedback (several sites in Canada).[103]

A qualitative evidence synthesis of health professionals' views and experiences of non-clinical interventions to reduce unnecessary CSs included 17 studies (2005–17) from 17 countries (Australia, Canada, China, Ethiopia, Finland, Germany, Iran, Ireland, Italy, Kenya, the Netherlands, Nicaragua, Sweden, Tanzania, Uganda, the UK, and the USA), in both rural and urban settings (Kingdon et al, unpublished). The findings here showed that health professionals' beliefs about birth (on a continuum from considering it a normal physiological process to inherently pathological) informed both their knowledge about what constitutes necessary and unnecessary CS and the importance they attached to reducing overuse. Some obstetric residents reported a need for improved communication among members of staff, although some feared that seeking a second opinion could negatively affect their clinical credibility and career. Some professionals were opposed to second-opinion policies because of consequent difficulties in establishing medical and legal responsibilities. A few professionals reported that they welcomed guidelines as providing a defendable basis for their practice (rather than as a basis for good practice per se), whereas others resisted guideline-directed practice, believing that they already only intervened when necessary.

Responses to interventions such as audit and feedback were influenced by fear of blame and recrimination, the value attached to personal financial reward, preference for CS as an efficient birth method that can be scheduled, and beliefs about women (including professionals' perceptions of women's preparedness to give birth vaginally, lack of antenatal education, sedentary lifestyles, and increasing prevalence of obesity). Doubts about local validity of guidelines, difficulty of keeping them up-to-date, and scarcity of resources hindered implementation of guidelines. In European settings, health professionals were reported to feel that interventions targeted at

overuse were most acceptable where this vision was shared within and between multidisciplinary groups, and when they felt supported by colleagues and opinion leaders.

Interventions targeted at health-care organisations, facilities, and systems

The drivers for CS at the systems level included financing and care-provision models, system integration, and environmental and resourcing conditions. Interventions at this level to reduce the prevalence of CS births include changes in organisational culture, insurance reforms, external peer review, legislative policy to limit legal liability in case of litigation, facility staffing models, specific goals for frequency of CS use, and targeted financial strategies.[12]

Three studies[104–106] testing such interventions were identified (appendix).[68] A single-site study[104] in the USA tested a change in the model of care: privately insured women were switched from a physicians' private-practice approach to a model of care provided primarily by midwives which had 24-h in-house obstetrician back-up without other competing clinical duties. This intervention led to a significant decrease in the frequency of primary CS and an increase in the frequency of VBACs. The other two studies[105,106] assessed financial incentives for health professionals, but they were of low quality (uncertain evidence). In one hospital in the USA, equalising physician fees for vaginal and CS delivery showed no significant reduction in the frequency of CS use.[105] In Taiwan, the National Health Insurance scheme increased the fee for a vaginal birth to the cost of CS, with no significant effect on CS frequency.[106]

A qualitative evidence synthesis of organisations, facilities, and system-level interventions[93] included 25 studies (1993–2016) from 17 countries (nine from Europe or North America, five from Africa, four from Latin America, three from China, two from Iran, one from Bangladesh, and one from Lebanon), in rural and urban settings. Some participants worked in settings where the organisational culture endorsed maternal requests for CS, or where the quality of care was believed to be compromised by reductions in CS use. In other settings, reducing the frequency of CS use was said to enhance overall quality of care. These attitudes influenced whether changes in the physical birth environment (such as increased space to allow the presence of a labour-support companion and improved facility resources and ambient conditions) to encourage labour and vaginal birth were properly maintained or not, and whether any change implemented to reduce the frequency of CS use was followed or ignored by staff.

There was a consistent message across studies and countries that the birth environment was affected by both the physical structures (eg, availability of individual or shared labour rooms, bathroom access, state of repair of the facilities) and resources of the health facility and the quality of relationships between professionals and stakeholders (ie, patients as well as higher level institutions such as health-facility management, or local and national governments), which are all elements that contribute to the organisational ethos. In Iran, Lebanon, and Nicaragua, substandard conditions in maternity care were reported as major barriers to reducing unnecessary CSs. Crucially, the balance of power between doctors, midwives, nurses, other maternity care providers, and childbearing women strongly influenced the willingness of each party to engage or not in the improvement of the organisational ethos. Respectful multidisciplinary teamwork and communication seemed to be fundamental to promoting efforts to reduce CS use.[93]

Mechanisms of effect

Strategies for successful implementation of interventions

The data we have presented suggest that few interventions (clinical or non-clinical) are targeted to the several drivers of high CS use and their interactions (Kingdon et al, unpublished),[45,68,93] which are complex, dynamic, and partly context-specific. Consequently, few of these interventions have been effective in reducing the frequency of unnecessary CSs.[8,12] For example, addressing preparedness and knowledge of pregnant women while ignoring health-care providers' demand for skill development and training or for more pro-vaginal birth malpractice policies that would create a safer environment for doctors who provide evidence-based care is unlikely to reduce the number of births by CS.

