Birmingham Women's and Children's NHS Foundation Trust

Standard Operating Procedure for Damage Control Surgery for Neonates on the Paediatric Intensive Care Unit at Birmingham Children's Hospital

Applies to BWH, BCH and KIDS/NTS

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Target audience:	*PICU Team, KIDS/NTS, Anaesthetic, Paediatric Surgical and Theatre Teams*

Contents

Referral of neonate with NEC/Acute abdomen to Retrieval Service

Teleconference
Referring Consultant, Retrieval, PICU & Paed Surgeon Consultant on call and PIC NIC

Obtain history and current patient status
DCS is management of choice for sick neonates with NEC and perforation or on inotropes

DCS Unlikely
Continue normal PICU/ surgical management

DCS Likely
Add PICU Nurse in Charge into conference call (if not already)
Request local hospital to take FBC, U&E, clotting
Urgent (aim <1hr) transfer to PICU@BCH (Parent(s) to come with transport team where possible)

Actions Required - *before* arrival
- KIDS/NTS to take & label blood into BCHXmatch bottle
- PICU NIC to arrange admission into DCS capable bedspace
- PICU nurses/Tech Team arrange bedspace as DCS poster
- PICU to ICE request Xmatch & prepare form for 'DCS blood pack'
- Surgeons to liaise with Theatre Team/Anaesthetics

DCS Blood Pack
PICU medical team to inform Blood Bank of need for 'DCS blood pack':
- 1 adult RBC
- 1 Octaplas
- 1 platelets (paed unit)

Actions Required - on arrival
- take blood sample taken by KIDS/NTS for Xmatch to Blood Bank - 1st task ***before*** pt handover
- **STOP/GO** surgical/PICU assessment - clinical decision on DCS and whether PICU or theatres
- Surgeons to update Anaesthetist/Theatre staff & PIC Consultant to inform PICU Nursing Team of decision
- Theatre Team to start prepping trolley as DCS poster in theatres & be ready to come down
- PICU to assess/insert central venous/periph arterial access (insertion by senior PICU clinician)
- If difficult access PICU to discuss with Anaesthetics (Help with insertion/use NIBP?)
- Send 2nd Xmatch sample to Blood Bank
- Aim to obtain crossmatch & start of surgery within 1hr of arrival (Blood Bank to inform PICU when available)

DCS start
- Entire theatre team to be involved plus bed side nurse
- Take positions as per DCS poster
- Full WHO checklist
- Aim for surgery including anaesthetic to take < 1 hour
- Sit-reps every 10 mins (TBCS - see bed space set up poster)
- Surgeons to note KTS and finish times for audit
- Sign out and handover

Debrief
Complete in every case and consider all parts of the pathway. Record feedback for audit

Damage Control Surgery - PICU Checklist

The following checklist can be used from the point a referral has been accepted for PICU admission where DCS on PICU is considered likely.

Print off the checklist and place in patient bedspace for use by PICU Team.

Action	Person Responsible	Tick
Pre-PICU Admission		
Allocate admission to DCS compatible bedspace	PICU Nurse in Charge	
Inform of requirement for DCS bedspace set up: - relevant Team Leader/Bedside Nurse - PICU Tech Team	PICU Nurse in Charge	
Inform relevant PICU medical/ANP team of admission and generate ICE request for urgent 'DCS blood pack' 1x adult packed RBC, 1x Octaplas, 1x paediatric platelets Use L number generated by KIDS/NTS	PICU Consultant/delegate	
Print ICE request label* and attach to cross match blood form	PICU Consultant/delegate	
Inform Blood Bank of patient ETA and requirement for DCS blood pack	PICU Consultant/delegate	
Inform Blood Bank of patient ETA following KIDS/NTS update	PICU Consultant/delegate	
On Arrival to PICU *before* Patient Handover		
Ensure 1st cross match blood sample taken by the KIDS/NTS Team is placed in pre-labeled request form and immediately walked down to Blood Bank	PICU Consultant/delegate	
***After* Patient Handover**		
Assess patient with Consultant Surgeon and make DCS STOP/GO decision	PICU and Surgical Consultant	
Ensure adequate/appropriate vascular access Discuss with Anaesthetic/Surgical Teams safest & most practical options	PICU Consultant/delegate	

*if labels cannot be printed, the request form can be handwritten, but a note should be made on the form that an electronic request has been made

Summary of Requirements for Cross Match of Blood Products for DCS

CROSS MATCHING OF BLOOD PRODUCTS IS A TIME-CRITICAL STEP IN THE DCS PROCESS

Pre-PICU Admission

KIDS/NTS Consultant:

1. Request information from referring hospital
   i. Is there any maternal blood group or antibody history available?
   ii. Was the mother given prophylactic anti-D at any point during pregnancy?
   iii. Is there information available from any blood group investigations for the patient?

