



British Association of
Perinatal Medicine



“During Lillie’s birth, the doctors explained that they would be doing a delayed cord clamping but while doing this they would make her warm, safe and care for her during that time. They made sure I knew what was happening and I wasn’t worried at all during that minute and Lillie was very happy! And I knew this would help with saving her life.”

Amie, parent to Lillie, born at 28 weeks gestation.

Optimal Cord Management in Preterm Babies

A Quality Improvement Toolkit

December 2020

in collaboration with

NNAP
National Neonatal
Audit Programme

Contents

Abbreviations	3
Overview	4
Introduction	5
Optimal Cord Management: Toolkit Aim	7
Optimal Cord Management: Implementation Evidence and Resources	11
Achieving Optimal Cord Management: Core Strategies for Best Practice.....	12
Optimal Cord Management: Best Practice Flowchart	16
Overview of the Improvement Journey	17
Phase One: Define the Problem.....	18
<i>Where are we now?</i>	18
<i>How did we get here?</i>	18
<i>The Improvement Plan</i>	23
<i>Learning from high performers</i>	24
<i>Learning from parents</i>	25
Phase Two: Develop a Shared Purpose.....	26
<i>The evolution of the perinatal team</i>	26
<i>Stakeholder engagement</i>	26
<i>Context</i>	28
Phase Three: Plan and Implement Changes	29
<i>Project Charter</i>	29
<i>Formulate, prioritise and test solutions</i>	29
<i>The Model for Improvement</i>	29
Phase Four: Test and Measure Improvement	31
<i>Measures</i>	31
<i>Data analysis and display</i>	31
Phase Five: Implement, Embed and Sustain.....	34
References	36
Appendix 1: Members of the Optimal Cord Management Toolkit Group.....	42
Appendix 2: BAPM Neonatal Service Quality Indicators.....	44
Appendix 3. Evidence Summary and Key Drivers	45
Appendix 4. Example Case Review or Exception Reporting Tool	46

Abbreviations

AHSN	Academic Health Science Network
APH	Antepartum haemorrhage
ERC	European Resuscitation Council
ICC	Immediate cord clamping
ILCOR	International Liaison Committee for Resuscitation
IVH	Intraventricular haemorrhage
LNU	Local Neonatal Unit
MatNeoSIP	Maternity and Neonatal Safety Improvement Programme
MCQIC-SPSP	Maternity & Children's QI Collaborative-Scottish Patient Safety Programme
NEC	Necrotising enterocolitis
NICE	National Institute for Health and Care Excellence
NICU	Neonatal Intensive Care Unit
NNAP	National Neonatal Audit Programme
NSQI	Neonatal Service Quality Indicators
OCM	Optimal cord management
PEEP	Positive End Expiratory Pressure
PBCC	Physiological-based cord clamping
PPV	Positive Pressure Ventilation
QI	Quality Improvement
SCU	Special Care Unit
STEPP	S ituation checks, T hink problems, E quipment checks, P repare, P roceed
TTTS	Twin to twin transfusion syndrome
UCM	Umbilical cord milking
WHO	World Health Organisation

Overview

The focus of this toolkit is to support implementation of:

Optimal Cord Management in all preterm babies less than 34 weeks gestation (defined by waiting at least 60 seconds before clamping the umbilical cord)

Why?

- **Optimal Cord Management reduces death in preterm babies by nearly a third**
- **The number of babies needing to receive OCM to prevent a death is around 30-50 overall and may be as low as 20 in the least mature babies**

This toolkit is aimed at those who are leading or working in a quality improvement team around Optimal Cord Management:

- If you have the resources to undertake a full change management QI project but have little knowledge or experience you may want to read this toolkit in its entirety
- If you have some QI experience but know a limited amount about Optimal Cord Management, you may wish to focus on the [evidence](#) and learning from [high performers](#) and [parent stories](#)
- If you know a lot about Optimal Cord Management and the key elements required for improvement but lack QI knowledge you may choose to focus on the [QI journey and resources](#)
- If you are tasked with collecting/understanding/interpreting data and do not know where to start, look out for the [data tools](#)
- If you are tasked with leading the project and you want to start building your project team, take a look at the section about [who you need to get involved and how to optimise the context](#)

If your QI project team is a mix of all of the above, there should be something in this toolkit for everyone to get your project started.

This toolkit will provide your team with the following resources:

- The [rationale](#) for Optimal Cord Management QI when you and your team, or those supporting the project at executive level, require knowledge of the [evidence for change](#)
- Easy to use QI tools to understand [where you are now](#) and [what you need to commence your project](#) without any prior QI experience
- Guidance about how to [build your team and secure buy-in](#) for your project
- [Examples of QI](#) that have been shown to be successful in improving Optimal Cord Management in preterm infants, including [improvement stories from high performing units](#)
- Tools to help you [measure and understand](#) the impact of your changes
- Examples of how to [embed change and sustain momentum](#) including [parent experience stories](#)

Introduction

The British Association of Perinatal Medicine (BAPM) aims to improve standards of perinatal care by supporting all those involved in providing this care to optimise their skills and knowledge. A key value of the BAPM is ‘working collaboratively’ to provide the safest and most effective service for babies and families and our current strategic aims are to deliver high quality perinatal care and provide support for perinatal professionals.

The National Neonatal Audit Programme (NNAP)¹ is commissioned by the Healthcare Quality Improvement Partnership, delivered by the Royal College of Paediatrics and Child Health, and funded by NHS England, along with the Scottish and Welsh Governments. The NNAP assesses whether babies admitted to neonatal units in the United Kingdom receive consistent high-quality care. It sets evidence-based standards on key clinical outcomes and in turn identifies areas for quality improvement (QI) in relation to the delivery and outcomes of neonatal care.

With these shared goals in mind, the BAPM, the NNAP and other key stakeholder organisations in perinatal care are collaborating in a three-year national quality improvement initiative which will target key NNAP measures. This initiative will align with and support other neonatal national quality workstreams such as the Maternity and Neonatal Safety Improvement Programme (MatNeoSIP)² in England, and the Maternity and Children Quality Improvement Collaborative-Scottish Patient Safety Programme (MCQIC-SPSP)³ in Scotland. The work is aligned with the Saving Babies’ Lives Care Bundle (SBLCBv2)⁴. Each improvement drive includes a QI toolkit mapped to the [BAPM Neonatal Services Quality Indicators](#) (NSQI)⁵ and has been developed by clinicians who have demonstrated excellence in the area of focus, led by the multidisciplinary BAPM Quality Steering Group ([Appendix 1](#)). Improvement at local and national level as a result of improvement work undertaken will be measured by the NNAP and other stakeholder organisations.

Each toolkit will:

- a. Provide the evidence base for effective interventions
- b. Facilitate units in interrogating their own data and processes in order to undertake selected quality improvement activities suited to the local context
- c. Assist units in interpreting and monitoring the results of their QI activities
- d. Provide and signpost resources to facilitate QI in the area of focus.

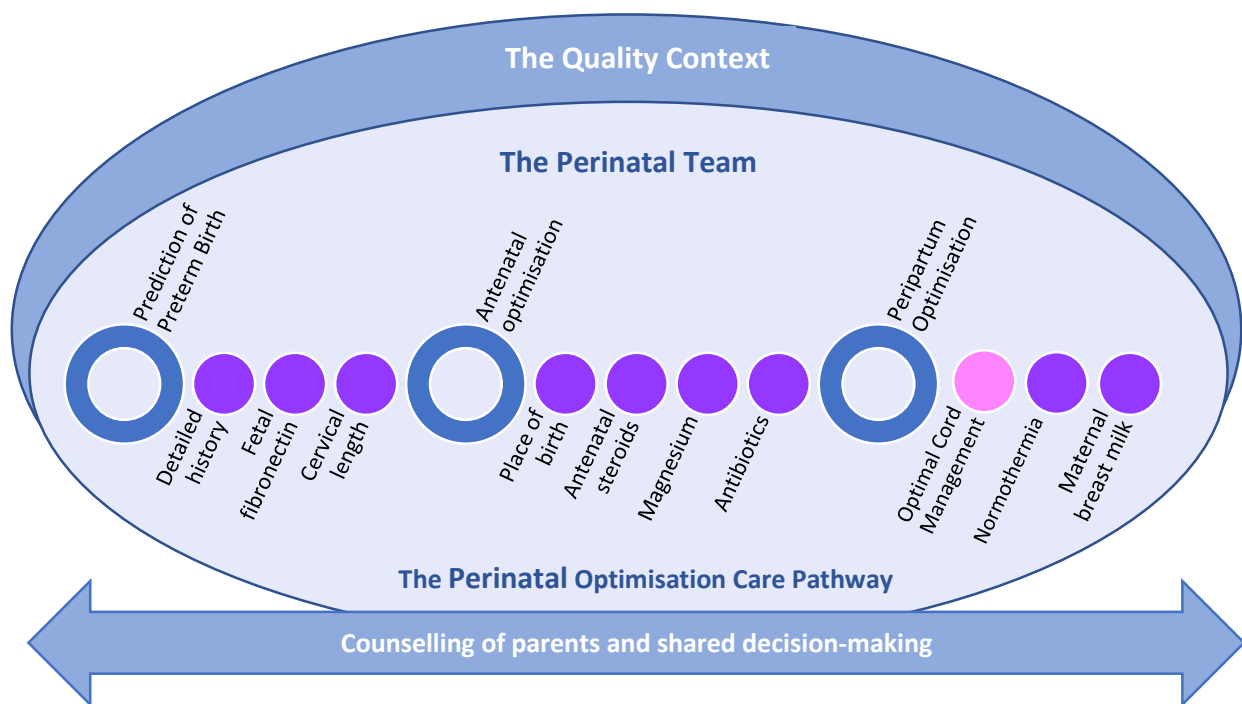
The toolkit has been designed using well-established QI methodology and under the Royal College of Paediatrics and Child Health ‘Quality Improvement in Child Health’ Strategic Framework⁶. The toolkit will introduce some basic QI tools and methods that are quick to learn and easy to apply. In addition the BAPM website also offers a range of free QI resources, links to easy-to-use templates and e-learning, QI tutorials and a forum for shared learning (www.bapm.org/quality). The toolkit is not intended to replicate any existing local or national QI activity undertaken in the area of focus but to complement these endeavours with a practical step-by-step guide.

The Perinatal Optimisation Care Pathway

Perinatal optimisation refers to the process of reliably delivering evidence-based interventions in the antenatal, intrapartum and neonatal period to improve preterm outcomes. Examples of current perinatal

optimisation initiatives, which aim to result in consistent application of a bundle of interventions, are those of the West of England AHSN PERIPrem bundle⁷ and the SPSP-MCQIC Perinatal Preterm Wellbeing Package⁸. The BAPM 'Perinatal Optimisation Care Pathway' refers to these various interventions (or in the case of Optimal Cord Management a 'non-intervention') as they occur over time, applying to both the mother and her preterm baby and aligns with the key elements of the above initiatives. The pathway is supported by four BAPM toolkits (Antenatal Optimisation, Optimal Cord Management, Normothermia and Maternal Breast Milk). These toolkits are a focus of the implementation programme led by MatNeoSIP which supports key recommendations from the Neonatal Critical Care Transformation Review⁹ and the Saving Babies' Lives Care Bundle v2¹⁰. Additional perinatal optimisation interventions such as respiratory management are recognised but are not yet included in this pathway.

The Perinatal Optimisation Care Pathway



This Perinatal Optimisation Care Pathway sits within the remit of the local and network 'Perinatal Team' whose strong teamworking culture, high quality communication habits and pursuit of common goals result in the reliable delivery of these protective interventions. Such implementation success can only occur within a favourable 'Quality Context' where the structure and processes support an optimal environment for delivering quality improvement. Such key contextual features are described in the [BAPM Neonatal Service Quality Indicators](#)⁵ ([Appendix 2](#)). Throughout the pathway high quality communication about risks and benefits of interventions should take place with parents. In the context of extreme preterm gestations, the principles of the BAPM Extreme Preterm Framework should be adhered to, including a joint discussion between the parents and both a senior obstetrician and neonatologist, which includes a risk-based assessment of prognosis¹¹. For communication guidance, see the appendices 'Helping parents to understand extreme preterm birth' and 'Communication Guidance for professionals consulting with families at risk of extreme preterm delivery'.

Optimal Cord Management: Toolkit Aim

Optimal Cord Management (OCM) is one of the key evidence-based peripartum interventions of the Perinatal Optimisation Care Pathway. This Toolkit focuses on providing support and resources to facilitate quality improvement (QI) around Optimal Cord Management. It contains evidence, best practice solutions, advice and techniques that support quality improvement in Optimal Cord Management for all babies who are likely to benefit from this key perinatal intervention. However, the central focus of this toolkit is supporting teams to overcome the unique challenges in delivering Optimal Cord Management in babies born less than 34 weeks gestation.

The aim of the toolkit is that:

All babies born <34 weeks gestation should have their umbilical cord clamped at least 60 seconds or more after birth, except when there are specific documented maternal or fetal conditions (see page 8) to justify earlier clamping.

This toolkit aims to provide practical suggestions to support multidisciplinary perinatal teams in improving compliance with the above aim to improve outcomes for preterm babies.

The toolkit group describe four core strategies to support the delivery of Optimal Cord Management:

1. Human factors and multidisciplinary perinatal team working
2. Provision of normothermia care
3. Supporting the onset of spontaneous breathing and lung inflation
4. Parent information and involvement

Rationale

- **Optimal Cord Management reduces death in preterm babies by nearly a third**
- **The number of babies needing to receive OCM to prevent a death is around 30-50 overall and may be as low as 20 in the least mature babies**

Optimal Cord Management is an evidence-based, simple and effective non-intervention for improving newborn outcomes. Preterm babies particularly benefit from this enhanced placental transfusion and physiological transition^{12 13}. Meta-analyses of studies comparing Optimal Cord Management versus unindicated immediate clamping show a 28% risk reduction for mortality in preterm babies ≤ 32 weeks gestation with a number needed to benefit of 33 (95% CI 25 to 100, $p=0.005$)^{12 13}. In infants of 28 weeks gestation or less, the number needed to benefit reduces to 20¹².

In addition Optimal Cord Management confers other benefits to the preterm infant such as reducing the need for blood transfusion by around 10%¹²⁻¹⁴ and improving mean blood pressure with a reduction in the need for inotropes^{13 14}.

Based on this evidence, the World Health Organisation (WHO) recommends waiting 60 seconds before clamping the cord in preterm babies and clearly states that immediate umbilical cord clamping is generally contraindicated¹⁵.

Despite clear evidence of harm, available figures suggest continuing use of the unindicated intervention of early clamping. For example, the Canadian Neonatal Network in 2018 reported only 51% of infants born at less than 29 weeks gestation received at least 30 seconds of placental transfusion before the cord was clamped¹⁶. Furthermore, from 2020 the NNAP will report on rates of cord clamping at or after 1 minute for infants < 32 weeks¹. Current data from quarter 3 2020, suggests a national rate of 34.6% so there is likely to be significant scope for improvement. Therefore there is an increasing need for perinatal teams to improve access to Optimal Cord Management so that all preterm babies can benefit.

This imperative has led to Optimal Cord Management being adopted as a key focus in perinatal improvement programmes including MatNeoSIP, the MCQIC-SPSP and the PERIPrem Care Bundle of the West of England AHSN^{2 3 7}.

This QI toolkit focusses on Optimal Cord Management defined by waiting for a minimum of 60 seconds before clamping the cord and provides users with a framework to understand the local context for QI, to understand enablers and barriers to implementation and to facilitate the embedding of Optimal Cord Management into perinatal team culture in order to achieve the aim of less babies being harmed by immediate cord clamping. Other methods of cord management have been studied and will be explained below.

A summary of the evidence and key drivers for Optimal Cord Management is provided in [Appendix 3](#).

Contraindications to optimal cord management:

There are almost no indications for early cord clamping, nor contraindications to Optimal Cord Management.