Additionally, the interactions between factors might require continuous adaptations and changes. For example, the establishment of positive reputation and respectful relationships between different cadres or between providers, pregnant women, and communities need time, effective communication, and understanding. Incremental adaptations are more likely to yield sustainable results than artificially imposed drastic changes in already tense environments.

Interventions for women should provide a sense of empowerment. They need to be implemented in conjunction with meaningful dialogue with health professionals and with those who set maternity care norms in local communities. These interventions should include recognition of previous experience of birth, consider short-term and long-term effects of CS on women and children, and provide effective emotional support.

Professional norms, beliefs, and values that influence local day-to-day decision making in clinical practice tend to operate independently of—and sometimes despite—the known evidence base. Some services that have safely reduced CS use as part of an overall programme of good-quality care are characterised by mutually respectful multidisciplinary teamwork where all staff groups are genuinely working to optimise positive and safe childbirth.

Barriers to effective collaboration and communication need to be removed to increase the chances of successfully reducing CS frequency. Appropriate management of the change process (eg, changes in work patterns, workloads, skills, and professional ethos that some new approaches require) is also crucial.

The importance of effective, tailored, and continuous professional education, training, and support cannot be overstated. Staff need to have and maintain the necessary skills to provide flexible support for individual women in their pursuit of safe vaginal birth. Along with continuous quality improvement, staff must also be trained to make good decisions about when interventions are needed. These requirements are essential to reduce fear of litigation.

Health systems are the structure that either supports or undermines clinical and professional efforts for change. The overall organisational ethos is important and must be understood and addressed. The creation of safe, private, welcoming, and adequately resourced labour and birth environments that promote relaxation and a sense of support for women and health professionals is essential.

Notably, the first step for success is local recognition of the problem. Changes externally imposed on facilities and professionals are a recipe for failure. Participatory approaches are more likely to be effective. At both the country and the facility level, strong and responsive leadership and authentic sustainable commitment to reduce unnecessary CSs are crucial. The reduction of overuse requires a change in organisational mentality and needs high visibility. Bringing this issue to the attention of the public requires production and distribution of printed, audio-visual, and virtual material and social and mass media coverage.

Implementing change effectively

Although all the factors discussed in this Series paper are essential, their number can seem overwhelming (figure). Implementation and improvement science offers a range of theories to operationalise effective interventions.[107–109] Successful initiatives for complex health systems have used participatory methods and action-led processes to introduce auditing and cycles of change during the intervention process.[110,111] These implementation mechanisms allow for more flexible designs to remove local barriers and integrate mediators, while incorporating population-level evidence. These strategies also help overcome the sense of helplessness that can arise when faced with the apparent complexity of insufficient human resources or materials, suboptimal communication, toxic power relations, perverse financial incentives, and adverse professional and societal norms. In contrast to simple, linear, top-down interventions that demand fidelity to very specific components, participatory approaches and subsequent adapted actions have the ability to pinpoint where change is possible in the local system and to adopt several interventions to address all the locally relevant blocking factors.[109–111] Indeed, evidence from specific sites and regions in China suggests that using multilevel interventions, such as change in government policy, financial incentives, local benchmarking, education of staff and of service users, provision of doula support, and access to pain relief can limit the increase in CS use.[112,113]

Future research priorities

With some exceptions, interventions tested thus far to reduce unnecessary CSs have been single faceted, targeted to one group (eg, women or health-care providers), tested in a single site or country with a relatively small number of participants, and have provided low-quality or very low-quality evidence. Women's views and experiences were often not included, and medium-term and long-term follow-up was not done. Studies have rarely considered the qualitative evidence of what might work for a particular barrier or facilitator. Future interventions are unlikely to be effective if they repeat these errors. Consideration of the local context, culture, norms, practice, and pre-existing initiatives is essential not only for the optimal design of the intervention and its components but also as a means to mediate negotiation and overcome resistance to change.[114–116]

Supportive models of care, including labour companionship,[77] midwife-led continuity of care,[91] and midwife-led units,[117] are promising approaches. They tend to prioritise positive human relationships and to optimise physiological labour and birth for healthy women and babies. In trials in high-income countries, these models have also been associated with safe outcomes, lower health-care costs, and positive maternal experiences for both healthy women and babies and those with complications, relative to control groups without these interventions. The feasibility and applicability of such approaches now need to be assessed in middle-income and low-income countries.

Research is also needed to evaluate the effect of overuse of CS on resolving concomitant underuse. Promising ideas that could solve both overuse and underuse, but that require more research, include methods to change organisational ethos and culture; ways to maximise respectful intraprofessional and interprofessional team work and relationships between providers and women; financial interventions that could involve physicians individually, but also hospitals or whole systems; maintenance of reimbursement costs for vaginal delivery close to those for CS or higher; establishment of targets for the frequency of CS use at a facility level; and public dissemination of CS use by hospital.[114,115,118–120]

All proposals to otimise the use of CS involve complex interventions, which are challenging to develop, evaluate, document, and reproduce and are subject to more variation than interventions that involve drug administration.[114,121] Many complex interventions are implemented in contexts

that prioritise action over generation of evidence.[109,115,118,122] In general, future research in this area should be based on well designed participatory and action-focused studies that combine the rigour of research and the flexibility needed to optimise complex multifaceted interventions.[109,110] Proper evaluation of the effectiveness of any intervention before widescale implementation takes place is crucial. Additionally, new interventions need to be designed and tested on the basis of the drivers for higher or lower use of CS identified in the qualitative data that we have presented.