Any available information should be e-mailed by the referring hospital to bch-tr.Bloodbank@nhs.net

KIDS/NTS Transfer Team:

2. Take blood sample of ≥ 2mls as 1st cross match sample (pink EDTA bottle)

Hand write patient details with L number on blood bottle ***(non-hand written bottles will be rejected by the lab)***
Samples <2mls require a longer manual process; Capillary samples should be avoided as they often clot.

PICU Consultant/delegate:

3. Generate ICE request for ***URGENT*** 'DCS blood pack'
   - 1x adult packed RBC, 1x Octaplas, 1x paediatric platelets
   - use L number generated by KIDS/NTS
4. Print ICE request label* and attach to cross match blood form
5. Inform Blood Bank of patient ETA and requirement for ***URGENT*** DCS blood pack
6. Inform Blood Bank of patient ETA following KIDS/NTS update

On Arrival to PICU *before* Patient Handover

PICU Consultant/delegate:

Ensure 1st cross match blood sample taken by the KIDS/NTS Team is placed in pre-labeled request form and immediately walked down to Blood Bank

After Patient Handover

PICU Consultant/delegate:

Take EDTA blood sample of ≥ 0.5mls as 2nd cross match sample (pink EDTA bottle)

Hand write patient details with L number on blood bottle ***(non-hand written bottles will be rejected by the lab)***

Sample 1 and 2 should be taken at least 30mins apart; do *NOT* wait for the 2nd sample before sending the 1st sample

*if labels cannot be printed, the request form can be handwritten, but a note should be made on the form that an electronic request has been made

Other points to note:

- A maternal blood sample is *not* required (often difficult to validate in relation to the patient)
- Do *not* wait for blood to be cross matched at the referring hospital
- Do *not* delay patient transfer waiting for referring hospital blood products
- If blood products are transferred with patient, inform BCH Blood Bank pre-transfer and still take 1st XM sample pre-PICU arrival
- Do *not* open a blood transport box at any point, but take the sealed box directly to Blood Bank on patient arrival (if opened the products can no longer be re-issued for use at BCH)

Damage Control Surgery (DCS) Bed Space Set Up - PICU

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DCS on PICU is best viewed as part of the on-going resuscitation process - rapid source control with minimal disruption. Expected surgical time 30 minutes

Positioning:

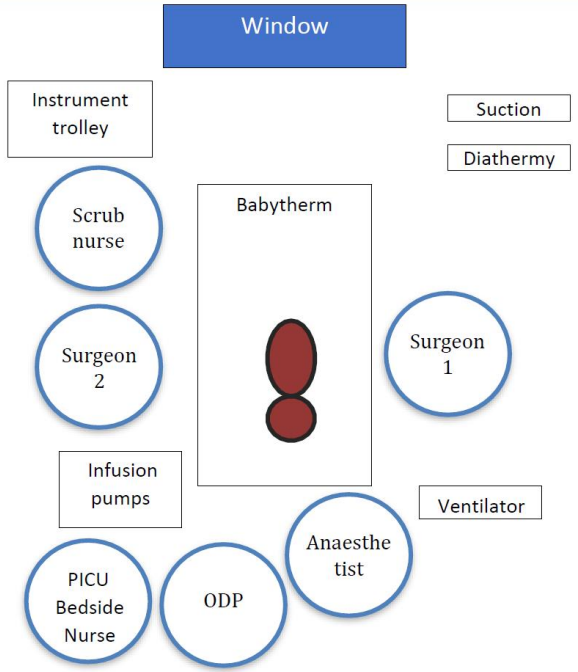
- baby on babytherm, feet towards the wall, diathermy plate on, lying on warming gel pack

Other equipment required from PICU:

- privacy screens
- line access and anaesthetic drugs as per anaesthetist
- (only Babytherm light required)