- The need for maternal resuscitation in the face of massive, acute haemorrhage would be a rare, justifiable reason to proceed with early clamping of the cord.
- A ruptured vasa praevia, snapped cord or other trauma to the cord vessels which will result in haemorrhage from the baby are also reasons for early cord clamping.

Special Circumstances:

Complete placental abruption:

Where the placenta is delivered at the same time as the baby, it could be held above the baby, with gentle application of pressure to the placenta, and then clamped at 60 seconds before the placenta is lowered. Umbilical cord milking could also be considered in this situation.

Short Cord length

A short cord length might interfere with the management of the mother or baby but can usually be addressed with optimal positioning. It should not be considered as an automatic indication for early cord clamping, nor a contraindication to Optimal Cord Management.

Umbilical cord milking

Although it is not physiological, milking the umbilical cord 2-4 times towards the baby has been studied as an alternative to waiting for at least 60 seconds before clamping the cord¹⁷⁻¹⁹. Meta-analyses of studies using cord milking show similar benefits to waiting for 60 seconds, with increased survival by 27% compared to immediate clamping of the cord with no difference in major morbidities^{13 14}. Based on this evidence, many key perinatal organisations recommend the use of cord milking before clamping the cord but only if Optimal Cord Management is deemed not feasible²⁰⁻²³. **However in reality there are very few situations in which a minute of waiting cannot be achieved.**

Additionally, concerns regarding the safety of cord milking have been raised following the results of one randomised controlled trial which showed an increased incidence of IVH associated with cord milking in babies less than 28 weeks gestation²⁴. An association with severe IVH has also been shown in a large retrospective Canadian cohort of infants less than 33 weeks²⁵. Moreover, physiological studies in newborn lambs undergoing cord milking suggest significant pressure and flow alterations in the main cerebral artery which may explain this increased risk²⁶. A recently published meta-analysis concluded that umbilical cord milking significantly increased the risk of severe IVH compared to optimal cord management²⁷. However, uncertainty regarding the association of severe IVH and umbilical cord milking persist due to difficulties in interpretation of this data.

Cord milking is often undertaken when there is a perceived acute concern that maternal or baby safety may be compromised by a delay of 60 seconds. In practice, the majority of these concerns are unsubstantiated by published evidence. For this reason, this toolkit group strongly recommends that units work to overcome barriers to Optimal Cord Management so that this intervention can be delivered as a standard of care for all babies. **We recommend that units should only reserve umbilical cord milking for those rare situations such as maternal collapse requiring resuscitation where cord clamping is required to be expedited for maternal safety. In these cases, the reason must be documented.**

Multiple gestations

Studies of multiple births have demonstrated feasibility of providing Optimal Cord Management to twins and triplets²⁸⁻³⁰. Thus, multiple births should not be routinely excluded from Optimal Cord Management. The plan for delivery should be considered on an individual basis with a decision made by an experienced perinatal team ahead of birth.

Prolonged stabilisation during fetal to neonatal transition

Studies examining initial stabilisation during Optimal Cord Management have included widely varying methodologies and no firm conclusion can yet be made at this time regarding safety or benefit^{13 14}. Over 90% of preterm babies will start to breathe during Optimal Cord Management with or without gentle stimulation^{31 32}. However, some units now undertake initial stabilisation with the cord intact routinely (mother-baby dyad intact) and have reported favourably on feasibility and safety^{18 19}. Where concerns about neonatal wellbeing during Optimal Cord Management cannot be addressed by comprehensive staff education and support at the time of birth, units may wish to explore providing stabilisation with the cord intact by liaising with other teams who already have standard operating procedures and data to support implementation and safety.

Parents

Qualitative studies using interviews with parents have reported overall positive feedback and support for Optimal Cord Management³³. Mothers report that they felt they could contribute to their preterm baby's care when they received Optimal Cord Management³⁴. Parents who are present during stabilisation with the cord intact report that they feel reassured by the procedure and that communication is improved³⁵.

How to use this toolkit

This toolkit is not intended to be read as a guideline which mandates a standard practice for all units. Instead it is a practical resource from which units can improve compliance rates of Optimal Cord Management, by selecting the most suitable approach for their own particular context as the improvement solution for each unit may be different. For example, the equipment available in each unit may vary and therefore the use of this toolkit needs to be adapted according to the local setting.

Some units may have already implemented various ways of providing Optimal Cord Management which will have helped to improve preterm outcomes. Those teams are encouraged to continue to develop their pathways and offer support and advice to other teams. Networks may also be able to facilitate the sharing of good practice and implementation of consistent practices.

Optimal Cord Management: Implementation Evidence and Resources

Implementation evidence

Table 1 provides evidence of the elements of successful implementation of Optimal Cord Management in preterm babies including identified enablers and barriers and lists other resources to support implementation. In addition two systematic reviews provide an overview of published quality improvement initiatives related to Optimal Cord Management from around the world^{36,37}.

Table 1. Elements used in successful implementation of Optimal Cord Management	Supporting reference(s) hyperlinked
Improving staff awareness of Optimal Cord Management including targeted education, constructive feedback sessions and simulation	38-49
Decreasing resistance to change in Optimal Cord Management	40 49
Addressing obstetric concerns with Optimal Cord Management	32 42 49-51
Addressing paediatric concerns with Optimal Cord Management	42 47 49-53
Addressing logistical difficulties in Optimal Cord Management	38 47 49 53
Delivery room checklists, brief and debrief tools for Optimal Cord Management	40 49 53 54
Multidisciplinary collaboration around Optimal Cord Management	38 39 42 44 46 48-50 53 54
Protocol development including Optimal Cord Management guidelines, standard operating procedures, pit stop techniques	38-46 48-50 53 54
Use of Optimal Cord Management champions	40 49 50 53
Use of QI methodology including addressing context specifically in relation to Optimal Cord Management	38-40 47 53 54
<p>Organisations and resources supporting or incentivising QI in Optimal Cord Management</p> <ul style="list-style-type: none"> • BloodtoBaby Campaign⁵⁵ • Maternity and Neonatal Safety Improvement Programme, NHS England² • Perinatal Wellbeing Package, Maternity and Children's Quality Improvement Collaborative, Scottish Patient Safety Programme⁸ • NNAP Online¹ • NICE guideline [NG25]: Preterm labour and birth⁵⁶ • PERIPrem care bundle, West of England Academic Health Sciences Network⁷ 	

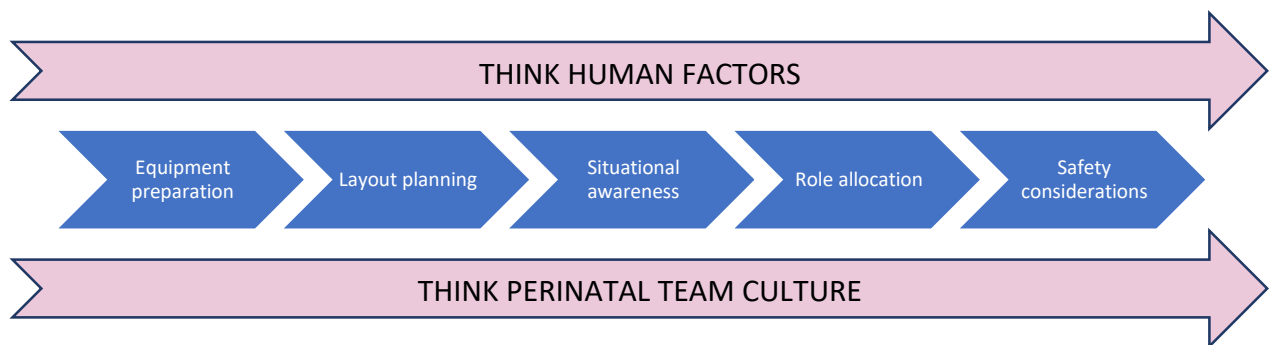
Achieving Optimal Cord Management: Core Strategies for Best Practice

The following core strategies have been identified by the members of the Optimal Cord Management toolkit group (Appendix 1), using evidence-based interventions and examples of best practice from high-performing units and networks, to provide a framework that is best designed to achieve a high rate of Optimal Cord Management with a low rate of adverse consequences. Units and networks who wish to improve rates of Optimal Cord Management should review each of these core strategies to identify how to achieve best practice.

Core strategies to support Optimal Cord Management:

1. Human factors and multidisciplinary perinatal team working
2. Provision of normothermia care
3. Supporting the onset of spontaneous breathing and lung inflation
4. Parental information and involvement

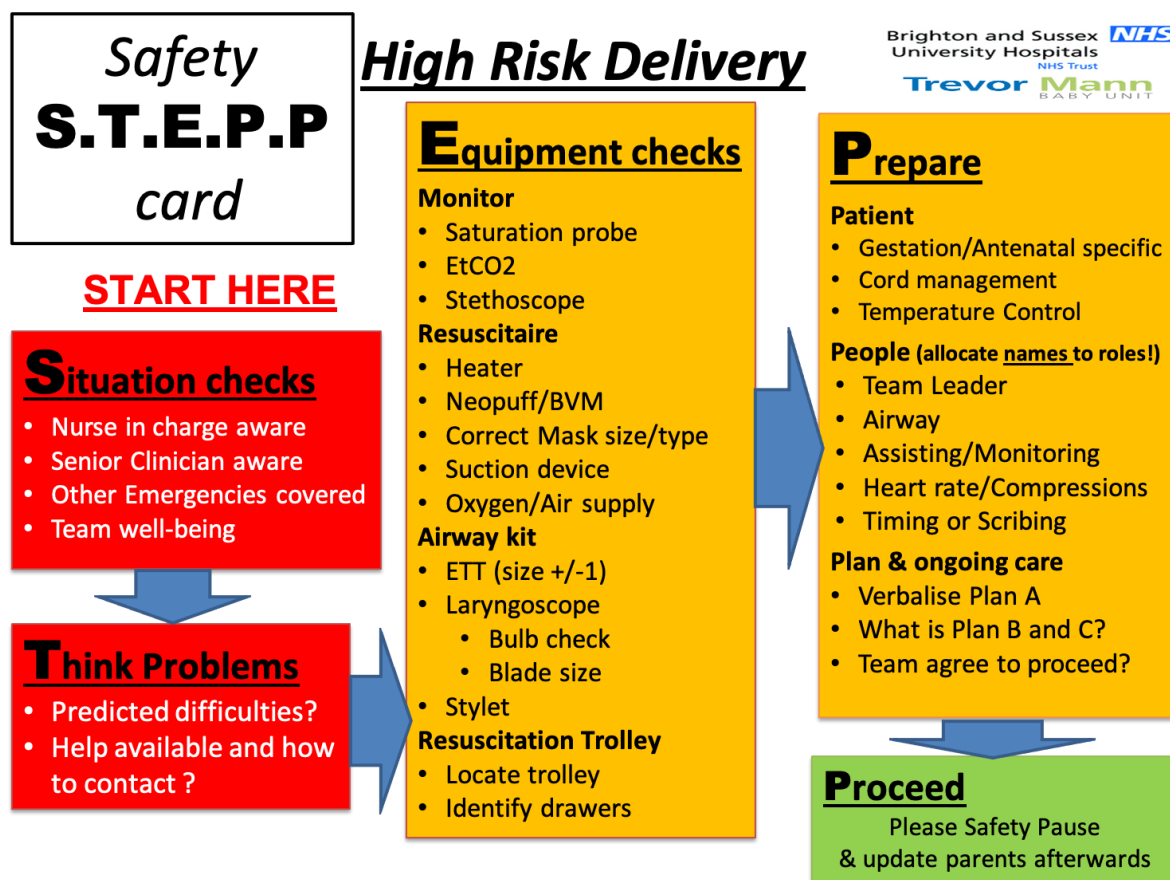
1. Human factors and multidisciplinary perinatal team working



A multidisciplinary team approach with high quality communication across the perinatal team is essential at the birth of a preterm baby. Team performance in such high acuity situations is important to outcomes, and team behaviours such as information sharing, vigilance, management of workload and leadership correlate strongly with the quality of resuscitation⁵⁷. Situational awareness training using the Situational Awareness Programme for Everyone (SAFE) Toolkit may be a valuable activity for perinatal teams to undertake⁵⁸.

At birth, Optimal Cord Management and ongoing stabilisation require multiple inputs from multiple individuals and perinatal teams may find it useful to employ a pit-stop model with checklists and well-orchestrated tasks to improve efficiency and safety in the delivery room⁵⁹. Situational awareness can be ensured by performing a pre-resuscitation huddle using the STEPP model. Checklists such as a STEPP card (provided courtesy of Brighton and Sussex University Hospitals NHS Trust Neonatal Human Factors team, Lead Dr Cassie Lawn) can be used to guide the team huddle prior to birth (Figure 1).

Figure 1: Example of a STEPP card for high risk births



2. Provision of normothermia care

Meta-analysis does not demonstrate an increased risk for hypothermia in preterm babies who receive Optimal Cord Management at birth¹³. Although not statistically significant, admission temperature is slightly higher compared to those who have early cord clamping. A study of Optimal Cord Management in near-term lambs reported better temperature control in those undergoing Optimal Cord Management versus early cord clamping⁴⁶.

The first minute is a potential risk period for thermoregulation as there may be a delay in transferring a wet baby to an external heat source and thus both evaporation and convection can be important properties of heat loss during the period of OCM. Nevertheless, rapidly transferring a baby who is relatively more 'hypovolaemic' by clamping the cord too early may also add to hypothermia. Optimal Cord Management is consistent with good thermal practices, such as putting the baby in a bag, drying, putting a hat on, and/or bringing an external heat source to the bedside. Teams should identify the risks, undertake a risk assessment before birth, and put in place measures to minimise hypothermia as below.

Users of this toolkit should refer to the BAPM Normothermia Toolkit to ensure optimal thermal care during Optimal Cord Management⁶⁰. Key measures to be undertaken during Optimal Cord Management are described in Table 2.

Table 2. Key thermal measures to be undertaken during OCM

- Ensure a warm draught-free environment of 24-26°C: this may require temporary elevation of theatre temperature in anticipation of Optimal Cord Management. As this may be uncomfortable for those scrubbed up, this will need prior engagement with theatre staff
- If the following are being used:
 - Ensure warmed (sterile) towels are available for holding the baby during Optimal Cord Management and for later transfer to the stabilisation area
 - Ensure (sterile) plastic bag or thermal suit available for use if gestation requires it
 - Ensure that the heat source is activated on the stabilisation trolley
 - Ensure transwarmer or other thermal mattress activated at the appropriate time. Note safety concerns related to adjunct use of transwarmer with radiant heater⁶¹
- If birthweight or gestation requires it, put the baby into a plastic bag or thermal heat suit immediately at birth and from the onset of Optimal Cord Management. Otherwise use warm and dry with towels while stimulating the baby
- Cover the baby's head as soon as possible using a wool hat or the relevant part of the plastic thermal suit
- Check temperature after Optimal Cord Management is complete ideally with continuous temperature monitoring and maintain normothermia thereafter

3. Supporting the onset of spontaneous breathing and lung inflation

Observations on the physiologic onset of breathing at birth

Once born, the preterm baby should receive multiple stimuli to encourage the onset of breathing whilst still attached by the umbilical cord. Two studies of Optimal Cord Management observed that 90% or more of all included babies started to breathe before 60 seconds, thus the majority of babies will not need additional respiratory support during the first minute of Optimal Cord Management^{31 32}. Proponents of physiological-based cord clamping oppose the idea of any time-based cord clamping and favour a baby-led approach, where the timing of cord clamping is determined by the behaviour and onset of spontaneous respiration of the baby as well as waiting for cord pulsations to cease. Until this debate has been resolved, we propose to adhere to the WHO guidance of using a **minimum** interval of one minute for deferring cord clamping. Stabilisation should start with gentle but deliberate stimulation, good thermal care and optimal positioning so that the airway is patent and does not get obstructed, while actively encouraging the onset and maintenance of spontaneous respiration. The [WHO Care of the Newborn Pathway](#) can be used as a guide⁶².