Among the few studies that exist in this area, even fewer are based in low-income countries, although these countries are also showing increasing numbers of unnecessary births by CS in parallel with underuse.[9] Future studies should also address drivers and interventions relevant to these countries, where inequities in the use of CS are more prevalent and detrimental effects are higher.[9]

Conclusions

Although there is almost universal consensus that current CS use has transgressed reasonable justification of need, effective interventions to optimise the frequency of births by CS by increasing use in settings with underuse and reducing overuse in areas where this is a key problem have proven elusive. The poor effect of these interventions in optimising the frequency of CS use might be due to the complexity of the factors that drive underuse and overuse of CS worldwide and to the prevalent approach in research to focus on single interventions that target only one driver. Given the issues discussed in this paper, addressing overuse is crucial to optimising the experiences and outcomes of maternity care. New multicomponent interventions that can be tailored to local contexts and drivers should be devised to address the concerns of women and health professionals and the limitations of health systems.

A CS is not a standalone event and it is not intrinsically an adverse outcome. Indeed, reducing the frequency of CS use to less than a safe threshold value, or replacing it with badly performed instrumental birth, is more likely to cause harm than good. However, most healthy women would prefer to labour and give birth physiologically if possible[16] and this outcome is most likely to be associated, as outlined in the second paper[3] of this three-part Series, with optimal wellbeing for both mother and baby in the short and longer term, and is more sustainable for health-care systems.[3] Qualitative and efficacy data suggest that interventions that prioritise positive human relationships, promote respectful and collaborative multidisciplinary teamwork, and address clinicians' beliefs and attitudes and women's fear of labour pain and of poor quality of care, might be effective in reducing unnecessary CS use and safely increasing physiological labour and birth. These interventions include labour companionship, midwife-led continuity of care, midwife-led units, antenatal education, training, and implementation of evidence-based guidelines at the point of care, along with mandatory second opinion and timely feedback to staff.

Comparing CS use in a standardised, meaningful, and action-oriented manner (such as with the Robson groups criteria) is crucial.[64,123] Where overuse is identified, the issue should be brought to the attention of the public, and should be high on the political agendas of countries with disproportionately frequent use of CS, especially where this occurs in parallel with underuse of CS for some population groups. Reduction strategies require interventions that take account of the drivers identified in this paper and that recognise the need to influence change in the beliefs and attitudes of providers, service users, and societies.

Contributors

APB, MT, CK, NO, and SD conceived and drafted the outline of the manuscript and wrote the first draft. APB and NO developed the appendix. CK made the figure with contributions from APB and SD. AM, MRT, JZ, OM, SZW, and AMG contributed substantial comments to the writing of the manuscript. All authors read and approved the final manuscript. APB, CK, NO, and SD had full access to the data from the systematic reviews. APB, MT, and SD had final responsibility for the decision to submit the manuscript for publication.

Declaration of interests

We declare no competing interests.

Acknowledgments

We would like to thank Markus MacGill of Green Ink for editorial assistance.

References

1 WHO, Human Reproduction Programme. WHO statement on caesarean section rates. Geneva: World Health Organization, April, 2015. http://www.who.int/reproductivehealth/publications/maternal_perinatal_health/cs-statement/en/ (accessed Sept 17, 2018).

2 Boerma T, Ronsmans C, Barros AJ, et al. Global epidemiology of use of and disparities in caesarean sections. *Lancet* 2018; published online Oct 11. http://dx.doi.org/10.1016/S0140-6736(18)31928-7.

3 Sandall J, Tribe RM, Avery L, et al. Short-term and long-term effects of caesarean section on the health of women and children. *Lancet* 2018; published online Oct 11. http://dx.doi.org/10.1016/S0140-6736(18)31930-5.

4 Gibbons L, Belizan JM, Lauer JA, Betran AP, Merialdi M, Althabe F. Inequities in the use of cesarean section deliveries in the world. *Am J Obstet Gynecol* 2012; **206:** 331.

5 Cavallaro FL, Cresswell JA, Ronsmans C. Obstetricians' opinions of the optimal caesarean rate: a global survey. *PLoS One* 2016; **11:** e0152779.

6 Betrán AP, Ye J, Moller AB, Zhang J, Gulmezoglu AM, Torloni MR. The increasing trend in caesarean section rates: global, regional and national estimates: 1990–2014. *PLoS One* 2016; **11:** e0148343.