Team approach:

- theatre team, surgeon, anaesthetist *and* PICU team to participate in WHO checklist
- during DCS, sit rep **(TCBS)** every 10-15 minutes between anaesthetist/surgeon and the team



Sit Rep Structure

T
- Time
- Temperature

B
- Blood products
- Blood pressure + inotropes
- Blood gases

C
- Clotting

S
- Surgical progress

Damage Control Surgery (DCS) Bed Space Set Up - Theatres

Damage Control Surgery (DCS) Bed Space Set Up - Theatre

Birmingham Women's and Children's NHS Foundation Trust

DCS on PICU is best viewed as part of the on-going resuscitation process - rapid source control with minimal disruption. Expected surgical time 30 minutes

Positioning:

- baby on babytherm, feet towards the wall, diathermy plate on, lying on warming gel pack

Equipment required from Theatre:

- **Prep & drapes**: Aqueous betadine, low-fluid drapes, trolley base
- **Sets**: General set, extras set, small Yankauer suction, lap-theatre head torch
- **Diathermy**: Covidien Valley lab *check pedals and plates*
- **Disposables**: 15 blade, 2packs 10x10swabs, discarder pad, diathermy point and handle, spare bipolar forceps
- **Sutures**: 3.0 silk ties, 4.0 PDS, 5.0 PDS
- **Bastion Sandwich**: 500ml saline bag, Blue gauze, 8Fr feeding tube, medium Tegaderm
- **Microbiology**: blue microbiology swab

Team approach:

- during DCS, sit rep **(TCBS)** every 10-15 minutes between anaesthetist /surgeon and the team

Sit Rep Structure

T
- Time
- Temperature

B
- Blood products
- Blood pressure + inotropes
- Blood gases

C
- Clotting

S
- Surgical progress

1. Introduction

1.1 Why do DCS?

Damage control surgery (DCS) is an new innovative surgical approach adapted from the battlefield to the management of neonates with life threatening necrotising enterocolitis (NEC); it was pioneered by the Department of Surgery here at Birmingham Children's Hospital. The principle behind damage control surgery is that for patients with life threatening injuries it is essential to interrupt the cause of the problem as quickly as possible to prevent an unrecoverable deterioration in the patient's physiology. In this way, **DCS should be seen simply as one part of the ongoing resuscitation process.**

NEC predominantly affects preterm babies and in most severe cases can lead to rapid deterioration with systemic sepsis, bowel ischaemia/infarction, multi-organ failure and death. Initial treatment is with resuscitation, antibiotics and gut rest but approximately 20% of babies with evidence of NEC will continue to deteriorate and require transfer to a surgical unit for operation. Operation traditionally involves laparotomy and formation of a stoma. Despite all the advances in neonatology, intensive care and anaesthesia the mortality remains the same at 30-50%.

Damage Control Surgery for neonates with NEC takes a different approach to traditional surgery and has been shown to be an effective means of rapid 'source control', thereby breaking the cycle of deteriorating physiology. The technique is simple - open the abdomen, quickly resect any dead gut, tie off the bowel ends, drop them back into the abdomen and leave the abdomen open. The surgery only takes approximately 30-40 minutes to perform. Once the baby's physiology improves, usually after 48-72 hours, the surgeon can return to repair the remaining bowel, form a stoma if required and close the abdomen.

1.2 Why do DCS on PICU?

Many of these babies are critically unwell and unstable. They may need high ventilator settings or high frequency oscillatory ventilation (HFOV); they could be on escalating inotropic support or needing active ongoing resuscitation. Transfer of these sick new-born babies is always a high risk and there is a risk of further haemodynamic deterioration, temperature instability or displacement of lines/tubes during a transfer to theatres. Hence performing DCS on PICU mitigates the risk of additional transfer to theatres and back. Additionally, performing DCS on PICU reduces time to start of surgery by removing transfer times, thereby reducing time to 'source control'. The principle of 'aggregation of marginal gains' applies here, with any time saved to the point of achieving source control potentially making significant improvements in patient outcome - this applies to reduced retrieval time, reduced cross match time, removal of transfer times within BWC and reduced surgery times. As already noted, DCS is a quick surgery, and this can be done while the patient continues to be stabilised on PICU.