Optimal timing of providing respiratory support at birth

The onset of spontaneous breathing and lung inflation during Optimal Cord Management can be supported in different ways. Of note, there is insufficient evidence to recommend which is best, but the following two strategies have been adopted with success by perinatal teams around the UK:

Optimal timing of providing respiratory support at birth

- a) Airway patency should be ensured by optimising head position. Gentle but deliberate stimulation and encouragement to support spontaneous breathing and providing measures for optimising thermal stability whilst the infant is still attached to the mother by the cord³⁸. Such measures in themselves will take around 60 seconds. If undertaken calmly and methodically they will also provide reassurance to team members. Once transferred to a resuscitaire, respiratory support can be provided as per NLS guidance ideally via a T-piece resuscitator or, if unavailable, a self-inflating bag^{20 63 64}.
- b) Whilst most preterm babies breathe at or shortly after birth, it has been suggested that some will require additional support with breathing. For those teams advocating the need to incorporate early respiratory support into Optimal Cord Management (i.e. respiratory support whilst the cord is intact), CPAP and positive pressure ventilation (PPV) are only likely to be effective once the larynx is patent and the airway unobstructed^{65 66}. During newborn stabilisation, this is most effectively ensured on a stable surface where the head position and mask fit can be controlled. In most delivery units in the UK currently, this will be the traditional resuscitaire which should be positioned close to the mother's bed, if additional respiratory support is to be provided. Experience from research centres^{67 68} and from quality improvement initiatives has shown that with careful planning and a dedicated multi-disciplinary team approach, practice change towards early respiratory support is possible^{69 70}. Expert guidance on how to plan and undertake early respiratory support in Optimal Cord Management within the context of a QI project will be available from specific members of this BAPM toolkit group at bapm@rcpch.ac.uk. More resources, such as a drill for Optimal Cord Management can be found on the [PERIPrem](#) website⁷¹. A particular focus for education in these centres is the need to ensure that Optimal Cord Management still takes place in the context of precipitate birth where the neonatal team may not be present at the time of birth to provide early respiratory support. **Immediate cord clamping should NOT be the alternative to stabilisation with the cord intact when the neonatal team are not present.**

4. Parental information and involvement

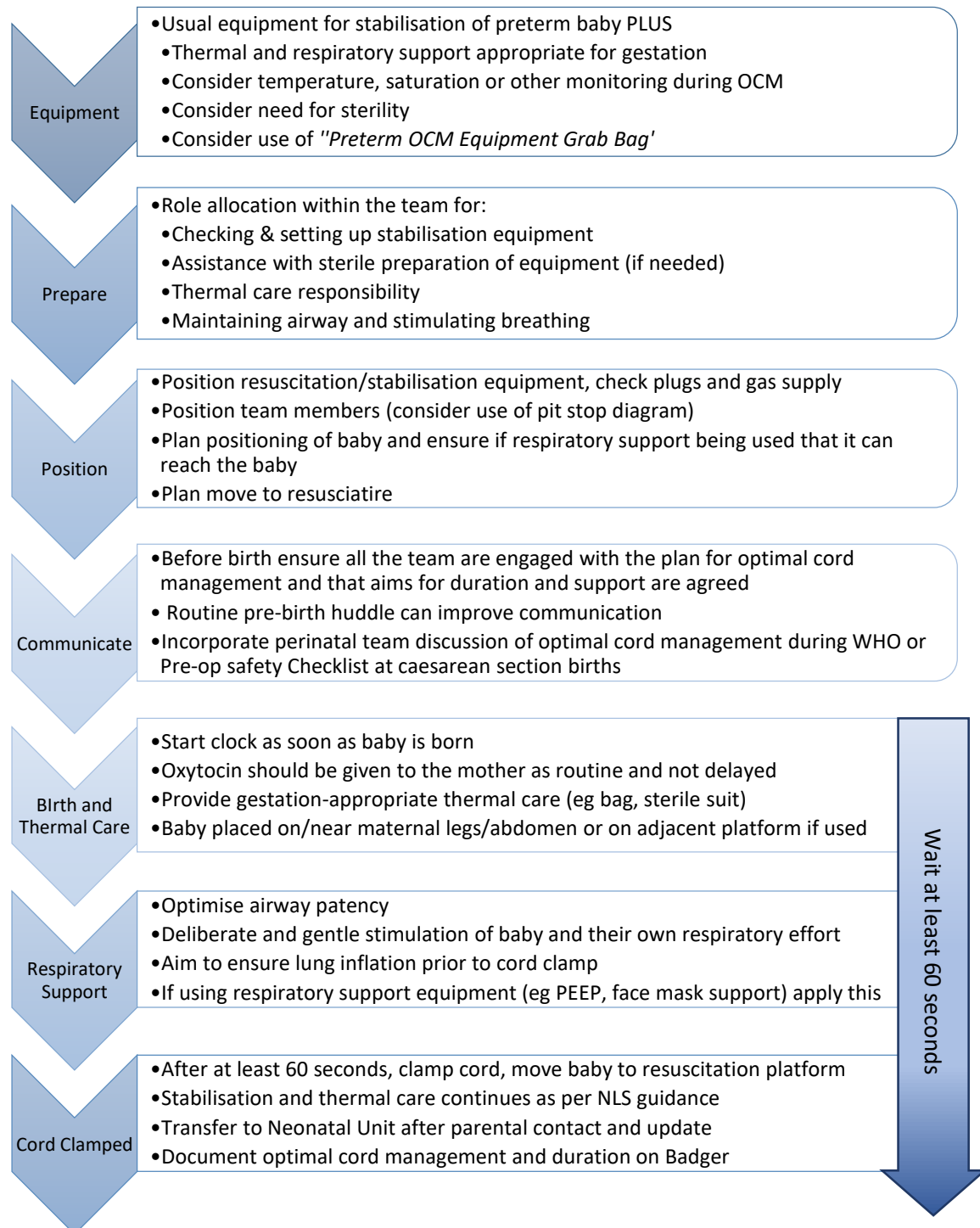
Parents should receive information about Optimal Cord Management at the time of antenatal counselling about their imminent preterm birth, along with information about early breast milk expression, the stabilisation process and the start of their neonatal journey. Some units have developed parent leaflets to support verbal information or a 'parent passport' of perinatal optimisation interventions which includes information about Optimal Cord Management. Such a document like that used within the [PERIPrem Care Bundle programme](#) is parent-held and can improve communication between professionals and between units about interventions already received and those planned⁷.

During Optimal Cord Management, parents should be given reassurance about their baby's wellbeing and be encouraged to touch or even hold their baby with clean hands where this is possible. Where this is not possible, photographs should be offered.

Optimal Cord Management: Best Practice Flowchart

The following flowchart has been adapted from Greater Glasgow and Clyde Paediatric Guideline on optimal cord management. It is an example of what might be considered best practice. Units may choose to adapt this to support improvement activity or as a process flowchart for staff use in the delivery suite.

Figure 2. Best Practice Flowchart for Optimal Cord Management



Overview of the Improvement Journey

A project is the way in which you accomplish change and the specific objectives of your improvement journey. The following table shows the steps that are commonly taken on this journey. Each step is discussed further in subsequent sections.



Phase	Approach	Methods and Tools	Outcome
1. Define the problem	Identify the problem and how large it is	Forcefield analysis Fishbone diagram Case review Process mapping Pareto chart Learn from experts	Define the problem, diagnose why the problem occurs and what improvement would look like
2. Develop a shared purpose	Form a team of enthusiasts	Engaging a team Engaging stakeholders Optimise context	Establish a shared objective and a culture for change
3. Plan and implement changes	Formulate, prioritise and test solutions	Driver diagram Project Charter QI Methodology	Complete a formalised plan of proposed improvements
4. Test and measure improvement	Test, review and re-test improvements	PDSA Measurement Run chart Statistical Process Control Chart Days between Chart	Determine whether improvement has resulted in change
5. Implement, embed and sustain	Implement widely and ensure sustainability	Education Communication Motivation Governance	Shared learning and embedding changes into practice

Phase One: Define the Problem

Where are we now?

It is important to understand your local data, and to consider it in the context of regional, national and international standards (NSQI 11,12) observing any changes over recent years. To achieve this, your team should understand how to look at your local data, what questions to ask and where to access benchmarking data such as Badgernet National reports and comparison charts, the network data dashboards, [NNAP Online](#) and [Nightingale, Vermont Oxford Network](#) as examples. Finally, being able to convey these data to the wider team clearly and concisely will facilitate a stronger commitment to the implementation of quality improvement interventions.

1. Collecting and assessing data for Optimal Cord Management

Aim: All babies born <34 weeks gestation should have their umbilical cord clamped at least 60 seconds or more after birth, except when there are specific documented maternal or fetal conditions to justify earlier clamping.

Ask:

- a. What proportion of babies born <34 weeks have their cord clamped *at or* after 1 minute?
- b. What proportion of babies born <34 weeks have their cord clamped *earlier* than 1 minute?
- c. Are the indications for early clamping documented, what are they, and are they appropriate?
- d. Have your normothermia data changed?

2. Using [NNAP Online](#) from 2021 for babies born <32 weeks gestation, it may be useful to ask:

- a. Are your data both accurate and complete?
- b. How have your data changed over time?
- c. How does this compare with the UK average?
- d. How does this compare with other units in your network?
- e. How does this compare with other units of similar size and acuity?

How did we get here?

There are many tools to help your team understand why preterm babies may not receive Optimal Cord Management (NSQI 13). You do not need to use all these tools but should explore which of these exercises works best for your team.

Resources:

[BAPM QI Made Easy: 'Investigating your Current Practice'](#)
[NHS Improvement: Project Management](#)

Understanding barriers and enablers and finding solutions

In this section we describe some of the commonly described barriers and enablers to Optimal Cord Management and provide you with quality improvement tools to interrogate your own context and processes, giving examples to get the discussion within your team rolling. We suggest solutions that have worked elsewhere (see [Table 1](#) for references) but encourage you to find solutions which are appropriate for your local setting as a solution which works for one team may not be successful in another.

In general, barriers fall into one of these categories:

1. Lack of awareness of benefits of Optimal Cord Management:
 - Carry out a rolling programme of education about Optimal Cord Management and its benefits: this may include face to face sessions, online tutorials, posters, safety briefs

- Develop a shared guideline for the perinatal team
 - Enrol the enthusiasm of Optimal Cord Management Champions in both neonatal and maternity teams
2. Resistance to change:
- Establish midwifery, obstetric and neonatal leads for Optimal Cord Management and build a culture of shared responsibility
 - Enrol the enthusiasm of Optimal Cord Management Champions in both neonatal and maternity teams
 - Encourage and share parental feedback about their experience of Optimal Cord Management
 - Ask high performing units to share their improvement journey for Optimal Cord Management
 - Start small, one birth at a time, build confidence
 - Provide regular feedback, invite feedback and address concerns of staff
 - Invite this individual or group to join the project team and find ways of working with and not against them
3. Concerns that Optimal Cord Management may harm the mother:
- Educate with the evidence that shows Optimal Cord Management is safe for the mother
 - Encourage maternity and anaesthetic staff ‘call out’ during Optimal Cord Management if concerns arise
 - Make prebirth huddles with neonatal team routine, where plan is agreed and actions rehearsed if challenges encountered
 - If the woman is bleeding, initial obstetric management for e.g. assessing for trauma, clamping of bleeding vessels/applying pressure can continue during Optimal Cord Management
 - Ensure the team respects and maintains a sterile operating field during Optimal Cord Management
4. Concerns that Optimal Cord Management may harm the baby:
- Educate with the evidence that shows Optimal Cord Management is safe for baby and that ‘too early’ cord clamping is harmful
 - Provide neonatal support for maternity staff during Optimal Cord Management, either by simply attending the birth of the baby, by providing gentle stimulation to the baby or where guidelines and training exist, in providing respiratory support
 - Ensure a package of normothermia care accompanies Optimal Cord Management
5. Logistical concerns and human factors in carrying out Optimal Cord Management particularly under sterile conditions:
- Develop a shared guideline for the perinatal team that walks people through the actions and tasks required
 - Walk through the process and identify risk and logistical issues including human factors (see Figure 3)
 - Sketch out a diagram such as a positioning diagram relevant to your unit’s layout (see Figure 4 for ideas) to guide attendees at birth
 - Conduct drills and simulation to improve confidence of staff

Figure 3. Issues to consider when walking through the process of Optimal Cord Management

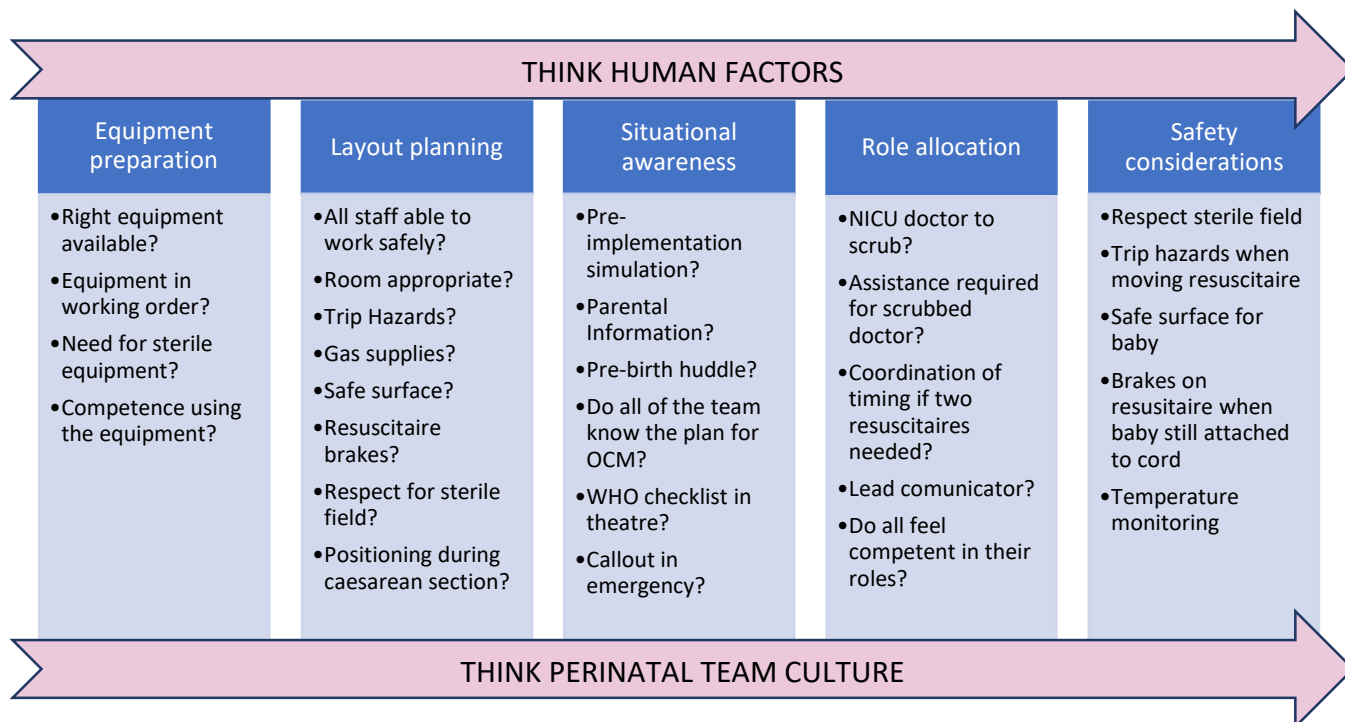
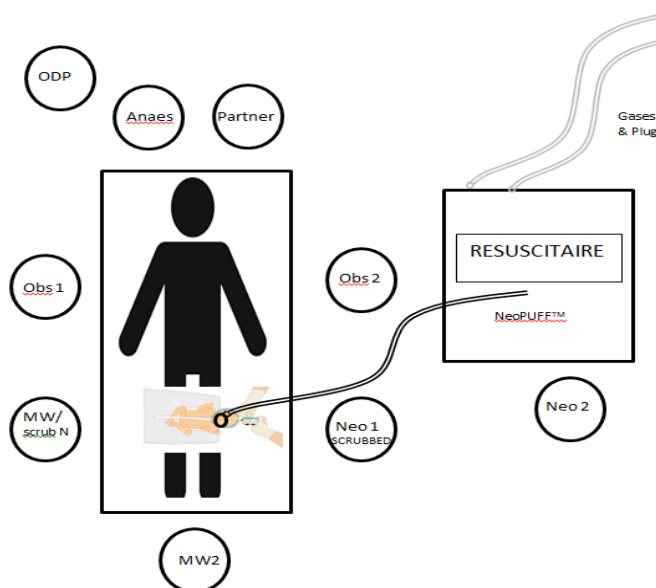