7 Habiba M, Kaminski M, Da Fre M, et al. Caesarean section on request: a comparison of obstetricians' attitudes in eight European countries. *BJOG* 2006; **113:** 647–56.

8 Main EK, Morton CH, Melsop K, Hopkins D, Giuliani G, Gould JB. Creating a public agenda for maternity safety and quality in cesarean delivery. *Obstet Gynecol* 2012; **120:** 1194–98.

9 Boatin AA, Schlotheuber A, Betran AP, et al. Within country inequalities in caesarean section rates: observational study of 72 low and middle income countries. *BMJ* 2018; **360:** k55.

10 Kabir AA, Steinmann WC, Myers L, et al. Unnecessary cesarean delivery in Louisiana: an analysis of birth certificate data. *Am J Obstet Gynecol* 2004; **190:** 10–19.

11 Koroukian SM, Trisel B, Rimm AA. Estimating the proportion of unnecessary Cesarean sections in Ohio using birth certificate data. *J Clin Epidemiol* 1998; **51:** 1327–34.

12 Chen I, Opiyo N, Tavender E, et al. Non-clinical interventions for reducing unnecessary caesarean section. *Cochrane Database Syst Rev* 2018; **9:** CD005528.

13 Robson SJ, Tan WS, Adeyemi A, Dear KBG. Estimating the rate of cesarean section by maternal request: anonymous survey of obstetricians in Australia. *Birth* 2009; **36:** 208–12.

14 Weaver JJ, Statham H, Richards M. Are there "unnecessary" cesarean sections? Perceptions of women and obstetricians about cesarean sections for nonclinical indications. *Birth* 2007; **34:** 32–41.

15 Bettes BA, Coleman VH, Zinberg S, et al. Cesarean delivery on maternal request: obstetrician-gynecologists' knowledge, perception, and practice patterns. *Obstet Gynecol* 2007; **109:** 57–66.

16 Mazzoni A, Althabe F, Liu NH, et al. Women's preference for caesarean section: a systematic review and meta-analysis of observational studies. *BJOG* 2011; **118:** 391–99.

17 McCourt C, Weaver J, Statham H, Beake S, Gamble J, Creedy DK. Elective cesarean section and decision making: a critical review of the literature. *Birth* 2007; **34:** 65–79.

18 Mi J, Liu F. Rate of caesarean section is alarming in China. *Lancet* 2014; **383:** 1463–64.

19 Buyukbayrak EE, Kaymaz O, Kars B, et al. Caesarean delivery or vaginal birth: preference of Turkish pregnant women and influencing factors. *J Obstet Gynaecol* 2010; **30:** 155–58.

20 Nieminen K, Wijma K, Johansson S, et al. Severe fear of childbirth indicates high perinatal costs for Swedish women giving birth to their first child. *Acta Obstet Gynecol Scand* 2017; **96:** 438–46.

21 Yilmaz SD, Bal MD, Beji NK, Uludag S. Women's preferences of method of delivery and influencing factors. *Iran Red Crescent Med J* 2013; **15:** 683–89.

22 Fuglenes D, Aas E, Botten G, Oian P, Kristiansen IS. Why do some pregnant women prefer cesarean? The influence of parity, delivery experiences, and fear. *Am J Obstet Gynecol* 2011; **205:** 45.

23 Kringeland T, Daltveit AK, Moller A. What characterizes women in Norway who wish to have a caesarean section? *Scand J Public Health* 2009; **37:** 364–71.

24 Long Q, Kingdon C, Yand F, et al. Preference for caesarean section in China: a mixed-methods systematic review of women's and healthcare providers' views and experience. *PLoS Med* (in press).

25 Bracken JN, Dryfhout VL, Goldenhar LM, Pauls RN. Preferences and concerns for delivery: an antepartum survey. *Int Urogynecol J Pelvic Floor Dysfunct* 2008; **19:** 1527–31.

26 Ghotbi F, Akbari Sene A, Azargashb E, et al. Women's knowledge and attitude towards mode of delivery and frequency of cesarean section on mother's request in six public and private hospitals in Tehran, Iran, 2012. *J Obstet Gynaecol Res* 2014; **40:** 1257–66.

27 Hopkins K. Are Brazilian women really choosing to deliver by cesarean? *Soc Sci Med* 2000; **51:** 725–40.

28 Loke AY, Davies L, Li SF. Factors influencing the decision that women make on their mode of delivery: the Health Belief Model. *BMC Health Serv Res* 2015; **15:** 274.

29 Torloni MR, Betran AP, Montilla P, et al. Do Italian women prefer cesarean section? Results from a survey on mode of delivery preferences. *BMC Pregnancy Childbirth* 2013; **13:** 78.

30 Pang MW, Lee TS, Leung AK, Leung TY, Lau TK, Leung TN. A longitudinal observational study of preference for elective caesarean section among nulliparous Hong Kong Chinese women. *BJOG* 2007; **114:** 623–29.