2. Purpose

For damage control surgery to be effective perhaps the most important factor is a good coordination between the multiple teams involved. This starts right from the referring unit, including transport teams, PICU, anaesthetic, surgical, theatre and blood bank teams. This SOP provides guidance for the whole DCS pathway,

from the point of the initial referral and transfer of the patient, through to the undertaking of the procedure on PICU.

It may be that on occasion, DCS is performed on PICU due to patient instability following an elapsed period of some time following admission. Although there may be common features to how such a patient is managed, this pathway is *not* intended to cover this eventuality, but rather the pathway of a new referral to PICU who is likely to require DCS in a time critical manner.

It is also accepted that there may be situations in which whilst performing DCS on PICU is the ideal, this may not be possible due to concurrent PICU workload, overall unit acuity, or other unforeseeable factors.

3. Scope

This SOP is relevant to all KIDS/NTS staff, PICU staff, paediatric surgical and anaesthetic staff, theatre teams and blood bank staff.

4. Duties

4.1 Duties within the Organisation

The Clinical Leads for Paediatric Surgery, KIDS/NTS and PICU or appointed nominees will have responsibility for dissemination, implementation and subsequent review of this document, which should occur at least every 3 years. They should also ensure that once approved and ratified, this document is accessible by Trust staff via the 'Documents' link on the Intranet.

4.2 Identification of Stakeholders

Stakeholders have been identified as those who will have major involvement in the DCS pathway and include:

a. PICU Medical Staff and Nursing Staff, including Advanced Nurse Practitioners
b. PICU Technical Team
c. Paediatric Surgeons
d. Neonatal Surgical Nursing Outreach Team
e. Anaesthetists
f. Theatre Nursing Staff
g. KIDS/NTS Medical and Nursing Staff
h. Neonatologists
i. Blood Bank Staff

5. Method for Development

5.1 Consultation and Communication with Stakeholders

The DCS pathway was developed through a multi-disciplinary team approach, which involved representatives of each of the stakeholder groups listed above. The proposed pathway was then reviewed and ratified by the individual PICU, Paediatric Surgical, Anaesthetic, KIDS/NTS, Blood Bank and Neonatal Departments.

6. Content

The DCS Pathway is summarised in the flowchart present at the beginning of this document. The following text outlines the detail of each step in the pathway, including the responsibilities which lie with each clinical team.

6.1 Initial referral and decision

The initial referral of all patients requiring PICU care at BCH are made via the KIDS/NTS team. Once it is established that the patient referred has a likely diagnosis of NEC, the KIDS/NTS Consultant should request the call operator to conference in the Paediatric Surgical Consultant on duty, the PICU consultant and PICU Nurse In Charge (NIC), along with the referring team who will be on the call.

A primary aim of the ensuing conference call discussion should be to determine if the patient is likely to require DCS. This decision should be based on the following:

a. Presence of bowel perforation
b. Requirement for Adrenaline and/or Noradrenaline at doses of ≥ 0.05microgram/kg/min, or doses below this which are escalating
c. A rising serum lactate

In addition, a decision that a patient is likely to require DCS may be based on the experienced but subjective judgements of the Consultant Surgeon/PICU/Anaesthetist in patients who may not yet fulfil these criteria, but who are felt likely to significantly deteriorate before PICU arrival.

The decision to perform DCS on PICU must also involve discussion with the PICU NIC regarding the feasibility of doing this with the PICU resources available, considering other factors such as acuity levels and concurrent unit procedures.

If the decision is made that although PICU admission is needed, DCS will likely *not* be required, then the patient can be transferred to PICU for further surgical assessment after arrival and no further action is required at this stage.

If the decision is made that DCS will likely be required, the following actions should be taken:

a. The Paediatric Surgical Consultant will inform the Anaesthetic Consultant and the Theatre Nursing Team Leader of likely DCS on PICU and give them estimated time frames for patient arrival and surgery
   - if the Anaesthetist on duty is already engaged in a case which will impact on the timing of the DCS then this should be communicated to the PICU and Surgical Teams
   - a decision can be made at this stage about the need for Theatre Nursing Team members to attend from home if not already within BCH, or whether a second Theatre Nursing Team is required, depending on other ongoing theatre activity
b. The PICU NIC will start to arrange PICU admission, including appropriate bed space allocation and informing the relevant Team Leader and the PICU Technical Team in order that the bed space can be prepared as below
c. The PICU Consultant will inform the relevant PICU medical/ANP team members of the admission and ensure Blood Bank is informed that DCS is likely to take place and provide an estimated time for receipt of an urgent blood cross match request (this action will likely be delegated to the middle grade team). The cross match request will be for a 'DCS Pack' (1 adult unit of packed red cells, 1 unit Octaplas and 1 paediatric unit of platelets)

6.2 Transfer of the patient to PICU

The KIDS/NTS team will facilitate the transfer of patient to PICU as a time-critical transfer. Transfer times will vary according to the location of the referring centre, but avoidable delays in transfer should be minimised.