Figure 4. Example of a positioning diagram for stabilisation on the cord at caesarean section (provided courtesy of the Perinatal Team, Great Western Hospital, Swindon)



EXAMPLE

Use some of these improvement tools to survey barriers and enablers in your own service:

1. **Forcefield analysis**- this tool balances the positive and negative drivers influencing Optimal Cord Management, with scores assigned to describe the strength of each force. Study, plan and act to strengthen the weaker positive forces and diminish the resisting forces (Figure 5). A template can be found on the [BAPM Quality Webpages](#).
2. **Pareto Chart**- in categorising the underlying problem, a Pareto chart gives a visual depiction of the frequency of problems in graphical form, allowing you to target the areas that offer the greatest potential for improvement (Figure 6).
Resource: [NHS Improvement Pareto Chart Tool](#)
3. **Fishbone diagram**- cause and affect analysis tool. This is a useful tool for categorising factors which influence the ability to deliver optimal cord management (Figure 7). A template can be found on the [BAPM Quality Webpages](#).
4. **Case review** – take the last 10-20 cases where Optimal Cord Management was not achieved and use a structured review tool (for example see [Appendix 4](#)) to identify any common themes. Consider reviewing 10 cases where optimal cord management was achieved and identify strengths.
5. **Process mapping** – walk through the journey that a preterm baby takes before birth, during birth and immediately after birth and think about the factors within the process and the environment that may contribute to optimal cord management.

Figure 5. An example of a forcefield analysis for Optimal Cord Management

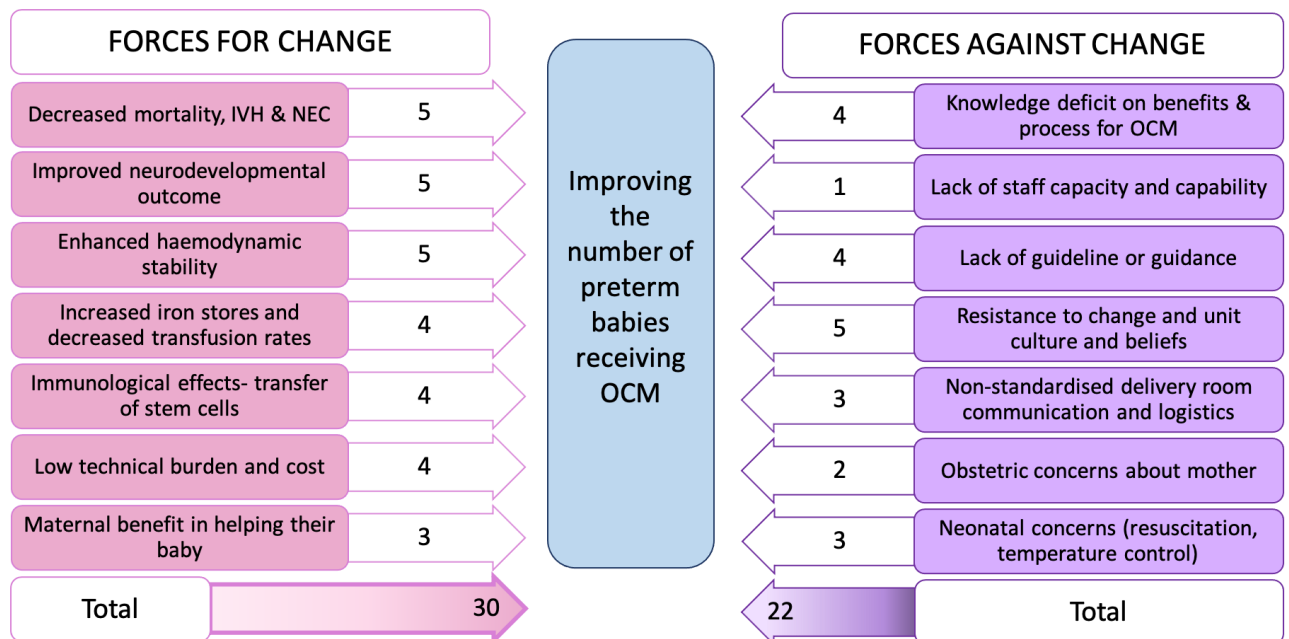
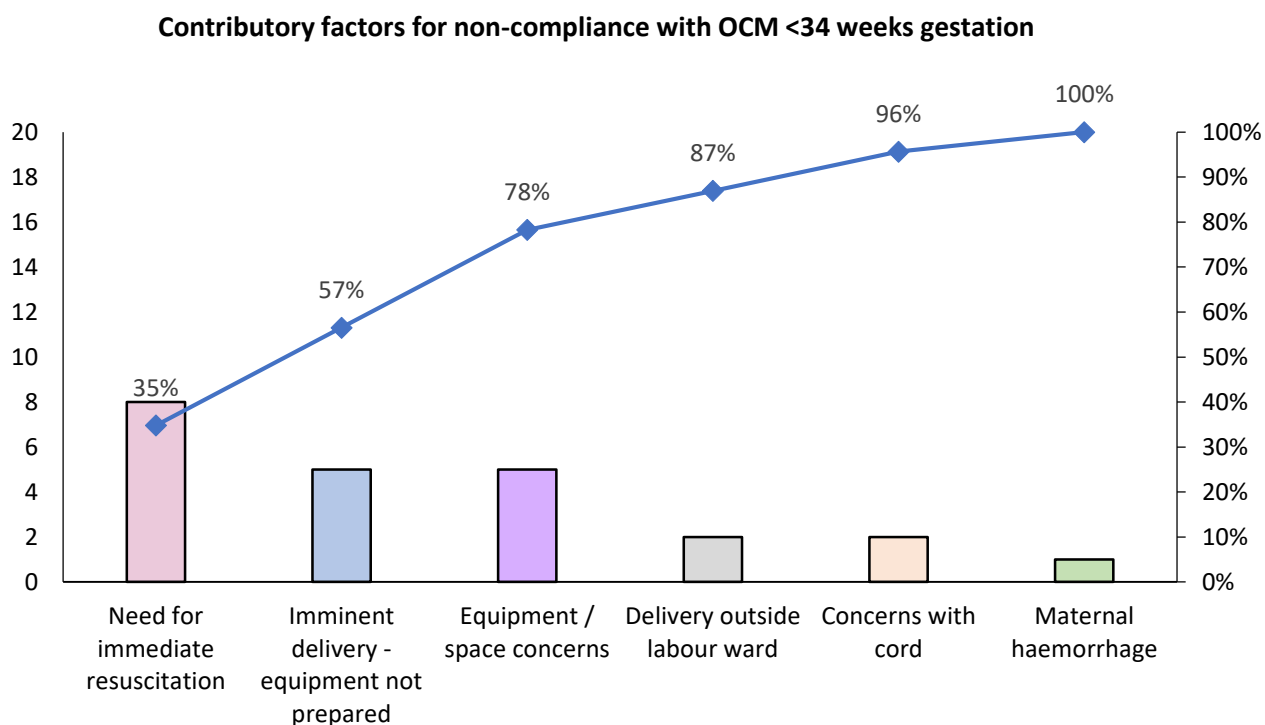
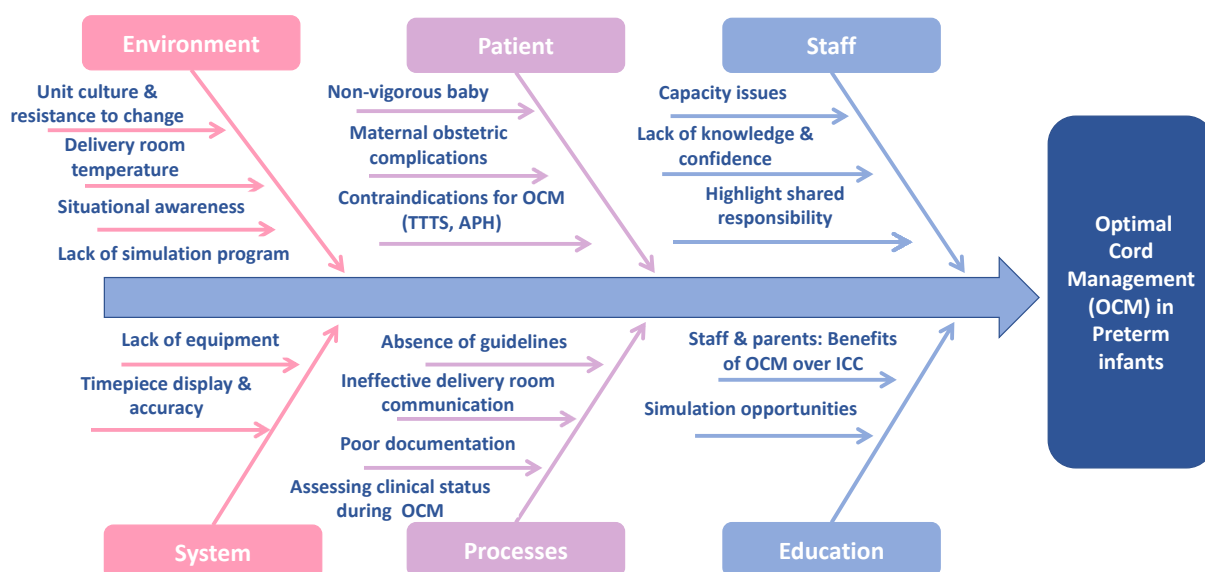


Figure 6. An example of a Pareto chart for Optimal Cord Management



This chart shows that around 80% of causes can be explained by 3 factors: the need for immediate resuscitation, equipment preparation and equipment/space concerns. Focussing on resolution of these three issues is therefore likely to produce maximum gain in achieving optimal cord management implementation.

Figure 7. An example of a fishbone diagram for Optimal Cord Management



The Improvement Plan

Using one or more of these tools will identify potential areas for improvement and ideas for change. These ideas can be pulled together into a driver diagram to allow you to apply a clear and organised structure to your project (Figure 8).

In developing your local driver diagram, both the BAPM and the NNAP strongly recommend that as part of a change programme to improve optimal cord management, this is developed with multidisciplinary input and uses evidence-based strategies to develop an effective implementation strategy.

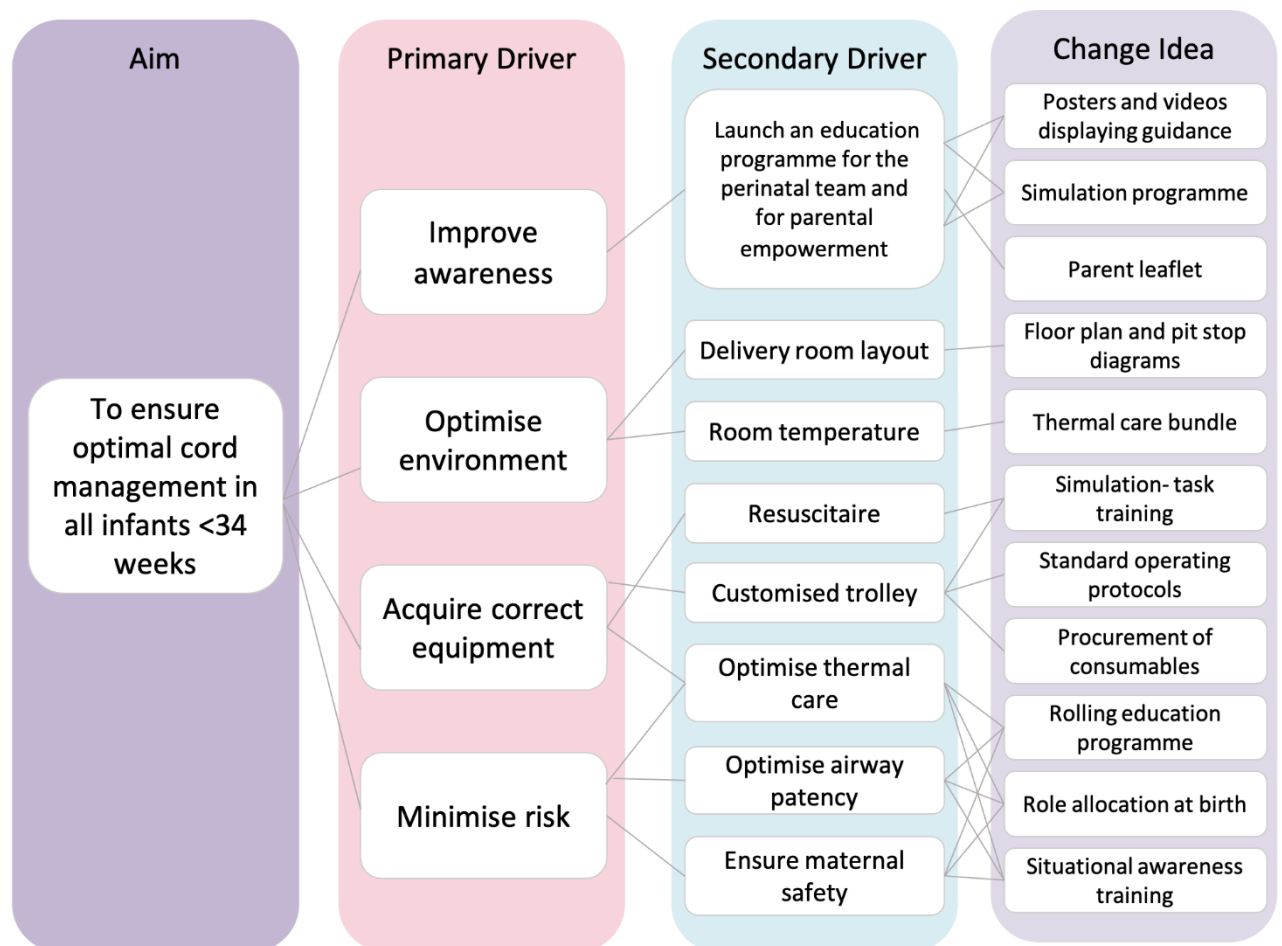
Resources

[NHS Improvement: Project Management](#)

[BAPM Quality Resource Templates](#)

[NHS Improvement Driver Diagram](#)

Figure 8. An example of a driver diagram to improve delivery of Optimal Cord Management



EXAMPLE

Learning from high performers

It can also be helpful to speak to other units about how they have tackled low rates of compliance (NSQI 18). High performing units and those who have made significant improvements over time can be identified from [NNAP Online](#). A number of these units have shared their learning below.