31 Hug I, Chattopadhyay C, Mitra GR, Kar Mahapatra RM, Schneider MC. Maternal expectations and birth-related experiences: a survey of pregnant women of mixed parity from Calcutta, India. *Int J Obstet Anesth* 2008; **17:** 112–17.

32 Dweik D, Girasek E, Toreki A, Meszaros G, Pal A. Women's antenatal preferences for delivery route in a setting with high cesarean section rates and a medically dominated maternity system. *Acta Obstet Gynecol Scand* 2014; **93:** 408–15.

33 Kasai KE, Nomura RM, Benute GR, de Lucia MC, Zugaib M. Women's opinions about mode of birth in Brazil: a qualitative study in a public teaching hospital. *Midwifery* 2010; **26:** 319–26.

34 Schantz C, Sim KL, Petit V, Rany H, Goyet S. Factors associated with caesarean sections in Phnom Penh, Cambodia. *Reprod Health Matters* 2016; **24:** 111–21.

35 Karlstrom A, Nystedt A, Johansson M, Hildingsson I. Behind the myth—few women prefer caesarean section in the absence of medical or obstetrical factors. *Midwifery* 2011; **27:** 620–27.

36 Tschudin S, Alder J, Hendriksen S, et al. Pregnant women's perception of cesarean section on demand. *J Perinat Med* 2009; **37:** 251–56.

37 Hogberg U, Lynoe N, Wulff M. Cesarean by choice? Empirical study of public attitudes. *Acta Obstet Gynecol Scand* 2008; **87:** 1301–08.

38 Fenwick J, Staff L, Gamble J, Creedy DK, Bayes S. Why do women request caesarean section in a normal, healthy first pregnancy? *Midwifery* 2010; **26:** 394–400.

39 Bryant J, Porter M, Tracy SK, Sullivan EA. Caesarean birth: consumption, safety, order, and good mothering. *Soc Sci Med* 2007; **65:** 1192–201.

40 Fioretti B, Reiter M, Betran A, Torloni M. Googling caesarean section: a survey on the quality of the information available on the internet. *BJOG* 2014; **122:** 731-39.

41 Torloni M, Campos Mansilla B, Merialdi M, Betran A. What do popular Spanish women's magazines say about caesarean section? A 21-year survey. *BJOG* 2014; **121:** 548–55.

42 Bantan N, Abenhaim HA. Vaginal births after caesarean: what does Google think about it? *Women Birth* 2015; **28:** 21–24.

43 Amyx M, Gibbons L, Xiong X, et al. Sources of influence on pregnant women's preferred mode of delivery in Buenos Aires, Argentina. *Birth* 2018; **45:** 71–78.

44 Johansson M, Radestad I, Rubertsson C, Karlstrom A, Hildingsson I. Few fathers-to-be prefer caesarean section for the birth of their baby. *BJOG* 2010; **117:** 761–64.

45 Kingdon C, Downe S, Betrán AP. Women's and communities' views of targeted educational interventions to reduce unnecessary caesarean section: a qualitative evidence synthesis. *Reprod Health* 2018; **15:** 130.

46 Ji H, Jiang H, Yang L, Qian X, Tang S. Factors contributing to the rapid rise of caesarean section: a prospective study of primiparous Chinese women in Shanghai. *BMJ Open* 2015; **5:** e008994.

47 Studdert DM, Mello MM, Gawande AA, et al. Claims, errors, and compensation payments in medical malpractice litigation. *N Engl J Med* 2006; **354:** 2024–33.

48 Kravitz RL, Rolph JE, McGuigan K. Malpractice claims data as a quality improvement tool: I. Epidemiology of error in four specialties. *JAMA* 1991; **266:** 2087–92.

49 Jena AB, Schoemaker L, Bhattacharya J, Seabury SA. Physician spending and subsequent risk of malpractice claims: observational study. *BMJ* 2015; **351:** h5516.

50 Asher E, Dvir S, Seidman DS, et al. Defensive medicine among obstetricians and gynecologists in tertiary hospitals. *PLoS One* 2013; **8:** e57108.

51 Grytten J, Skau I, Sorensen R. The impact of the mass media on obstetricians' behavior in Norway. *Health Policy* 2017; **121:** 986–93.

52 Bettes BA, Strunk AL, Coleman VH, Schulkin J. Professional liability and other career pressures: impact on obstetrician-gynecologists' career satisfaction. *Obstet Gynecol* 2004; **103:** 967–73.

53 Litorp H, Mgaya A, Mbekenga CK, Kidanto HL, Johnsdotter S, Essen B. Fear, blame and transparency: obstetric caregivers' rationales for high caesarean section rates in a low-resource setting. *Soc Sci Med* 2015; **143:** 232–40.

54 Localio AR, Lawthers AG, Bengtson JM, et al. Relationship between malpractice claims and cesarean delivery. *JAMA* 1993; **269:** 366–73.

55 Dweik D, Girasek E, Meszaros G, Toreki A, Kereszturi A, Pal A. Non-medical determinants of cesarean section in a medically dominated maternity system. *Acta Obstet Gynecol Scand* 2014; **93:** 1025–33.