Where possible, patients should be transferred with minimal intervention by the transport team at the referring centre, in order to achieve rapid arrival to PICU. This of course, needs to be balanced by achieving a level of patient stability in order to perform a safe transfer. This balance of rapid transfer versus achieving stability before transfer must be a decision made by the transport team in consultation with the KIDS/NTS duty Consultant.

The transport team, at some point during the transfer process, **before arrival to PICU**, should collect a cross match sample from the patient. This involves:

a. Ensuring a BWC L number is available from the KIDS/NTS database
b. Taking a sample of at least 2mls of blood and placing in an EDTA bottle
c. **Handwriting** the patient details, with L number, on the blood bottle

The KIDS/NTS Team do not have access to ICE label printers, so the blood bottle can only be placed in a labelled blood request form on arrival to PICU (see below).

A request should be made by the KIDS/NTS Team for any information already held by the referring hospital regarding previous blood group investigations on the patient and mother. Specifically:

i. Is there any maternal blood group or antibody history available?
ii. Was the mother given prophylactic anti-D at any point during pregnancy?
iii. Is there information available from any blood group investigations for the patient?

This information will need to be obtained by the referring clinician from the referring hospital Blood Bank. If such information is available, then the request should be made that the referring hospital team to e-mail this to bch-tr.Bloodbank@nhs.net. In this case, this is likely to speed up the cross-match process in BCH.

During patient transfer, the KIDS/NTS Team should keep both the PICU Team and the Surgical Consultant on-call informed of the patients progress and estimated arrival time (ETA). In turn the Surgical Consultant should keep the Anaesthetic and Theatre Teams updated.

6.3 Preparation of PICU

The PICU NIC should allocate an appropriate bed space for the patient and liaise with the relevant Team Leader and the PICU Technical Team in order to set it up as per the schema in Figure 1 above.
Privacy screens and the overhead surgical light will be required.
The PICU Consultant should delegate to a member of the PICU medical team the responsibility of requesting the 'DCS blood pack'. For more details of what this will involve, see 6.5.1 below.

6.4 Arrival on PICU

DCS admission processes are recognised as high intensity and time critical. Incivility has a direct impact on performance and safety and therefore, in stressful situations, respectful communication is paramount.

On arrival to PICU, the cross match blood sample taken by the KIDS/NTS Team should be immediately handed over to the PICU team. **This should be done *before* the handover of the patient.** A member of PICU team should place the sample into the prepared labelled request form and walk down this first cross match sample to Blood Bank so the urgent cross match can be started. **This is a time critical step;** any delays in taking the first cross match sample to Blood Bank will result in a delay to the start of surgery.

After the blood sample has been handed over, the Transport Team can then hand over the patient to the PICU Team. It is also ideal for a senior member of the Surgical Team to attend PICU for arrival and handover of the patient. This will reduce the time taken for repeated handovers between teams. It is though accepted that whilst this is the ideal, this may not always be feasible, if for example the surgical team are operating at this time.

The PICU Team will proceed to perform a clinical assessment of the patient and continue stabilisation and resuscitation as needed along with arranging any other investigations required. This may include further blood tests and imaging. At this point the second cross match sample (minimum 0.5mls) should be collected and the walked down to the Blood Bank. It is important to note that the delivery of the first cross match sample should *not* be delayed waiting for the second sample to be taken. If this is done, this will lead to delays in the cross match process and therefore time to start of surgery.