We successfully increased the optimal cord management rates in our preterm babies from 29% to over 90% in a 6-month period. These are our tips for implementing this change:

- *Establish an invested multi-disciplinary team with named champions in the different specialties.*
- *Develop a clear aim and agree on change ideas. We decided to use a purpose built bedside resuscitaire to help facilitate optimal cord management.*
- *Identify and engage stakeholders. These may not always be the obvious people; for us this included theatre staff and clinical engineering.*
- *Educate, train and promote. If staff understand the significance of optimal cord management for babies, they will be more motivated to support change in practice.*
- *Persevere when facing the inevitable barriers. There will always be a solution. We had an issue with the gas supply for the resuscitaire which we managed to overcome and found an alternative.*
- *Be passionate and retain this throughout the project. Your passion will drive and enthuse others*

Julia Arthur, ST8 Neonatal GRID Trainee, Luton and Dunstable Hospital

The day that I realised that we had reached a key milestone was when a member of our theatre team was excited to tell me about the part she had played in ensuring that deferred cord clamping was given and how proud she was to have made a significant impact on that baby and their chances of survival. Our success has very much been determined by the collective ownership by all members of the MDT of our vision for all babies to have deferred cord clamping.

Emma Burdon, Midwife, Plymouth

We introduced and maintained 97% optimal cord management rates using a lead by example approach, we ensured that a neonatal practitioner experienced in optimal cord management attended deliveries to support clinicians and to facilitate the practicalities of caring for the infant whilst the cord was intact.

George Brooks, Nurse Consultant, Northumbria Hospital

We successfully increased the rate of optimal cord management in infants born <32w gestation from 0 – 80% over the past 12 mo and achieved 72% in infants born <28w gestation. We also managed to defer until 2m in certain situations.

Tips for implementation:

- *Identify dedicated champions among neonatal, obstetric and midwifery staff*
- *Ensure multiple sessions of education with simple presentation of the evidence*
- *Dedicated simulation sessions to train and embed this practice.*
- *Trouble shooting and careful analysis of missed events*
- *Create a positive experience and share news of positive change*
- *Be passionate but patient*

Amitava Sur, Consultant Neonatologist, Lancashire Women and Newborn Centre

As a unit we have been focusing on OCM for the last 6 months. It has been fantastic to work alongside my neonatal colleagues to form a true perinatal team ensuring improved outcomes for our preterm infants. OCM is used routinely in our term deliveries but staff were anxious about the preterm infants. Following collaborative support and education, our OCM rates in < 34 week babies has increased from 64% to 100% in November.

Tracey Kay, Consultant Obstetrician, Royal Devon and Exeter Hospital

Learning from parents

Parent feedback and experience can be extremely useful in understanding their role in successful implementation of your change strategy (NSQI 9). Parent education, attitudes and beliefs can be important in both preventing and facilitating change. Parents also help you to understand the impact of your change idea and can be impactful voices in helping staff understand the need for change (NSQI 10). We are grateful to the parents who have shared their experience of optimal cord management in the examples below:

"Delaying clamping the cord was discussed with me and my partner by the neonatal nurse before delivery. At birth our little boy was covered in plastic wrap and given oxygen and other treatment at my bedside before the midwife clamped his cord. We have since read about the benefits of him getting extra blood from the placenta at birth and are glad they did this ...to give him the best possible start."

"Before Ollie was born, my midwife Lorna, explained the delayed cord clamping to me and why this was especially beneficial for him as he was going to be born early. Though, I was initially concerned Lorna talked me through the process, explaining the benefits and how it would be done safely. I was reassured and very keen to do anything that will improve my Ollie's outcome. I was also surprised that a blood transfusion from my placenta could do a world of good for him. I was pleased I was able to do that for my baby".

"Just before he was born the Nurse Practitioner explained that the baby would be covered in plastic wrap and he would get a hat to keep him warm. I'd read about delayed cord clamping and was pleased this was done for my son. He was cared for on a small trolley (Lifestart™) close to me for a few minutes so he would benefit from getting some cord blood. I loved being able to see how they were caring for him; they were so confident and gentle.... I often thought of this time when we were apart as he was soon transferred to a bigger baby unit."

"During Lillie's birth, the doctors explained that they would be doing a delayed cord clamping but while doing this they would make her warm, safe and care for her during that time. They made sure I knew what was happening and I wasn't worried at all during that minute and Lillie was very happy! And I knew this would help with saving her life."

"My wee Brodie was born at 25 weeks. Before his birth, I had a discussion with the doctors, they explained to me what would be done to help him at delivery and afterwards. They talked about the steroids, delayed cord clamping, breast milk and other medicines that would help improve his chances of survival. The delayed cord clamping benefits and how it would be done safely was explained more by my midwife. Brodie was delivered into a plastic bag, I remember how tiny and feisty he was, the midwives kept a close eye on him to make sure he was okay and like she had told me before, after one minute she clamped the cord. Though I was frightened as my baby was coming early, I was consoled that there was something I could be part of that would be benefit him"

Phase Two: Develop a Shared Purpose

The evolution of the perinatal team

Midwifery, Obstetric and Neonatal teams all have an important role to play in the safe delivery of care for women in preterm labour and the subsequent care of their baby. This care at times may be delivered in professional silos leading to potential poor communication and missed opportunities for antenatal interventions which may lead to suboptimal outcomes. Developing a strong perinatal team within your workplace will help facilitate communication, understanding and collaboration across departments and allow more cohesive implementation and embedding of antenatal interventions. Having shared goals, a shared vision and sharing experience ensures your project has momentum and that barriers and enablers can be best appreciated and tackled. The benefits of actively seeking to create a perinatal team are highlighted in this [video](#) developed by the PReCePT2 study⁷².

One of the key components to any successful project is having a team that is engaged, resilient, enthusiastic and committed to working together to create the right culture for change (NSQI 2, NSQI 15). Teams should ideally be around 8-10 members and include:

- An overall project lead (can be medical or nursing)
- Parent representation (NSQI 10)
- People with QI expertise (NSQI 17)
- Data analyst
- Service manager
- Staff educators (maternity and neonatal)
- Other multidisciplinary representation including a range of seniority from neonatologists/paediatricians, neonatal nurses, midwives, obstetricians, labour ward and maternity operating theatre representatives

When forming your team consider:

- **Who** are the most influential people within the maternity/neonatal team? -these may not be the most senior staff members. Consider inviting those who are unsure or oppositional to understand perspective and secure buy in from the outset.
- **Where** are the areas likely to be affected by any changes? – consider staff in these areas.
- **Why** should people want to be involved in your project? – not everyone understands the impact and harms of ‘too early’ cord clamping, take time to share your vision and think how you are going to engage people and maintain their commitment
- **What** is your expectation of team members – what will they be required to do in terms of time and effort? How will you manage team members who do not deliver on tasks/actions?
- **When** are people available and are your time commitments realistic?
- **How** often are you going to meet? Keep up momentum for change; short but frequent meetings.
- **What else** is going on? Are there existing workstreams with overlapping agendas that could be pulled together to prevent duplication. Are there other QI projects which take priority?

Find out if your local hospital has a central improvement team who can facilitate projects and provide valuable skills and knowledge in designing and implementing improvement work. Local data analysts are valuable in helping to collect, analyse and display data.

Stakeholder engagement

Who else needs to be involved? Start by brainstorming the groups of people likely to be affected by the proposed change (NSQI 2). Within the topic of optimal cord management, they are likely to include:

- Senior and junior paediatricians/neonatologists

Optimal Cord Management in Preterm Babies
A Quality Improvement Toolkit

- Neonatal nurses
- Senior and junior obstetricians
- Midwives of all grades of seniority
- Maternity Care Assistants and Maternity Support Workers
- Maternity operating theatre staff including anaesthetic teams
- Parent groups

These groups need to be:

- **Prioritised**- in terms of the power they have to make your project succeed or fail
- **Understood**- how are they likely to feel or react to the proposed changes?
- **Informed**- devise a communication plan to sustain interest and win over doubters. This plan should include modalities of communication (e.g. presentations, emails, newsletters), frequency (monthly, weekly, daily) and key messages you want to deliver.

Examples of perinatal team and stakeholder engagement are shown below:

"I have never met a parent when given the evidence about the benefits of OCM, who has not been on board. In my experience educated parents have been some of the biggest change agents. We need to involve them more."

Amanda Burleigh, Midwifery Consultant

"A memorable case for me was that of a first time mother who required to be delivered by emergency Caesarean section in the maternal interests because of severe preeclampsia. Delivery took place at 30w and surgery was carried out under spinal anaesthesia. Her baby son was born in good condition weighing 1500g. We had a team brief prior to surgery to enable correct use of the Lifestart, and this went well. As an obstetrician I found it fascinating to see the neonatal team begin the care of the baby while he was still attached to his placenta. It really felt like patient centred care for both the mother and the baby - an obstetric/neonatal team effort with the desire for best outcomes at the heart of it."

Judith Roberts, Consultant Obstetrician, Queen Elizabeth University Hospital, Glasgow

"We love the approach to cord clamping with very premature babies. The mother can sit up and see their preterm baby and even touch them during OCM. It's wonderful they can do that before baby goes to the resuscitaire."

Tina Smith, Midwife, Queen Elizabeth University Hospital, Glasgow

"In our Local Neonatal Unit, we started working on OCM in 2017. Key to success was working together as a perinatal team, with obstetric, midwifery and neonatal involvement. We worked together in simulation sessions to develop a simple low-cost technique and recruited champions from all members the maternity team to promote this. Including OCM in our WHO checklist at Caesarean sections was also crucial. By 2019, our rates of babies born <32 weeks who had their cord clamped at or after 60 seconds was 90-95%."

Sarah Bates, Consultant Paediatrician and Neonatologist, GWH, Swindon

"I was only able to stop early and immediate clamping myself when I realised the harm I must have done to so many babies for so many years by not thinking more carefully. I knew about the incredible fetal-to-neonatal transition that must take place in the minutes after birth. Of course, babies have been coping without breathing for 9 months and don't need to have the placental circulation cut off, nor do they have to cry immediately. They are protected by fetal haemoglobin's affinity for oxygen, they need the placental transfusion to fill the new pulmonary circulation. If there is a decent heartbeat there is absolutely no urgency to 'hand the baby over' to someone else in the mistaken belief that interference with this transition is benign. It is not. I gradually realized there are no real indications to clamp the cord at all, especially when full and pulsating. We need the neonatologist to come to the baby, not the other way around. It's a human rights abuse to remove a baby from its mother without good cause"

A 'rueful' reflection from a retired Obstetrician, London

Context

It is a worthwhile activity at this stage to review the context in which you wish to implement your changes. Although the changes you wish to implement have been successful elsewhere, differences in the culture and the context between units may result in variable results. Useful information can be obtained from the results of your Safety Culture Survey which may indicate how well staff feel listened to, how ready your unit is for change, or what might be needed to optimise communication (NSQI 3). The [BAPM Neonatal Service Quality Indicators](#) resource provides a helpful framework for units and networks who wish to optimise their culture for delivering successful quality improvement projects.

Phase Three: Plan and Implement Changes

Project Charter

It can be useful to construct a Project Charter at the start of this phase to detail your proposed improvement, including the resources required and the potential benefits to patients. A Project Charter is a format endorsed by many Trust Improvement Teams and will provide direction and a sense of purpose, and may give your project increased leverage with management (NSQI 15).

Resources:

[NHS Improvement: Project Management](#)

[NHS Improvement Project Charter](#)

[NHS Education for Scotland Project Charter](#)

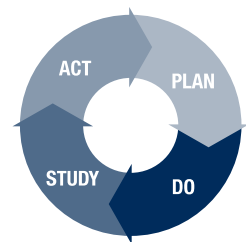
Formulate, prioritise and test solutions

There are a number of methodologies that can be adopted to implement a quality improvement strategy, for example Lean, Six Sigma and the Model for Improvement which all draw on a similar set of principles. No single quality improvement method is better than others; what matters more is having a consistent approach that you are familiar with and skilled in applying. The Model for Improvement is a widely recognised approach within healthcare and is frequently associated with positive outcomes for improvement and will be used here as an illustration.

The Model for Improvement

Ask yourself:

- What is it you want to achieve? **Aim**
- How will you know that a change is an improvement? **Measures**
- What changes can you test that will result in an improvement? **Changes**



For each change idea, a PDSA cycle can be used:

1. Plan

Which intervention(s) to try first? This may be the intervention most likely to make an impact, the easiest to implement or the one that will best win hearts and minds.

How will this intervention be introduced into clinical practice?

Who and what will be required to make this happen?

Predict what you think the change might be?

2. Do

When and how will this plan be carried out? A timescale is important. Document problems and unexpected observations.

3. Study

Use established tools to analyse your data (see Phase 4). Has your change idea resulted in improvement? Is this a real improvement? Does your data suggest your change idea needs to be modified? Why might this be so? Compare your data to your predictions.

4. Act

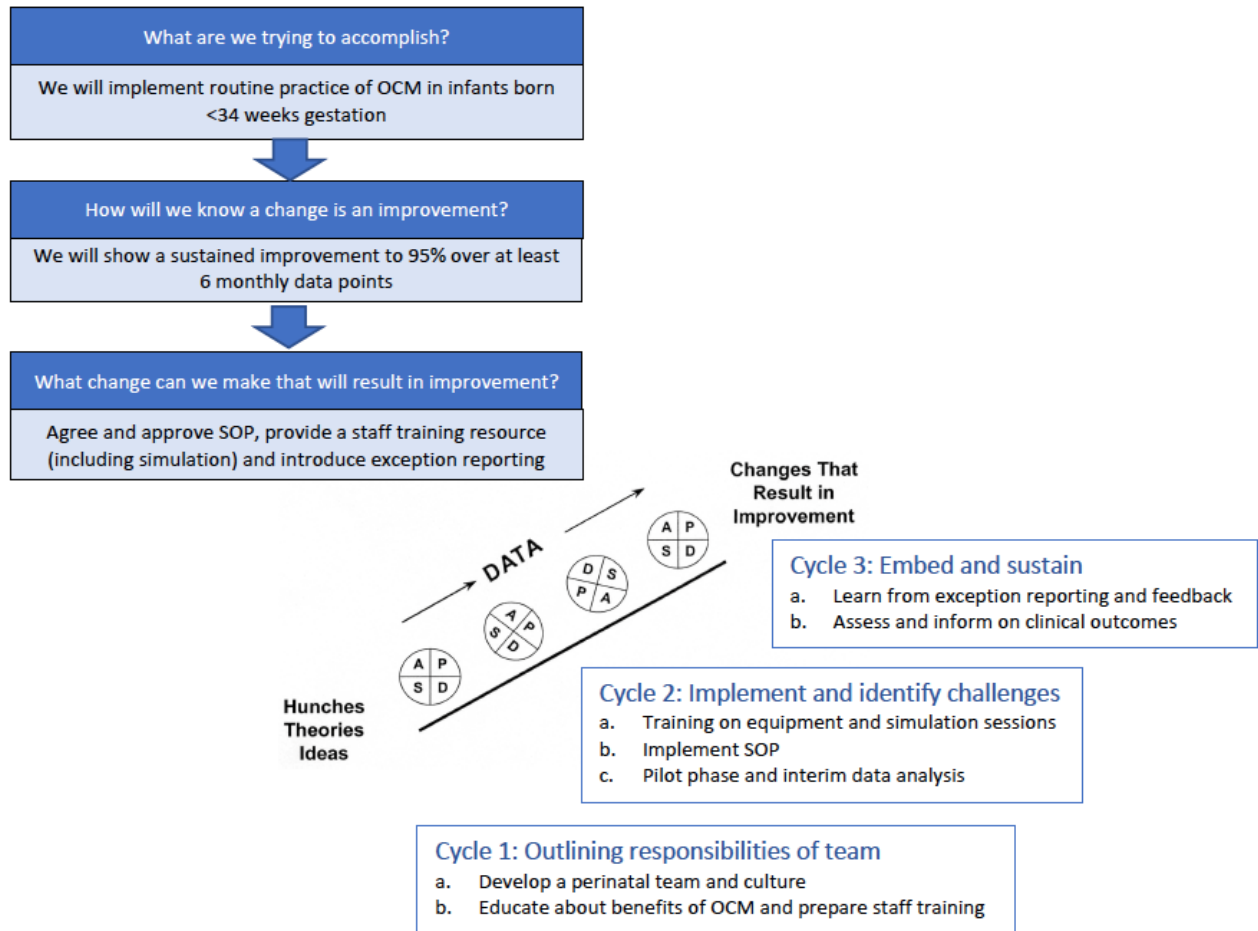
Identify and carry out any modifications needed to this change idea to make it more effective, using further PDSA cycles as needed i.e. Adapt, Adopt or Abandon, Repeat. Start with rapid testing your change on a small scale for example small numbers of patients or a specific subgroup of patients. If effective, increase the numbers or widen to include other groups of patients. Test and repeat with increasing scale until you can show effectiveness throughout your patient group.