56 Gomes UA, Silva AA, Bettiol H, Barbieri MA. Risk factors for the increasing caesarean section rate in southeast Brazil: a comparison of two birth cohorts, 1978–1979 and 1994. *Int J Epidemiol* 1999; **28:** 687–94.

57 Murray SF. Relation between private health insurance and high rates of caesarean section in Chile: qualitative and quantitative study. *BMJ* 2000; **321:** 1501–05.

58 Al Rifai RH. Trend of caesarean deliveries in Egypt and its associated factors: evidence from national surveys, 2005–2014. *BMC Pregnancy Childbirth* 2017; **17:** 417.

59 Brazil Ministry of Health. SUS hospital procedures. 2015. http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sih/cnv/qiuf.def (accessed July 12, 2016; in Portuguese).

60 Brazil Ministry of Health. MS/SVS/DASIS - national data system on live births - SINASC. 2016. http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sinasc/cnv/nvuf.def (accessed July 12, 2016; in Portuguese).

61 Fauveau V. Is vacuum extraction still known, taught and practiced? A worldwide KAP survey. *Int J Gynaecol Obstet* 2006; **94:** 185–89.

62 Bailey PE. The disappearing art of instrumental delivery: time to reverse the trend. *Int J Gynaecol Obstet* 2005; **91:** 89–96

63 Robson MS. Classification of caesarean sections. *Fetal Matern Med Rev* 2001; **12:** 23–39.

64 Betrán AP, Torloni MR, Zhang J, Gülmezoglu AM, WHO Working Group on Caesarean Section. Commentary: WHO statement on caesarean section rates. *BJOG* 2016; **123:** 667–70.

65 Robson M, Hartigan L, Murphy M. Methods of achieving and maintaining an appropriate caesarean section rate. *Best Pract Res Clin Obstet Gynaecol* 2013; **27:** 297–308.

66 WHO. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva, Switzerland: World Health Organization, 2016. http://www.who.int/reproductivehealth/publications/maternal_perinatal_health/anc-positive-pregnancy-experience/en/ (accessed Sept 17, 2018).

67 WHO. WHO recommendations: intrapartum care for a positive childbirth experience. Geneva, Switzerland: World Health Organization, 2018. http://www.who.int/reproductivehealth/publications/intrapartum-care-guidelines/en/ (accessed Sept 17, 2018).

68 WHO. WHO recommendations on non-clinical interventions to reduce unnecessary caesarean births. Geneva: World Health Organization, 2018.

69 Walker KF, Bugg GJ, Macpherson M, et al. Randomized trial of labor induction in women 35 years of age or older. *N Engl J Med* 2016; **374:** 813–22.

70 Saccone G, Berghella V. Induction of labor at full term in uncomplicated singleton gestations: a systematic review and metaanalysis of randomized controlled trials. *Am J Obstet Gynecol* 2015; **213:** 629–36.

71 Mishanina E, Rogozinska E, Thatthi T, Uddin-Khan R, Khan KS, Meads C. Use of labour induction and risk of cesarean delivery: a systematic review and meta-analysis. *CMAJ* 2014; **186:** 665–73.

72 National Institutes of Health. Induced labor after 39 weeks in healthy women may reduce need for C section. Feb 1, 2018. https://www.nih.gov/news-events/news-releases/induced-labor-after-39-weeks-healthy-women-may-reduce-need-c-section (accessed Sept 17, 2018).

73 Middleton P, Shepherd E, Crowther CA. Induction of labour for improving birth outcomes for women at or beyond term. *Cochrane Database Syst Rev* 2018; **5:** CD004945.

74 Grobman W. LB01: a randomized trial of elective induction of labour at 39 weeks compared with expectant management of low-risk nulliparous women. *Am J Obstet Gynecol* 2018; **218:** S601 (abstr).

75 Main E, CMQCC Leadership Team. Comments on the Arrive Trial. California Maternal Quality Care Collaborative, Feb 8, 2018. https://www.cmqcc.org/sites/default/files/Arrive%20Trial%20Statement%20Final.pdf (accessed Sept 17, 2018).

76 Brown HC, Paranjothy S, Dowswell T, Thomas J. Package of care for active management in labour for reducing caesarean section rates in low-risk women. *Cochrane Database Syst Rev* 2013; **4:** CD004907.

77 Bohren MA, Hofmeyr GJ, Sakala C, Fukuzawa RK, Cuthbert A. Continuous support for women during childbirth. *Cochrane Database Syst Rev* 2017; **7:** CD003766.

78 Hutton EK, Hofmeyr GJ, Dowswell T. External cephalic version for breech presentation before term. *Cochrane Database Syst Rev* 2015; **7:** CD000084.

79 Hofmeyr GJ, Hannah M, Lawrie TA. Planned caesarean section for term breech delivery. *Cochrane Database Syst Rev* 2015; **7:** CD000166.