If not able to be present at the KIDS/NTS handover, the Surgical Team should be informed of the patient's arrival to PICU, so a senior member of the team can attend as soon as possible and assess the patient. Once this assessment has been completed, a discussion with the PICU Consultant should take place which should confirm the need for DCS or not. Following this confirmation decision, the Paediatric Surgical Team should inform the Theatre Nursing Team Leader and the Anaesthetic Consultant on call regarding the decision. If at this stage DCS is actually felt not to be required, both of these teams can stand down. The PICU Consultant should also inform the PICU NIC and the PICU Bedside Nurse of the DCS decision.

Out of hours, the seniority of the different teams required to attend at the point of patient arrival must be judged by the individual teams. The PICU Consultant on duty can make a judgement based on patient condition/stability and seniority of the current medical/ANP team to determine whether or not their presence on the unit is required. Likewise, although there is an expectation that the actual DCS surgery will be performed by the Consultant Surgeon on duty, they in turn can make the judgement regarding whether or not their presence is required to make the initial surgical assessment based on the seniority of the other surgical team members on duty at that time.

6.5 Actions required to prepare for DCS

6.5.1 Requesting of Blood Products

Blood products will be required for DCS. As already described, initially a 'DCS blood pack' should be requested which includes 1 adult unit of packed red cells, 1 unit of Octaplas and 1 paediatric unit of platelets. Further products should be as per clinical need.

It is important to note that blood product availability is a time limiting step in the DCS pathway. Therefore, all efforts should be taken to minimise delays in this part of the pathway. This will include:

a. The PICU Consultant should delegate to a member of the PICU medical team the responsibility of requesting the 'DCS blood pack'. This will involve:
    i. Electronic requesting of an urgent 'DCS blood pack' on ICE (using the L number provided by the KIDS/NTS Team)
    ii. Printing of ICE labels

iii. Ensuring the labels are placed on a cross match form ready for immediate use on patient arrival (if labels cannot be printed, the request form can be handwritten, but a note should be made on the form that an electronic request has been made)

iv. Phoning Blood Bank to ensure they are aware what blood products will be required and that the request will need to be processed urgently on receipt of the first cross match sample. An estimated patient arrival time should also be provided to Blood Bank.

b. The PICU Team should keep Blood Bank informed about the patient's ETA when this information is provided by the Transport Team

c. The first cross match sample should be taken by the Transport Team at some point before arrival to PICU. It should then be handed to the PICU Team on arrival, prior to patient handover

- a blood sample of ≥ 2mls should be taken as the 1st cross match sample (pink EDTA bottle)

- the patient details should be hand written on the bottle with the patient's L number ***(non-hand written bottles will be rejected by the lab)***
- samples <2mls can be sent, but require a longer manual process for the cross-match to be completed
- capillary samples should be avoided as they often clot, therefore reducing the sample available to preform the cross-match and again meaning a longer manual process will be required

d. A member of the PICU Team should place the blood sample into the pre-labelled request form, and then immediately walk the sample down to the Blood Bank. *If possible,* it may also be useful for a member of the PICU team to phone Blood Bank to inform them of the patient's arrival, again stating the need for the sample to be processed urgently and that the sample will be brought to them imminently.

e. The second cross match sample can then be taken after patient handover, as stabilisation of the patient continues. This should then also be walked down to Blood Bank.

- a blood sample of ≥ 0.5mls should be taken as the as 2nd cross match sample (pink EDTA bottle)

- the patient details should be hand written on the bottle with the patient's L number ***(non-hand written bottles will be rejected by the lab)***
- Sample 1 and 2 should be taken at least 30mins apart; do NOT wait for the 2nd sample before sending the 1st sample, as this will delay the cross match process

Maternal blood samples:

There is no need to get a maternal blood sample for cross match purposes, as this is most often difficult to validate in relation to the patient and will therefore not achieve any time saving.

Blood products from the referring Hospital:

The Transport Team should not wait for blood to be cross matched at the referring hospital, as this will add delays to the pathway. If blood products are already available, they can be transported with the patient *only* if they can be readied for transport within the time the patient themselves are ready for transfer.

If blood products are transferred with the patient, BCH Blood Bank should be informed that this is occurring so they can be prepared to receive and process the products. The blood transport box should not be opened at any point, but the sealed box should be taken directly to Blood Bank on patient arrival, so that the contents can be checked and re-issued with a BCH number. **If the box is opened prior to be arrival at Blood Bank, they will not be able to accept it and the products can no longer be used.**

Even if blood products are available from the referring hospital and are transferred with the patient, a cross match sample for processing at BCH should still be taken by the Transport Team and taken to Blood Bank immediately on arrival following the process above. This will ensure that if there are any problems with the products from the referring hospital, delays will be minimised.