Resources:

[BAPM QI Made Easy: 'Planning your Change Idea'](#)
[BloodtoBaby 'Stabilisation with an Intact Cord' module](#)

Below in Figure 8 the Model for Improvement is used to work through an example of implementation in delivering optimal cord management. A template can be found on the [BAPM Quality webpages](#) for your own use.

Figure 8. Example of a Model for Improvement



EXAMPLE

Phase Four: Test and Measure Improvement

In this phase, improvements are tested, reviewed and re-tested in order to find a solution.

Measures

Measuring for improvement is different to the data collected for research or to prove whether clinical interventions work or not. This type of measurement asks the questions ‘how do we make it work in our context?’ and ‘how do we know that a change is an improvement?’ It is important that you collect the right data for your project (NSQI 1).

Resources:

[BAPM QI Made Easy: ‘Planning and Implementing Change’](#)

[NHS Improvement: Project Management](#)

1. **Outcome measures:** reflect the impact on the patient, e.g. survival, necrotising enterocolitis, intraventricular haemorrhage, requirement for blood transfusion during the first six weeks of life etc.
2. **Process measures:** the way systems and processes work to deliver the desired outcome, e.g. number of babies receiving optimal cord management with cord clamping at or greater than 60 seconds.
3. **Balancing measures:** this is what may be happening elsewhere in the system as a result of the change, e.g. the number of babies admitted with a temperature outside the normothermic range

Data analysis and display

How will any change be measured, assessed and displayed in your unit or network? Common tools to present and analyse your data include run charts, statistical process control (SPC) charts and days between charts (see examples below, Figures 9, 10 and 11). All require a level of knowledge and skill to collate and interpret correctly (NSQI 15). Importantly measurement should not be a ‘before and after’ audit which is unreliable in measuring true change, but a continuous process over time during which your changes can be evaluated and modified.

Note that you may choose a different type of chart to be understood by your audience. Run charts and statistical process control charts should always be used by the QI project team in understanding data and assessing change, while other charts and tools may be used to prepare your data in a format which is best understood by frontline staff (Figure 12). You may need an easy to read key to explain your chart or provide a summary interpretation.

Resources:

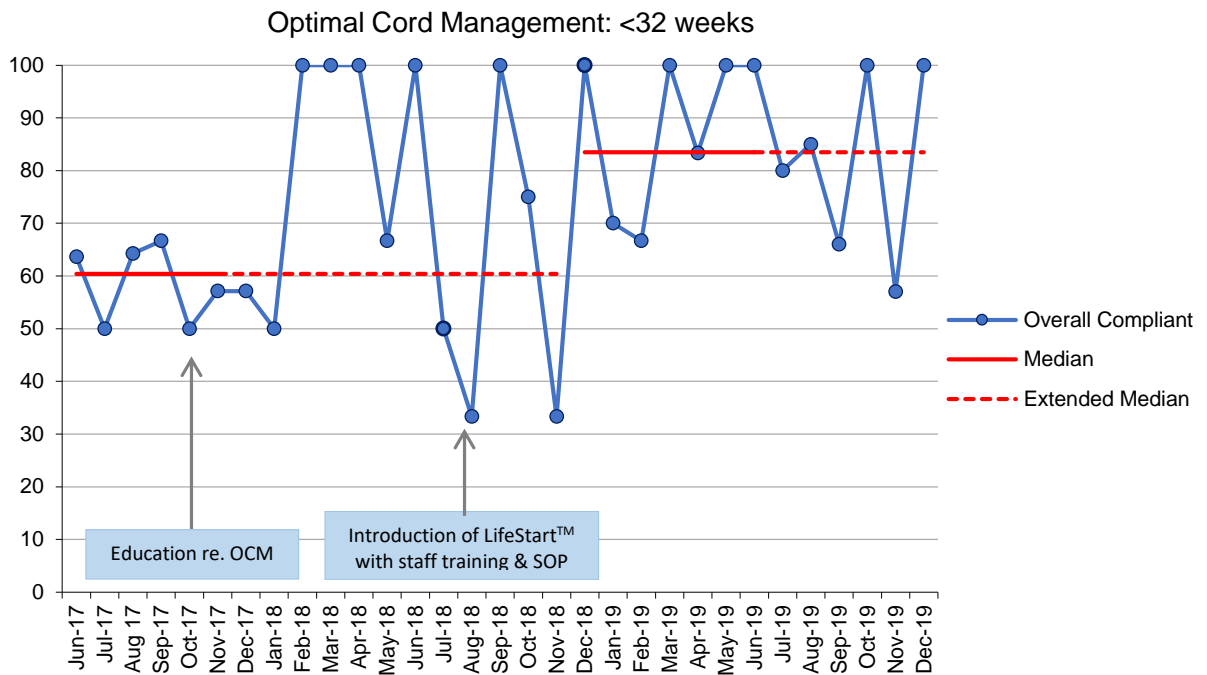
[BAPM QI Made Easy: ‘Interpreting your Data’](#)

[NHS Improvement Statistical Process Control Charts](#)

[NHS Improvement Making Data Count](#)

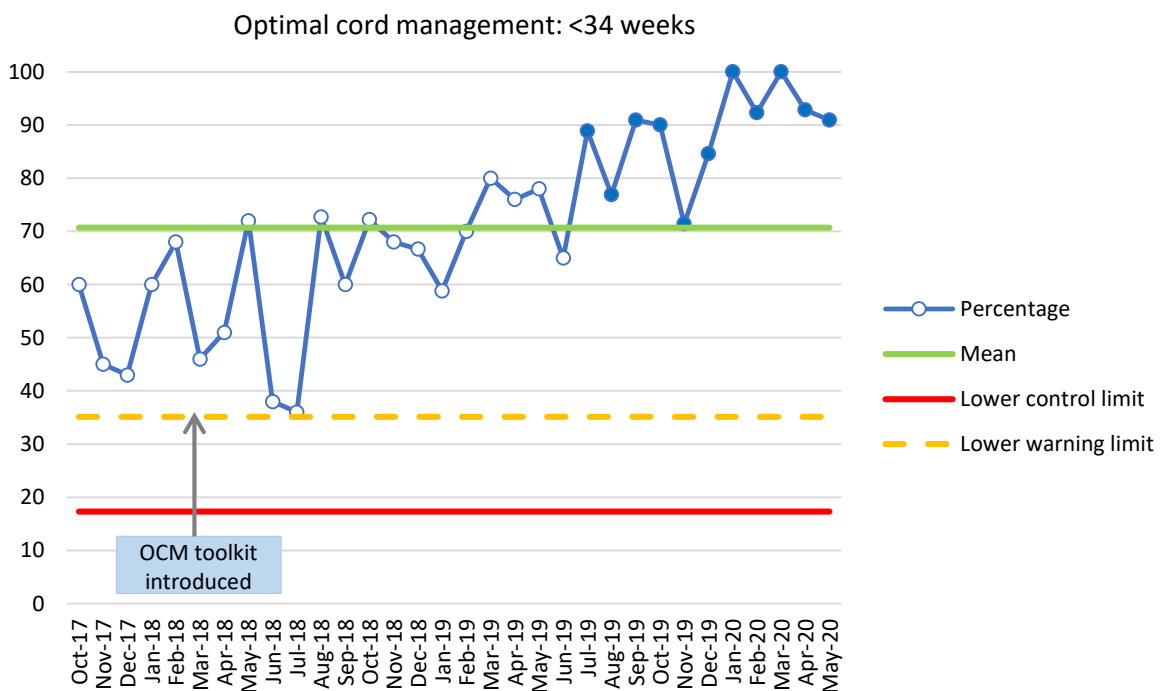
[NHS Improvement: Project Management](#)

Figure 9. Example Run Chart



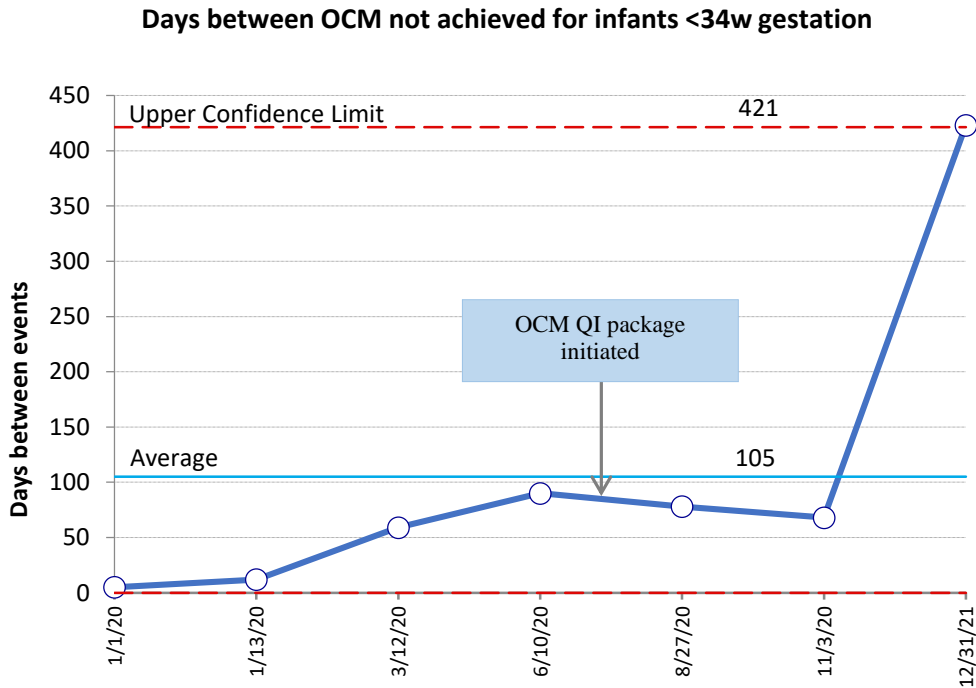
This chart shows that following the implementation of Optimal Cord Clamping in two phases, a shift (with six points above the median) was seen in the percentage of babies born at <32w gestation having Optimal Cord Clamping (i.e. cord clamping at or > 60 seconds), from 60.4% to 83.5%. Run charts are relatively easier to understand than statistical process control charts. The live NNAP dashboard on BadgerNet can be used to generate live run charts.

Figure 10. Example of a Statistical Process Control Chart



This chart shows the mean (solid green line), lower warning limit (dotted yellow line) and lower confidence limit (solid red line). It shows that while there appear to be more points sitting above the mean since Optimal Cord Clamping was introduced, it is yet too early to say there has been a true shift (that is, 7 consecutive points or more above the mean). SPC charts are a better tool for looking at the stability of your process over time and avoid over interpretation of change occurring by chance (random variation).

Figure 11. Example of a Days Between Chart



This chart shows that the days between Optimal Cord Clamping not being achieved in babies born <34 weeks gestation has increased over time. At the beginning of study this event occurred once every 1-2 months but there has now been a year since the last baby born <34 weeks had cord clamping <60 seconds.

Figure 12. Example of feedback targeting frontline staff

Remember your target audience. Graphics and simple messages may be more impactful and less confusing than graphs and charts, although run charts/SPC charts remain essential in understanding the effectiveness of change.

Optimal Cord Management July 2020	
7 out of 10 babies born less than 34 weeks received OCM this month = 70%	
Recommendations for August 2020	
1. Perinatal team to make OCM plan together before every birth	2. Neonatal team to support the maternity team in OCM at every birth

EXAMPLE

Phase Five: Implement, Embed and Sustain

This phase involves the wider implementation of improvements such that change becomes embedded in routine practice throughout the system and is sustained with governance arrangements.

Spread

This can involve formal methods such as *dissemination* that includes presentations, publications, leaflets, learning boards, social media or informal methods of *diffusion* where word of mouth, champions and opinion leaders can accelerate your message. Consider carefully what is required for the embedding of changes within your service (NSQI 2, NSQI 18).

Exception reporting

We recommend that neonatal units undertake a case review when optimal cord management is not achieved in preterm babies <34 weeks gestation using local risk reporting mechanisms (NSQI 13). The case review tool ([Appendix 4](#)) can be used or adapted for this purpose.

Sustainability

The ability of a service to implement and sustain change is dependent on various strengths and weaknesses of any one project. These can be assessed and addressed from the outset of a project and be reviewed regularly throughout the time course to improve the likelihood of sustaining improvement beyond its lifespan. A useful tool to do so is the NHS Sustainability Model (see resources below).

Barriers and loss of motivation

It is not unusual to find the size of a previous improvement lessen over time. It is important to understand why so that solutions can be tailored to the problem. Different approaches will be effective for different people and different situations. The following activities may be useful: talk to key individuals, observe clinical practice in action, use a questionnaire to survey staff, brainstorm with a focus group. Education is a key element of overcoming barriers particularly within an interactive forum; using opinion leaders to influence others within your staffing structure; reminder systems to prompt clinicians; and ensuring feedback of data to staff in a format that they find useful; use of parent stories; all these can help to reinvigorate and embed your changes for improvement (NSQI 2, NSQI 18).

One Trust identified and overcame barriers to implementing Optimal Cord Management as below:

Barrier	Action	Outcome
Clinical Engineering & Infection control approval	Relevant forms signed off	Approved for use
Theatre Layout	MDT Simulations to identify agreed positioning of LifeStart	Position diagrams created for guidelines.
No piped air in Labour ward, no small air cylinders stocked in hospital	Small air cylinders sourced from gas supplier after approval from managers	Small air and oxygen cylinders available for use
Training time and staff engagement	Regular MDT education & training session held. Training videos were created for those who could not make face –face training.	Sign off sheet for staff who had been trained and videos available on staff share drive.
Awaiting guideline approval	Guidelines reviewed by Neonatal and Maternity teams	Guidelines ratified and put on intranet

Resources:

[NHS Improvement: Project Management](#)

[NHS Improvement: Sustainability Model and Guide](#)

[PERIPrem](#)

Incentivising stories from high performers

Examples of high performing units implementing, embedding and sustaining Optimal Cord Clamping are shown below:

“Northumbria introduced optimal cord management (OCM) in 2009, though there have been periods of reduced compliance to the guidance since then. Whilst the midwifery and nursing workforce is largely consistent, junior doctors rotate frequently through the obstetric unit, with varied experiences of OCM. To promote OCM, a neonatal nurse practitioner started to assist with the induction of newly appointed staff to provide information and discuss through scenarios the practicalities of doing OCM safely. This has helped considerably with maintaining high levels of compliance to our OCM guideline.”

George Brooks, Neonatal Nurse Consultant, Northumbria Healthcare Foundation NHS Trust

“We used QI methodology within a multidisciplinary team framework involving staff education, clear OCM guidance, simulation and a buddy system, with more experienced staff guiding less experienced staff in administering OCM. With this approach we were delighted to achieve and maintain an 86.5% implementation rate of OCM in our preterm deliveries and these babies also had admission temperatures within the normal range. In cases where OCM was not achieved, this was due to baby being non vigorous at birth or due to APH. In the initial month of the Covid-19 pandemic restrictions, we noted a reduction in reliability with OCM in preterm babies with only 48.6% receiving it. Further investigation using both maternal and neonatal records highlighted several issues especially around the number of babies who had received OCM for only 50 - 60 seconds. On review, it became apparent, different timers were being used simultaneously in the delivery theatre, resulting in differing records of OCM clamping times. By addressing the problem and making slight changes, our reliability improved. This highlighted the importance of real time data review and keeping unintended variation to a minimum. On a personal note, as a QI midwife involved in the implementation of preterm OCM, one of my highlights was listening to a junior midwifery colleague speak excitedly about how proud she was when she, an obstetrician and the attending neonatal staff were able to facilitate OCM for preterm twins, especially in a unit that does not have access to a Lifestart trolley. It was reassuring to see staff take “ownership” of this improvement work and become completely engaged because they understand the benefits of OCM to preterm babies and their mothers.”