80 Hannah ME, Hannah WJ, Hewson SA, Hodnett ED, Saigal S, Willan AR. Planned caesarean section versus planned vaginal birth for breech presentation at term: a randomised multicentre trial. *Lancet* 2000; **356:** 1375–83.

81 Whyte H, Hannah ME, Saigal S, et al. Outcomes of children at 2 years after planned cesarean birth versus planned vaginal birth for breech presentation at term: the International Randomized Term Breech Trial. *Am J Obstet Gynecol* 2004; **191:** 864–71.

82 Bjellmo S, Andersen GL, Martinussen MP, et al. Is vaginal breech delivery associated with higher risk for perinatal death and cerebral palsy compared with vaginal cephalic birth? Registry-based cohort study in Norway. *BMJ Open* 2017; **7:** e014979.

83 Dodd JM, Crowther CA, Hiller JE, Haslam RR, Robinson JS. Birth after caesarean—planned vaginal birth or planned elective repeat caesarean for women at term with a single previous caesarean birth: protocol for a patient preference study and randomised trial. *BMC Pregnancy Childbirth* 2007; **7:** 17.

84 Crowther CA, Dodd JM, Hiller JE, Haslam RR, Robinson JS. Planned vaginal birth or elective repeat caesarean: patient preference restricted cohort with nested randomised trial. *PLoS Med* 2012; **9:** e1001192.

85 Dodd JM, Crowther CA, Huertas E, Guise JM, Horey D. Planned elective repeat caesarean section versus planned vaginal birth for women with a previous caesarean birth. *Cochrane Database Syst Rev* 2013; **12:** CD004224.

86 Clarke M, Savage G, Smith V, et al. Improving the organisation of maternal health service delivery and optimising childbirth by increasing vaginal birth after caesarean section through enhanced women-centred care (OptiBIRTH trial): study protocol for a randomised controlled trial (ISRCTN10612254). *Trials* 2015; **16:** 542.

87 Lomas J, Enkin M, Anderson GM, Hannah WJ, Vayda E, Singer J. Opinion leaders vs audit and feedback to implement practice guidelines. Delivery after previous cesarean section. *JAMA* 1991; **265:** 2202–7.

88 Committee on Practice Bulletins-Obstetrics. Practice bulletin no. 184: vaginal birth after cesarean delivery. *Obstet Gynecol* 2017; **130:** e217–33.

89 Royal College of Obstetricians & Gynecologists. Birth after previous caesarean birth (green-top guideline no. 45). February, 2017. https://www.rcog.org.uk/en/guidelines-research-services/guidelines/gtg45/ (accessed Sept 17, 2018).

90 Rossignol M, Chaillet N, Boughrassa F, Moutquin JM. Interrelations between four antepartum obstetric interventions and cesarean delivery in women at low risk: a systematic review and modeling of the cascade of interventions. *Birth* 2014; **41:** 70–8.

91 Sandall J, Soltani H, Gates S, Shennan A, Devane D. Midwife-led continuity models versus other models of care for childbearing women. *Cochrane Database Syst Rev* 2016; **4:** CD004667.

92 Alfirevic Z, Devane D, Gyte GM, Cuthbert A. Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. *Cochrane Database Syst Rev* 2017; **2:** CD006066.

93 Kingdon C, Downe S, Betrán AP. Non-clinical interventions to reduce unnecessary caesarean section targeted at organisations, facilities and systems: systematic review of qualitative studies. *PLoS One* 2018; **13:** e0203274.

94 Bastani F, Hidarnia A, Montgomery KS, Aguilar-Vafaei ME, Kazemnejad A. Does relaxation education in anxious primigravid Iranian women influence adverse pregnancy outcomes?: a randomized controlled trial. *J Perinat Neonatal Nurs* 2006; **20:** 138–46.

95 Feinberg ME, Roettger ME, Jones DE, Paul IM, Kan ML. Effects of a psychosocial couple-based prevention program on adverse birth outcomes. *Matern Child Health J* 2015; **19:** 102–11.

96 Valiani M, Haghighatdana Z, Ehsanpour S. Comparison of childbirth training workshop effects on knowledge, attitude, and delivery method between mothers and couples groups referring to Isfahan health centers in Iran. *Iran J Nurs Midwifery Res* 2014; **19:** 653–58.

97 Rouhe H, Salmela-Aro K, Toivanen R, Tokola M, Halmesmaki E, Saisto T. Obstetric outcome after intervention for severe fear of childbirth in nulliparous women - randomised trial. *BJOG* 2013; **120:** 75–84.

98 Navaee M, Abedian Z. Effect of role play education on primiparous women's fear of natural delivery and their decision on the mode of delivery. *Iran J Nurs Midwifery Res* 2015; **20:** 40–46.

99 Eden KB, Perrin NA, Vesco KK, Guise JM. A randomized comparative trial of two decision tools for pregnant women with prior cesareans. *J Obstet Gynecol Neonatal Nurs* 2014; **43:** 568–79.