Emergency surgery with no cross matched blood products available:

If there is a need to perform surgery emergently, a discussion should occur with the clinical teams involved and Blood Bank to assess the risks/benefits of the following options:

a. Proceed, using O negative blood if required
b. Use blood which has been group matched (this process takes ~ 30 minutes), or
c. Continue to wait for fully cross matched blood (takes between 45 to 60 minutes)

Collection of Blood Products

Blood Bank should inform PICU as soon as the products are available for collection. Packed red cells and Octaplas can be collected and placed in the PICU Blood fridge until required. A conversation between the Anaesthetist and the PICU Team should occur to determine whether the platelets are required at this time. Unless platelets are required for immediate transfusion, these should be left in Blood Bank until needed, as PICU does not own a platelet agitator.

6.5.2 Vascular access

Many of the patients requiring DCS will be preterm babies and vascular access in these group of patients is likely to be challenging. A discussion should take place between PICU, Anaesthetic and Surgical Teams regarding the safest and most practical options for vascular access required for DCS once a clinical assessment has been done.

The need for further access will be determined by:

- the presence of any existing access
- ease with which further access can be obtained
- how sick the patient is

If there is a need to place new arterial or venous lines the most experienced PICU operator should attempt this. **If the Anaesthetic Team are available, their assistance should be sought and a collaborative approach to in this aspect of stabilisation and preparation for DCS should take place.**

Venous access:

- a central line and 1 peripheral line is the most ideal access, to allow security of access and the delivery of central drugs such as inotropes during DCS
- PICC (long lines) and leaderflex lines can be considered as central lines if the tip is within a central vein
- an umbilical venous catheter (UVC) is not desirable as it may hinder the surgical approach, however if this is the only central access available and further central access cannot be achieved, a discussion should take place with the Paediatric Surgeon regarding whether it can remain in place during the surgery (if necessary, it can then be replaced post-operatively, when more time allows and the patient is more stable)
- if there is a need to place new lines the most experienced PICU operator should attempt this
- if the PICU team are unable to achieve the desired venous access, a discussion should take place with the Consultant Anaesthetist regarding whether they are able to assist in line placement

Arterial Access:

- arterial access allows accurate blood gas measurement and invasive blood pressure monitoring and so is ideal for DCS
- if there is a need to place new arterial access the most experienced PICU operator should attempt this
- however, if arterial access cannot be achieved, non-invasive blood pressure may be done, along with venous or capillary blood gas measurement

- as with UVCs, umbilical arterial catheters (UACs) lines may also hinder the surgical approach, but if a UAC is in place and other arterial access cannot be achieved, a discussion should take place with the Paediatric Surgeon regarding whether it can remain in place during the surgery (if necessary, it can then be replaced post-operatively, when more time allows and the patient is more stable)
- **it is important to note that in neonates, particularly those < 2.5kg, there are significant risks associated with the placement of arterial lines**
- ischaemic injuries in this patient population are more common due to their size, particularly when combined with poor perfusion due to severe illness
- any potential benefits of having arterial access for DCS should be weighed up with the potential risks of severe ischaemic injury, which may include digit, partial of even compete limb loss
- in this situation, the decision to insert peripheral or central arterial access should be made jointly by the PICU and anaesthetic consultants, and the parents/carers must be informed of the potential risks *before* any such line is placed

6.5.3 Equipment and bed space preparation

As noted above, when a patient is referred to PICU who is likely to need DCS, they should be allocated to a bed space (by the PICU NIC) where this can readily take place. Some bed spaces on PICU are not of a sufficient size to allow DCS to take place there safely. It may be that existing PICU patients need to be moved within the unit to allow the DCS patient to be admitted to a bed space in which the operation can be performed safely. It is for this reason that the PICU NIC should be part of the initial referral conference call, so that when a decision is made to perform DCS on PICU, the appropriate admission preparations can be made in a timely manner.

The bed space should be set up in a manner that will allow DCS to take place most easily from both a surgical and anaesthetic perspective. The diagram on p6-7 shows how this should be done. The PICU Technical Team should be involved in this set up process in order that this can be achieved in a timely manner, before patient arrival.