Lorna Lennox, Staff Midwife, University Hospital Wishaw, NHS Lanarkshire, Scotland

“We designed a Labour Ward optimisation package which included optimal cord management (OCM) for preterm deliveries. Post-implementation data collection showed that of 88 infants (23-31 weeks), 72% (85% of these on Lifestart) received OCM >60 seconds with a median cord clamp time of 2 mins (mean 2.5 and max 4.4). All were normothermic on admission. Those who didn't get OCM >60 seconds (mean 30) were significantly more likely to require an early blood transfusion despite being well matched for gestation, birth weight and maternal antenatal factors. Within the wider perinatal multidisciplinary team, we explored the barriers to receiving OCM which were clinician anxiety, GA section and placental separation.”

Dr Anne Marie Heuchan, Consultant Neonatologist, Royal Hospital for Children, Glasgow

“For 13 months 100% eligible babies have had their cord clamped at 60 seconds or longer after birth. Although we do not provide stabilisation manoeuvres prior to cord clamping, we do apply a plastic bag and have not seen an increase in hypothermia.

The key to this success has been:

- 1. Establishment of a perinatal team approach with shared goals and joint responsibilities*
- 2. Streamlining of guidelines to ensure a clear message about the benefits to babies*
- 3. Neonatal support at the time of birth. With a member of the neonatal team present, our obstetric and midwifery colleagues feel more confident in babies' wellbeing during the first minutes of life.”*

Dr Julie-Clare Becher, Consultant Neonatologist, Simpson Centre for Reproductive Health, Edinburgh

References

1. NNAP Online. National Neonatal Audit Programme: Royal College for Paediatrics and Child Health; [Available from: <https://nnap.rcpch.ac.uk>]
2. Maternity and Neonatal Safety Improvement Programme: NHS Improvement; [Available from: <https://improvement.nhs.uk/resources/maternal-and-neonatal-safety-collaborative/>]
3. Maternity and Children's Quality Improvement Collaborative- Scottish Patient Safety Programme [Available from: <https://ihub.scot/improvement-programmes/scottish-patient-safety-programme-spsp/maternity-and-children-quality-improvement-collaborative-mcqic/neonatal-care/>]
4. Saving Babies' Lives Care Bundle Version 2: COVID-19 information. Appendix I: Implications of COVID-19 on reducing preterm births: NHS England, 2020.
5. Neonatal Service Quality Indicators: Standards relating to structures and processes: British Association of Perinatal Medicine; 2017 [Available from: <https://www.bapm.org/resources/11-neonatal-service-quality-indicators-standards-relating-to-structures-and-processes-2017>].
6. Quality Improvement in Child Health Strategic Framework: Royal College of Paediatrics and Child Health [Available from: <https://www.rcpch.ac.uk/resources/quality-improvement-child-health-framework-supporting-delivery-high-quality-care>]. .
7. PERIPrem Care Bundle: West of England Academic Health Sciences Network 2020 [Available from: <https://www.weahsn.net/our-work/transforming-services-and-systems/periprem/periprem-project/>].
8. Preterm Perinatal Wellbeing Package: Maternity and Children Quality Improvement Collaborative, Scottish Patient Safety Programme. Health Improvement Scotland; [Available from: <https://ihub.scot/media/5311/20180808-preterm-web.pdf>]
9. Implementing the Recommendations of the Neonatal Critical Care Transformation Review: NHS England; 2019 [updated 2019. Available from: <https://www.england.nhs.uk/publication/implementing-the-recommendations-of-the-neonatal-critical-care-transformation-review/>].
10. Saving Babies Lives' Version 2. A care bundle for reducing perinatal mortality: NHS England; 2019 [Available from: <https://www.england.nhs.uk/wp-content/uploads/2019/07/saving-babies-lives-care-bundle-version-two-v5.pdf>].
11. Perinatal Management of Extreme Preterm Birth Before 27 weeks of Gestation. A BAPM Framework for Practice: British Association of Perinatal Medicine; 2019 [Available from: <https://www.bapm.org/resources/80-perinatal-management-of-extreme-preterm-birth-before-27-weeks-of-gestation-2019>].
12. Fogarty M, Osborn DA, Askie L, et al. Delayed vs early umbilical cord clamping for preterm infants: a systematic review and meta-analysis. *Am J Obstet Gynecol* 2018;218(1):1-18. doi: 10.1016/j.ajog.2017.10.231 [published Online First: 2017/11/04]
13. Rabe H, Gyte GM, Díaz-Rossello JL, et al. Effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. *Cochrane Database Syst Rev* 2019;9(9):Cd003248. doi: 10.1002/14651858.CD003248.pub4 [published Online First: 2019/09/19]

14. Seidler AL, Gyte G, Rabe H, et al. Umbilical Cord Management for Newborns < 34 week's gestation: a meta-analysis. *Pediatrics (in press, accepted 25 Aug 2020)*
15. WHO Guideline: Delayed Umbilical Cord Clamping for Improved Maternal and Infant Health and Nutrition Outcomes Geneva: World Health Organization. Copyright © World Health Organization 2014.
16. The Canadian Neonatal Network 2019 Annual Report on 2018 Data.
17. Rabe H, Jewison A, Alvarez RF, et al. Milking compared with delayed cord clamping to increase placental transfusion in preterm neonates: a randomized controlled trial. *Obstet Gynecol* 2011;117(2 Pt 1):205-11. doi: 10.1097/AOG.0b013e3181fe46ff [published Online First: 2011/01/22]
18. Duley L, Dorling J, Pushpa-Rajah A, et al. Randomised trial of cord clamping and initial stabilisation at very preterm birth. *Arch Dis Child Fetal Neonatal Ed* 2018;103(1):F6-f14. doi: 10.1136/archdischild-2016-312567 [published Online First: 2017/09/20]
19. Brouwer E, Knol R, Vernooij ASN, et al. Physiological-based cord clamping in preterm infants using a new purpose-built resuscitation table: a feasibility study. *Arch Dis Child Fetal Neonatal Ed* 2019;104(4):F396-f402. doi: 10.1136/archdischild-2018-315483 [published Online First: 2018/10/05]
20. Draft 2020 European Resuscitation Council Guidelines for Newborn Resuscitation and Support of Transition of Infants at Birth. <https://api.resuscitation2020.eu/asset-document/35-Draft%20NLS%20Guidelines%20for%20Public%20Comment%2019Oct20.pdf>.
21. Wyckoff MH, Wyllie J, Aziz K, et al. Neonatal Life Support 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Resuscitation* 2020;156:A156-a87. doi: 10.1016/j.resuscitation.2020.09.015 [published Online First: 2020/10/26]
22. Sweet DG, Carnielli V, Greisen G, et al. European Consensus Guidelines on the Management of Respiratory Distress Syndrome – 2019 Update. *Neonatology* 2019;115(4):432-50. doi: 10.1159/000499361
23. Ghirardello S, Di Tommaso M, Fiocchi S, et al. Italian Recommendations for Placental Transfusion Strategies. *Front Pediatr* 2018;6:372. doi: 10.3389/fped.2018.00372 [published Online First: 2018/12/19]
24. Katheria A, Reister F, Essers J, et al. Association of Umbilical Cord Milking vs Delayed Umbilical Cord Clamping With Death or Severe Intraventricular Hemorrhage Among Preterm Infants. *Jama* 2019;322(19):1877-86. doi: 10.1001/jama.2019.16004 [published Online First: 2019/11/20]
25. El-Naggar W, Afifi J, Dorling J, et al. A Comparison of Strategies for Managing the Umbilical Cord at Birth in Preterm Infants. *J Pediatr* 2020;225:58-64.e4. doi: 10.1016/j.jpeds.2020.05.018 [published Online First: 2020/05/23]
26. Blank DA, Polglase GR, Kluckow M, et al. Haemodynamic effects of umbilical cord milking in premature sheep during the neonatal transition. *Arch Dis Child Fetal Neonatal Ed* 2018;103(6):F539-f46. doi: 10.1136/archdischild-2017-314005 [published Online First: 2017/12/07]
27. Balasubramanian H, Ananthan A, Jain V, et al. Umbilical cord milking in preterm infants: a systematic review and meta-analysis. *Archives of Disease in Childhood - Fetal and Neonatal Edition* 2020;105(6):572. doi: 10.1136/archdischild-2019-318627

28. Ram Mohan G, Shashidhar A, Chandrakala BS, et al. Umbilical cord milking in preterm neonates requiring resuscitation: A randomized controlled trial. *Resuscitation* 2018;130:88-91. doi: 10.1016/j.resuscitation.2018.07.003 [published Online First: 2018/07/10]
29. Jegatheesan P, Belogolovsky E, Nudelman M, et al. Neonatal outcomes in preterm multiples receiving delayed cord clamping. *Arch Dis Child Fetal Neonatal Ed* 2019;104(6):F575-f81. doi: 10.1136/archdischild-2018-316479 [published Online First: 2019/03/22]
30. Ruangkit C, Bumrungphuet S, Panburana P, et al. A Randomized Controlled Trial of Immediate versus Delayed Umbilical Cord Clamping in Multiple-Birth Infants Born Preterm. *Neonatology* 2019;115(2):156-63. doi: 10.1159/000494132 [published Online First: 2018/11/28]
31. Katheria A, Poeltler D, Durham J, et al. Neonatal Resuscitation with an Intact Cord: A Randomized Clinical Trial. *J Pediatr* 2016;178:75-80.e3. doi: 10.1016/j.jpeds.2016.07.053 [published Online First: 2016/10/30]
32. Murphy MC, McCarthy LK, O'Donnell CPF. Crying and breathing by new-born preterm infants after early or delayed cord clamping. *Arch Dis Child Fetal Neonatal Ed* 2020;105(3):331-33. doi: 10.1136/archdischild-2018-316592 [published Online First: 2019/05/16]
33. Ayers S, Sawyer A, Düring C, et al. Parents report positive experiences about enrolling babies in a cord-related clinical trial before birth. *Acta Paediatr* 2015;104(4):e164-70. doi: 10.1111/apa.12922 [published Online First: 2015/02/03]
34. Sawyer A, Rabe H, Abbott J, et al. Parents' experiences and satisfaction with care during the birth of their very preterm baby: a qualitative study. *Bjog* 2013;120(5):637-43. doi: 10.1111/1471-0528.12104 [published Online First: 2013/01/08]
35. Katheria AC, Sorkhi SR, Hassen K, et al. Acceptability of Bedside Resuscitation With Intact Umbilical Cord to Clinicians and Patients' Families in the United States. *Front Pediatr* 2018;6:100. doi: 10.3389/fped.2018.00100 [published Online First: 2018/05/15]
36. Anton O, Jordan H, Rabe H. Strategies for implementing placental transfusion at birth: A systematic review. *Birth* 2019;46(3):411-27. doi: 10.1111/birt.12398 [published Online First: 2018/09/29]
37. Liyanage SK, Ninan K, McDonald SD. Guidelines on Deferred Cord Clamping and Cord Milking: A Systematic Review. *Pediatrics* 2020;146(5) doi: 10.1542/peds.2020-1429 [published Online First: 2020/10/23]
38. Hoyle ES, Hirani S, Ogden S, et al. Quality improvement programme to increase the rate of deferred cord clamping at preterm birth using the Lifestart trolley. *Arch Dis Child Fetal Neonatal Ed* 2020;105(6):652-55. doi: 10.1136/archdischild-2019-318636 [published Online First: 2020/05/01]
39. Aliyev G, Gallo AM. Implementation of Delayed Cord Clamping in Vigorous Preterm Neonates. *J Obstet Gynecol Neonatal Nurs* 2018;47(6):803-11. doi: 10.1016/j.jogn.2018.09.003 [published Online First: 2018/10/08]
40. Gams RL, Popp KK, Cramer J, et al. How to Engage Your Team to Implement Delayed Cord Clamping. *Nurs Womens Health* 2017;21(6):489-98. doi: 10.1016/j.nwh.2017.10.003 [published Online First: 2017/12/11]
41. Pantoja AF, Ryan A, Feinberg M, et al. Implementing delayed cord clamping in premature infants. *BMJ Open Qual* 2018;7(3):e000219. doi: 10.1136/bmjoq-2017-000219 [published Online First: 2018/10/03]

42. McAdams RM, Backes CH, Hutchon DJ. Steps for implementing delayed cord clamping in a hospital setting. *Matern Health Neonatol Perinatol* 2015;1:10. doi: 10.1186/s40748-015-0011-8 [published Online First: 2015/01/01]
43. Liu LY, Feinglass JM, Khan JY, et al. Evaluation of Introduction of a Delayed Cord Clamping Protocol for Premature Neonates in a High-Volume Maternity Center. *Obstet Gynecol* 2017;129(5):835-43. doi: 10.1097/aog.0000000000001987 [published Online First: 2017/04/07]
44. Aziz K, Chinnery H, Lacaze-Masmonteil T. A single-center experience of implementing delayed cord clamping in babies born at less than 33 weeks' gestational age. *Adv Neonatal Care* 2012;12(6):371-6. doi: 10.1097/ANC.0b013e3182761246 [published Online First: 2012/11/29]
45. Rhoades JS, Bierut T, Conner SN, et al. Delayed Umbilical Cord Clamping at <32 Weeks' Gestation: Implementation and Outcomes. *American journal of perinatology* 2017;34(11):1048-53. doi: 10.1055/s-0037-1603591 [published Online First: 2017/05/25]
46. Rich D. Delayed Cord Clamping: A Multidisciplinary Approach. *Journal of Obstetric, Gynecologic, & Neonatal Nursing* 2015;44(s1):S9-S10. doi: 10.1111/1552-6909.12670
47. Sæther E, Gülpen FR, Jensen C, et al. Neonatal transitional support with intact umbilical cord in assisted vaginal deliveries: a quality-improvement cohort study. *BMC Pregnancy Childbirth* 2020;20(1):496. doi: 10.1186/s12884-020-03188-0 [published Online First: 2020/08/29]
48. Perrone B, Ghirardello S. Placental Transfusion Strategies in Italy: A Nationwide Survey of Tertiary-Care Delivery Wards. *Am J Perinatol* 2017;34(7):722-28. doi: 10.1055/s-0036-1597995 [published Online First: 2017/01/07]
49. Oddie S, Rhodes P. Barriers to deferred cord clamping in preterm infants. *Arch Dis Child Fetal Neonatal Ed* 2014;99(5):F391-4. doi: 10.1136/archdischild-2014-305968 [published Online First: 2014/06/07]
50. Bolstridge J, Bell T, Dean B, et al. A quality improvement initiative for delayed umbilical cord clamping in very low-birthweight infants. *BMC Pediatr* 2016;16(1):155. doi: 10.1186/s12887-016-0692-9 [published Online First: 2016/09/15]
51. Jelin AC, Kuppermann M, Erickson K, et al. Obstetricians' attitudes and beliefs regarding umbilical cord clamping. *J Matern Fetal Neonatal Med* 2014;27(14):1457-61. doi: 10.3109/14767058.2013.864275 [published Online First: 2013/11/13]
52. Jelin AC, Zlatnik MG, Kuppermann M, et al. Clamp late and maintain perfusion (CLAMP) policy: delayed cord clamping in preterm infants. *J Matern Fetal Neonatal Med* 2016;29(11):1705-9. doi: 10.3109/14767058.2015.1061496 [published Online First: 2015/07/03]
53. Bates SE, Isaac TCW, Marion RL, et al. Delayed cord clamping with stabilisation at all preterm births - feasibility and efficacy of a low cost technique. *Eur J Obstet Gynecol Reprod Biol* 2019;236:109-15. doi: 10.1016/j.ejogrb.2019.03.012 [published Online First: 2019/03/25]
54. Balakrishnan M, Falk-Smith N, Detman LA, et al. Promoting teamwork may improve infant care processes during delivery room management: Florida perinatal quality collaborative's approach. *J Perinatol* 2017;37(7):886-92. doi: 10.1038/jp.2017.27 [published Online First: 2017/04/14]
55. BloodtoBaby. Optimal Cord Clamping [Available from: <https://www.bloodtobaby.com/what-is-bloodtobaby>].