100 Fraser W, Maunsell E, Hodnett E, Moutquin JM. Randomized controlled trial of a prenatal vaginal birth after cesarean section education and support program. *Am J Obstet Gynecol* 1997; **176:** 419–25.

101 Shorten A, Fagerlin A, Illuzzi J, et al. Developing an internet-based decision aid for women choosing between vaginal birth after cesarean and planned repeat cesarean. *J Midwifery Womens Health* 2015; **60:** 390–400.

102 Althabe F, Belizan JM, Villar J, et al. Mandatory second opinion to reduce rates of unnecessary caesarean sections in Latin America: a cluster randomised controlled trial. *Lancet* 2004; **363:** 1934–40.

103 Chaillet N, Dumont A, Abrahamowicz M, et al. A cluster-randomized trial to reduce cesarean delivery rates in Quebec. *N Engl J Med* 2015; **372:** 1710–21.

104 Rosenstein MG, Nijagal M, Nakagawa S, Gregorich SE, Kuppermann M. the association of expanded access to a collaborative midwifery and laborist model with cesarean delivery rates. *Obstet Gynecol* 2015; **126:** 716–23.

105 Keeler EB, Fok T. Equalizing physician fees had little effect on cesarean rates. *Med Care Res Rev* 1996; **53:** 465–71.

106 Lo JC. Financial incentives do not always work: an example of cesarean sections in Taiwan. *Health Policy* 2008; **88:** 121–29.

107 Hulscher ME, Schouten LM, Grol RP, Buchan H. Determinants of success of quality improvement collaboratives: what does the literature show? *BMJ Qual Saf* 2013; **22:** 19–31.

108 Mazzucca S, Tabak RG, Pilar M, et al. Variation in research designs used to test the effectiveness of dissemination and implementation strategies: a review. *Front Public Health* 2018; **6:** 32.

109 Portela MC, Pronovost PJ, Woodcock T, Carter P, Dixon-Woods M. How to study improvement interventions: a brief overview of possible study types. *BMJ Qual Saf* 2015; **24:** 325–36.

110 Brown CH, Curran G, Palinkas LA, et al. An overview of research and evaluation designs for dissemination and implementation. *Annu Rev Public Health* 2017; **38:** 1–22.

111 Brown CH, Ten Have TR, Jo B, et al. Adaptive designs for randomized trials in public health. *Annu Rev Public Health* 2009; **30:** 1–25.

112 Liu X, Lynch CD, Cheng WW, Landon MB. Lowering the high rate of caesarean delivery in China: an experience from Shanghai. *BJOG* 2016; **123:** 1620–28.

113 Yu Y, Zhang X, Sun C, Zhou H, Zhang Q, Chen C. Reducing the rate of cesarean delivery on maternal request through institutional and policy interventions in Wenzhou, China. *PLoS One* 2017; **12:** e0186304.

114 Ayres-De-Campos D, Cruz J, Medeiros-Borges C, Costa-Santos C, Vicente L. Lowered national cesarean section rates after a concerted action. *Acta Obstet Gynecol Scand* 2015; **94:** 391–98.

115 Borem P, Ferreira JB, da Silva UJ, Valério JJ, Orlanda CM. Increasing the percentage of vaginal birth in the private sector in Brazil through the redesign of care model. *Rev Bras Ginecol Obstet* 2015; **37:** 446–54 (in Portuguese).

116 Smith H, Peterson N, Lagrew D, Main EK. Toolkit to support vaginal birth and reduce primary cesareans: a quality improvement toolkit. Stanford, CA: California Maternal Quality Care Collaborative, 2016. https://www.cmqcc.org/VBirthToolkit (accessed Sept 17, 2018).

117 Long Q, Allanson ER, Pontre J, Tuncalp O, Hofmeyr GJ, Gulmezoglu AM. Onsite midwife-led birth units (OMBUs) for care around the time of childbirth: a systematic review. *BMJ Glob Health* 2016; **1:** e000096.

118 Oleske DM, Glandon GL, Tancredi DJ, Nassirpour M, Noak JR. Information dissemination and the cesarean birth rate. The Illinois experience. *Int J Technol Assess Health Care* 1992; **8:** 708–18.

119 Kim CY, Ko SK, Kim KY. Are league tables controlling epidemic of caesarean sections in South Korea? *BJOG* 2005; **112:** 607–11.

120 Khang YH, Yun SC, Jo MW, Lee MS, Lee SI. Public release of institutional Cesarean section rates in South Korea: which women were aware of the information? *Health Policy* 2008; **86:** 10–16.

121 Shepperd S, Lewin S, Straus S, et al. Can we systematically review studies that evaluate complex interventions? *PLoS Med* 2009; **6:** e1000086.

122 Auerbach AD, Landefeld CS, Shojania KG. The tension between needing to improve care and knowing how to do it. *N Engl J Med* 2007; **357:** 608–13.

123 Torloni MR, Betran AP, Souza JP, et al. Classifications for cesarean section: a systematic review. *PLoS One* 2011; **6:** e14566.