During DCS itself, particular attention should be paid to patient's temperature and this should be continuously monitored and maintained to normothermia. An appropriate trolley/neonatal cot should be used for the surgery along with trans-warmer or similar device to maintain the baby's temperature. Blood products should be administered via a blood warmer.

6.5.4 DCS Surgery

The theatre WHO Safer Surgical Checklist should be used prior to and after the DCS.

The Consultant Anaesthetist should lead patient care during the surgery, following handover of care from the PICU Team. If a patient is on high frequency oscillator ventilation (HFOV), input from the PICU Medical Team and the PICU Technical Team (if available) may be needed for ventilation management during the surgery.

The PICU Medical Team should also attend the WHO Time Out so they have an awareness of the details of the surgical and anaesthetic plan and can then also determine if they are required to provide any assistance during the surgery itself.

Choice and timing of antibiotics will be as per discussion with the Surgical Consultant and if needed advice should be sought from duty Microbiologist.

Role of PICU Bedside Nurse during surgery

The theatre team should aim to be as self-sufficient as possible during the DCS procedure, but it is likely that the PICU bedside nurse will be needed to provide vital support to the Theatre Team and the Anaesthetist during the this time. This may include:

- support with procurement of anaesthetic drugs/fluids, blood products and basic equipment such as needles, syringes and giving sets
- procurement/preparation of any emergency drugs
- ensuring adequate amounts remain of any ongoing infusions, such that they don't run out during the procedure
- blood gas sampling and analysis - it is ideal for the bed side nurse to delegate the analysis of blood gas samples to another member of the PICU team, so they can remain in the bed space to support the DCS team
- 'support requester' - the bed side nurse has an important role during DCS of someone who knows where to find things and who to call for support

Documentation

Documentation is essential and should include the decision-making process, the discussion which occur between the various teams involved, patient examination, any practical procedures performed and any discussions with parents/carers. Full documentation of the surgery and anaesthesia should be made on the appropriate BWC paperwork.

DCS Completion and WHO Sign Out

Once surgery is completed, the WHO Sign Out should take place, again following the theatre WHO Safer Surgical Checklist. This should involve all staff who have had a role in the procedure, surgical, anaesthetic, theatre and PICU staff (medical and nursing).

Handover back to PICU

Following completion of the DCS procedure and the WHO Sign Out, handover of patient care from the Anaesthetic Team, back to the PICU Team (medical and nursing) should take place. A suggested format is for an anaesthetic handover first, followed by a surgical handover and then theatre nursing handover. Opportunities to ask questions and clarify on-going management plans should be included in this process.

6.5.5 Debrief

Following completion of DCS, WHO Sign Out and handover of care back to the PICU Team, opportunity should be made for a formal Debrief. This should follow the format as laid out in the *'BCH Local Safety Standards for Invasive Procedures (LocSSIP) WHO CHECKLIST: 5 Steps to Safer Surgery'*

file:///U:/Downloads/locssip_who_checklist_5_steps_to_safer_surgery_2019.pdf

This should ideally involve all staff who have had a role in the procedure, surgical, anaesthetic, theatre and PICU staff (medical and nursing). The post-procedure time period is usually very demanding on the PICU Bedside Nurse, so support should be provided by the PICU Team Leader to allow the PICU Bedside nurse to attend the debrief.

7. Education & Training Requirements

This SOP has been produced with wide consultation involving PICU, KIDS/NTS, Surgical, Anaesthetic and Theatre Teams.

Further training requirements are minimal as procedure is largely already in use. Points of change from existing practice have been highlighted to senior staff who will manage the process:

- PICU Band 7, Team Leaders and Consultants and the KIDS/NTS Teams have been made aware of this SOP and their roles in the patient pathway
- Surgical Consultant Team and Anaesthetic Teams - no specific training required
- Theatre Team have been made aware of the SOP/patient pathway

8. Process for Monitoring Compliance and Effectiveness

This SOP forms the basis of a Quality Improvement project for neonates with severe NEC. Data collection was started before the pathway launch and will continue afterwards. Analysis of this data will enable further changes to the patient pathway as required.

9. References

Damage Control Surgery in Neonates: lessons learned from the battlefield. GS Arul, M Singh, A Ali Mohammed, O Gee (2019). *Journal of Pediatric Surgery. 54;2069-274*