56. Preterm Labour and Birth: National Institute for Clinical Excellence; 2019 [Available from: <https://www.nice.org.uk/guidance/ng25>].
57. Thomas EJ, Sexton JB, Lasky RE, et al. Teamwork and quality during neonatal care in the delivery room. *J Perinatol* 2006;26(3):163-9. doi: 10.1038/sj.jp.7211451 [published Online First: 2006/02/24]
58. Situation Awareness for Everyone (S.A.F.E) toolkit: Royal College for Paediatrics and Child Health; [Available from: <https://www.rcpch.ac.uk/resources/situation-awareness-everyone-safe-toolkit-introduction>].
59. Vergales BD, Dwyer EJ, Wilson SM, et al. NASCAR pit-stop model improves delivery room and admission efficiency and outcomes for infants <27 weeks' gestation. *Resuscitation* 2015;92:7-13. doi: 10.1016/j.resuscitation.2015.03.022 [published Online First: 2015/04/22]
60. BAPM. Improving Normothermia in Very Preterm Infants: A Quality Improvement Toolkit. [published Online First: 2019]
61. BAPM. Safety Issue - Transwarmer Mattresses 2019 [Available from: <https://www.bapm.org/posts/44-safety-issue-transwarmer-mattresses>].
62. WHO Early Essential Newborn Care: clinical practice pocket guide. WHO 2014 ISBN 978 92 9061 685 6. [Available from: https://apps.who.int/iris/bitstream/handle/10665/208158/9789290616856_eng.pdf?sequence=1&isAllowed=y]
63. Roehr CC, Davis PG, Weiner GM, et al. T-piece resuscitator or self-inflating bag during neonatal resuscitation: a scoping review. *Pediatr Res* 2020 doi: 10.1038/s41390-020-1005-4 [published Online First: 2020/06/12]
64. Roehr CC, O'Shea JE, Dawson JA, et al. Devices used for stabilisation of newborn infants at birth. *Arch Dis Child Fetal Neonatal Ed* 2018;103(1):F66-f71. doi: 10.1136/archdischild-2016-310797 [published Online First: 2017/10/29]
65. Kuypers K, Martherus T, Lamberska T, et al. Reflexes that impact spontaneous breathing of preterm infants at birth: a narrative review. *Arch Dis Child Fetal Neonatal Ed* 2020;105(6):675-79. doi: 10.1136/archdischild-2020-318915 [published Online First: 2020/05/01]
66. Crawshaw JR, Kitchen MJ, Binder-Heschl C, et al. Laryngeal closure impedes non-invasive ventilation at birth. *Arch Dis Child Fetal Neonatal Ed* 2018;103(2):F112-f19. doi: 10.1136/archdischild-2017-312681 [published Online First: 2017/10/22]
67. Knol R, Brouwer E, Vernooij ASN, et al. Clinical aspects of incorporating cord clamping into stabilisation of preterm infants. *Arch Dis Child Fetal Neonatal Ed* 2018;103(5):F493-f97. doi: 10.1136/archdischild-2018-314947 [published Online First: 2018/04/24]
68. Knol R, Brouwer E, van den Akker T, et al. Physiological-based cord clamping in very preterm infants - Randomised controlled trial on effectiveness of stabilisation. *Resuscitation* 2020;147:26-33. doi: 10.1016/j.resuscitation.2019.12.007 [published Online First: 2019/12/25]
69. Weeks AD, Watt P, Yoxall CW, et al. Innovation in immediate neonatal care: development of the Bedside Assessment, Stabilisation and Initial Cardiorespiratory Support (BASICS) trolley. *BMJ Innov* 2015;1(2):53-58. doi: 10.1136/bmjinnov-2014-000017 [published Online First: 2015/07/21]

70. Thomas MR, Yoxall CW, Weeks AD, et al. Providing newborn resuscitation at the mother's bedside: assessing the safety, usability and acceptability of a mobile trolley. *BMC Pediatr* 2014;14:135. doi: 10.1186/1471-2431-14-135 [published Online First: 2014/06/03]
71. PERIPrem Care Bundle: Delayed Cord Clamping. 2020
72. Perinatal Teamworking. The PReCePT2 Study.: The Health Foundation; [Available from: <https://www.health.org.uk/improvement-projects/precept2-reducing-brain-injury-through-improving-uptake-of-magnesium-sulphate>].
73. WHO recommendations on interventions to improve preterm birth outcomes France: World Health Organisation; 2015 [Available from: https://apps.who.int/iris/bitstream/handle/10665/183037/9789241508988_eng.pdf;jsessionid=966E028B4E46B3A246043A64E83F85EC?sequence=1].

Appendix 1: Members of the Optimal Cord Management Toolkit Group

Chair: Grenville Fox	Consultant Neonatologist, Evelina London Children's Hospital, Guy's & St Thomas' NHS Foundation Trust, London
Josie Anderson	Campaigns and Policy Manager, Bliss
Augusta Anenih	Consultant Neonatologist, University Hospital Wishaw. NHS Lanarkshire, Scotland
Sarah Bates	Consultant Paediatrician & Neonatologist, Great Western Hospital NHS Foundation Trust, Swindon
Julie-Clare Becher	Lead for Quality, British Association of Perinatal Medicine and Consultant Neonatologist, Royal Infirmary of Edinburgh
George Brooks	Neonatal Nurse Consultant, Northumbria Healthcare Foundation NHS Trust
Amanda Burleigh	Midwifery Consultant, Senior Clinical Advisor Yorkshire Ambulance Service and Public Health Practitioner Public Health England
Claudia Chetcuti Ganado	Consultant Neonatologist, Luton & Dunstable University Hospital
Fraser G Christie	Specialty Trainee / Neonatal Transport & Research Fellow, Simpson Centre for Reproductive Health, Edinburgh
Anne-Marie Heuchan	Consultant Neonatologist, Royal Hospital for Children and Queen Elizabeth University Hospital, Glasgow
Tracey Kay	Consultant Obstetrician, Royal Devon & Exeter NHS Trust
Heike Rabe	Professor of Perinatal Medicine, Brighton and Sussex Medical School, University of Sussex, Brighton
Charles Roehr	Academic Consultant Neonatologist, Oxford University Hospitals NHS Foundation Trust, Oxford Clinical Director, National Perinatal Epidemiology Unit, Clinical Trials Unit. Nuffield Department of Population Health, Medical Sciences Division, University of Oxford, Oxford
Charlotte Sullivan	Consultant Obstetrician, Great Western Hospital NHS Foundation Trust, Swindon
Amitava Sur	Consultant Neonatologist, Lancashire Women and Newborn Centre, East Lancashire Hospitals NHS Trust, Burnley

With many thanks to Susan Bewley, Emeritus Professor of Obstetrics and Women's Health, Kings College London for her careful review of this toolkit.

Additional stakeholders involved in consultation:

- British Intrapartum Care Society
- British Maternal and Fetal Medicine Society

Optimal Cord Management in Preterm Babies
A Quality Improvement Toolkit

- Lead Maternity Safety Champions, NHS England: Matthew Jolly, National Clinical Director for Maternity and Women's Health and Jacqueline Dunkley-Bent, Chief Midwifery Officer
- Maternity and Neonatal Safety Improvement Programme
- Maternity and Children's Quality Improvement Collaborative, Scottish Patient Safety Programme
- Neonatal Nurses Association
- Royal College of Midwives
- Royal College of Obstetricians and Gynaecologists
- Scottish Neonatal Nurses Group
- UK Preterm Clinical Network

Appendix 2: BAPM Neonatal Service Quality Indicators

Evidence-based care

NSQI 1 Care Guidelines supported by Audit

Team working and communication

NSQI 2 Team communication

NSQI 3 Staff Safety Culture

NSQI 4 Pathways of Care and Referral for high risk babies

NSQI 5 Collaborative multidisciplinary care for babies with complex conditions

Parental partnership in care

NSQI 6 Family facilities

NSQI 7 Family involvement in care planning and delivery

NSQI 8 Parent information

NSQI 9 Parent feedback

NSQI 10 Parent involvement in service development

Benchmarking

NSQI 11 Other Neonatal Service Standards

NSQI 12 Engagement in National and International Audit and Benchmarking

Patient Safety

NSQI 13 Adverse Event Review

NSQI 14 Death and Serious Adverse Event Review

Quality Improvement

NSQI 15 Structure and Resources for Quality Improvement

NSQI 16 Annual Quality Strategy and Quality Report

Education and Training

NSQI 17 Training for Quality and Patient Safety

NSQI 18 Engagement in shared learning about Quality of Care

Research

NSQI 19 Engagement in Research

Appendix 3. Evidence Summary and Key Drivers

Optimal Cord Management in Preterm Babies		
<p>All babies born <34 weeks gestation should have their umbilical cord clamped at least 60 seconds or more after birth, except when there are specific documented maternal or fetal conditions to justify earlier clamping</p>		
Evidence-base	Professional Recommendations	Quality Improvement Initiatives
<p>Mortality Preterm babies have reduced risk of death by at least 27% if they receive Optimal Cord Clamping, with a NNT of 33-55¹²⁻¹⁴</p> <p>Babies ≤28 weeks have reduced risk of death by 32% if they receive Optimal Cord Clamping, with a NNT of 20¹²</p> <p>Cardiovascular benefits Preterm babies have improved circulatory transition after birth with higher blood pressure (mean improvement in mean BP 2.87mmHg, (95% CI 1.09 to 4.64mmHg) and less need for inotrope treatment (RR 0.37, 95% CI 0.17 to 0.81)^{13 14}</p> <p>Blood transfusion requirements Reduces proportion of preterm babies requiring red blood cell transfusion by 9-10% during the first six weeks of life¹²⁻¹⁴</p> <p>Other benefits Parents report higher satisfaction and contribution to the care of their preterm baby^{18 33-35}</p>	<p>NICE⁵⁶:</p> <ul style="list-style-type: none"> • Wait at least 30 seconds, but no longer than 3 minutes, before clamping the cord of preterm babies if the mother and baby are stable • Position the baby at or below the level of the placenta before clamping the cord • If a preterm baby needs to be moved away from the mother for resuscitation, or there is significant maternal bleeding: <ul style="list-style-type: none"> - consider milking the cord and - clamp the cord as soon as possible <p>BAPM¹¹:</p> <ul style="list-style-type: none"> • Delayed cord clamping is recommended as part of package of active perinatal care of extreme preterm birth before 27 weeks gestation <p>ILCOR⁶³:</p> <ul style="list-style-type: none"> • Delayed cord clamping is recommended for preterm babies not requiring immediate resuscitation <p>WHO^{15 73}:</p> <ul style="list-style-type: none"> • In newly born term or preterm babies who do not require positive-pressure ventilation, the cord should not be clamped earlier than 1 min after birth. <p>International stakeholders³⁷</p> <ul style="list-style-type: none"> • Guidelines on Optimal Cord Clamping have been published by 44 stakeholders at national and international level. 	<ul style="list-style-type: none"> • NNAP¹. From 2020: ‘Deferred cord clamping for very preterm babies’ – Does a baby born less than 32 weeks gestational age have their cord clamped at or after one minute? • MatNeoSIP² • MCQIC-SPSP in Scotland Preterm Perinatal Wellbeing package⁸ • PERIPrem care bundle of the West of England AHSN: Delayed cord clamping is one of the ten PERIPrem bundle elements⁷ • BloodtoBaby⁵⁵ – a perinatal professionals campaign and resource provision for optimal and delayed cord clamping • A multitude of quality improvement projects on Optimal Cord Clamping implementation have been published across 4 continents (see table of implementation evidence and ⁶⁵)

Appendix 4. Example Case Review or Exception Reporting Tool

Exception identified from BadgerNet:		Born <34w and cord clamped for less than 60s	
Provider/Unit		Date of Report	
Maternal Badger ID		Baby Badger ID	
Date of birth		Time of Birth	

Part A: Peripartum Optimisation	
Name of person completing part A:	
Was Optimal Cord Clamping and benefits discussed with the parents before birth and a record documented? (Provide detail if no)	<i>Comments</i>
Did the perinatal team prepare the birth environment in order that Optimal Cord Clamping could be achieved? (Provide detail if no)	<i>Comments</i>
Was the cord clamped <60 seconds after birth? If Yes-Has this been verified from maternal notes (Ensure Badgernet accuracy)	<i>Comments</i>
Was a reason for this recorded in the notes? For eg: <input type="checkbox"/> Placental abruption or early separation <input type="checkbox"/> Maternal concerns e.eg shock/seizure/PPH <input type="checkbox"/> Uterine Inversion <input type="checkbox"/> Cord issues i.e. snapped, incised, limited cord length <input type="checkbox"/> A requirement for immediate resuscitation which could not be undertaken with cord intact: <ul style="list-style-type: none"> ▪ Equipment not available ▪ Environment not appropriate ▪ Experienced resuscitator (with OCM skills) not present ▪ Other reason (please detail) Please provide detail about time lapse before cord was clamped in seconds <input type="checkbox"/> Second twin needs immediate birth <input type="checkbox"/> Milking of the intact umbilical cord, how many times <input type="checkbox"/> Enrolled in research study on optimal cord management (do <u>not</u> unblind) <input type="checkbox"/> Other reason (please detail)	<i>Comments</i>
Was early cord clamping discussed with parents and reason given?	<i>Comments</i>
Most senior maternity professional at birth	<i>Comments</i>
Most senior neonatal professional at birth	<i>Comments</i>

Optimal Cord Management in Preterm Babies
A Quality Improvement Toolkit

Part B: Neonatal Care			
Name of person completing part B:			
Gestation	Weight		
Apgar Scores: _/_/_	Admission Temperature:		Admission Hb
Cord gas results	Arterial		
	Venous		
Was the neonatal team in attendance at birth and of appropriate seniority to manage Optimal Cord Clamping for a preterm baby?	<i>Comments</i>		
Brief details of delivery room management:	<i>Comments</i>		
Brief details of NNU stay (to date at time of reporting)	<i>Comments</i>		
Notes review: <input type="checkbox"/> IVH <input type="checkbox"/> Surgical treatment for NEC <input type="checkbox"/> Hypotension in first 72 hours <input type="checkbox"/> Blood transfusion during first 7 days of life (or 6 weeks of life): 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> >3 <input type="checkbox"/> <input type="checkbox"/> Broncho-pulmonary Dysplasia (O2 requirement @36 w corrected) <input type="checkbox"/> Survived until discharge	<i>Comments</i>		

Optimal Cord Management in Preterm Babies
A Quality Improvement Toolkit

Part C: Governance			
Name of person completing part C:			
Was an incident form submitted locally?		Has there been a local maternity review?	
Did neonatal team input to the review?			
Was there a missed opportunity for Optimal Cord Clamping?	<i>Comments</i>		
Was cord clamping before 60 seconds avoidable?	<i>Comments</i>		
Was early cord clamping deemed appropriate/not appropriate? What indication was given and was this documented in the notes?	<i>Comments</i>		
Learning identified following local review:	<i>Comments</i>		
Any communication issues identified with this case: comment specifically on communication with parents and the maternity/neonatal teams	<i>Comments</i>		
Further action required	<i>Comments</i>		
Detailed action completed			
Date completed and closed			
Name of person closing exception			