Major Haemorrhage Protocol for Paediatric Patients (MHPPP)

TARGET AUDIENCE	All Acute Hospital clinical staff (board-wide) involved in managing Major Haemorrhage.
PATIENT GROUP	Infants and children from the 29th day of life; who have not yet reached their 16th birthday.

Quick Reference: Summary Flowchart.

- Generic, summary flowchart is shown for quick reference.
- Additional site-specific information is shown alongside the flowchart, in poster format within Appendix 2.

Clinical Picture Compatible with Massive Blood Loss
OR
20% of Blood Volume lost in < 1 hour
OR
50% of Blood Volume lost in <3 hours

Less than 1 year (infant) blood volume: **90ml/kg**
1 year - 15 years (child) blood volume: **80ml/kg**

↓

Declare **Paediatric Major Haemorrhage**

· **Call 2222**
· **State "Paediatric Major Haemorrhage"** and **patient location**, switchboard will repeat back.

· Designate **Resuscitation Team Leader**
· Designate **Paediatric Major Haemorrhage Co-Ordinator**
· Issue Resuscitation Team Leader and Paediatric Major Haemorrhage Co-ordinator **Action Cards**

↓

Simultaneously (Delegate / Allocate)

· Consider **O-Negative Packed Red Cells: 20 ml / kg**
Available for immediate release from blood transfusion lab.

· Continue **Packed Red Cells (PRCs)** as required: **20 ml / kg** aliquots
- **O-Negative PRCs** if ongoing immediate need.
- Then use **Group Specific PRCs** *(approx. 15 minutes to issue)*
- Aim for **Fully Cross-Matched PRCs** *(approx. 35 minutes to issue)*

· **Fresh Frozen Plasma** (FFP): **20 ml / kg** *(approx. 30 minutes to issue)*
· **Platelets:** **15 - 20 ml / kg** *(order early - may have to come from another site)*
· **Cryoprecipitate:** **5ml/kg** *(approx. 30 minutes to issue)*

Consider if **2:1:1** or **1:1:1 product ratios** required.

· **Control bleeding**
Direct compression, splinting, surgical control and/or interventional radiology.

· **Keep patient warm**
Remove wet / blood-soaked clothes, use air warming blanket, warmed fluids, warmed blood)

· **Obtain Intravenous (IV) and/or Intraosseous (IO) access.**
Maximum of 2 attempts at IV before proceeding to IO

· Send **Cross-match, FBC, U&E, Calcium** and **Coag Screen**.

· Give **Tranexamic Acid**:
Loading dose 15 mg / kg (max 1 gram) over 15 minutes.
Then infusion of 2 mg / kg / hr (max 125 mg / hr) for 8 hours.

· Consider **IV Calcium** if ionised Ca^{2+} < 1.0 mmol/L
Calcium Gluconate 10%: 0.5 ml / kg (maximum 20ml) over 10 mins

Quick Reference: Product Volumes and Laboratory Values.

The standard aliquots to be rapidly infused (aiming ≤ 15 mins), alongside repeated clinical assessments are:

Component	Volume
Packed Red Cells (PRCs)	**20ml/kg** *(maximum of 4 adult units in any single aliquot)*
Fresh Frozen Plasma (FFP)	**20ml/kg** *(maximum 4 adult units in any single aliquot)*
Platelets	**15-20ml/kg** *(maximum 1 adult pool / 4 adult units in any single aliquot)*
Cryoprecipitate (Cryo)	**10ml/kg** *(maximum 2 pools in any single aliquot)*

STANDARD ALIQUOTS SHOULD BE REPEATED IF ONGOING HAEMODYNAMIC INSTABILITY OR EVIDENCE OF CONTINUING MAJOR BLEEDING

Transfusion should be continued or aliquots repeated as required to achieve:

Parameter	Target Value
Haemoglobin (Hb)	**> 80 g/L**
Platelets (Plt)	**> 75 x 10^9/L** and **> 100 x 10^9/L** if: major trauma or head injury or taking anti-platelet agents.
Fibrinogen (Fib)	**> 1.5 g/L** and **> 2.0 g/L** if: major trauma or head injury
PT	< 1.5x midpoint of normal. (in NHSL this corresponds to **< 17 seconds**)
APTT	< 1.5x midpoint of normal. (in NHSL this corresponds to **< 41 seconds**)

Contents

NHS LANARKSHIRE

Major Haemorrhage Protocol for Paediatric Patients (MHPPP)

1. Introduction to the Major Haemorrhage Protocol for Paediatric Patients

This Major Haemorrhage Protocol for Paediatric Patients (MHPPP) will give guidance for clinical staff involved in managing Major Haemorrhage (as defined in Section 1.3, page 2) affecting infants and children from the 29th day of life who have not yet reached their 16th birthday (see: Target Population, Section 1.2, below).

Management of Neonatal or Adult Major Haemorrhage patients is not within the scope of this document.

- Neonatal patients (up to and including the 28th day of life) should be managed within their own specialised group under consultant care.
- Separate NHSL documents exist covering the management of adult (age 16 and above) both maternity [1] and non-maternity [2] patients experiencing Major Haemorrhage.
  These documents are available via FirstPort, the NHSL Guidelines website (https://rightdecisions.scot.nhs.uk/nhsl-guidelines) and the NHSL Guidelines app.

This document includes activation instructions, communication plans, administrative information and clinical guidance to achieve the optimal care for patients.

All staff who may be involved in the care of children experiencing major haemorrhage should be familiar with the content of this document and have read it in a non-clinical setting:

This document should not be being read for the first time during a live Major Haemorrhage response.

[Continues Overleaf]

For staff familiar with the content of the MHPPP document, **the MHPPP Quick Reference Documents (Appendices 10.1.1 – 10.2.2) are provided *for clinical use during a Major Haemorrhage response.***

For each NHSL acute hospital site, three quick-reference documents are provided:

- One overview poster (Appendix 10.1) for the MHPPP principal logistical and organisational actions.
  - This should be printed A2 size and displayed in the relevant clinical areas.
  - **There are three versions of this document – each specific to a given acute hospital site (Appendices 10.1.1 – 10.1.3).**
    Care should be taken to ensure that the correct poster is used.

- Two Action Cards (Appendix 10.2), covering the immediate clinical response to Paediatric Major Haemorrhage, comprising:
  - **Clinical Team Leader Action Card** - covering management principles of Paediatric Major Haemorrhage and listing the standard doses of blood components (Appendix 10.2.1).
  - **Major Haemorrhage Co-ordinator Action Card** – covering direct clinical support and for the Clinical Team Leader and logistical actions required in the immediate Paediatric Major Haemorrhage Response.

    As the clinical principles should be the same across all sites, these Action Cards have single versions for use across all of NHSL.

The Posters and Action Cards are provided in Appendix 10 of this document for reference. Full-size, high-resolution versions are available as PDFs for printing at A2 size for posters, A5 and A6 double-sided format for Action cards - via the MHPPP folder in the Blood Transfusion section of FirstPort (FirstPort > Staff Support > Laboratories > Blood Transfusion).

MHPPP posters *(Note site-specific nature of MHPPP posters)*,
and action cards should be made easily available in all relevant clinical areas.

1.1 Objectives

1. Allow rapid and co-ordinated response to major haemorrhage affecting infants and children.
2. Open and maintain an effective channel of communication between clinicians / clinical areas and Blood Bank.
3. Provide rapid, appropriate and effective delivery of blood components for paediatric patients experiencing major haemorrhage.

1.2 Target Population

- Infants and children from the 29th day of life who have not yet reached their 16th birthday (i.e. immediately following the neonatal period and including those still aged 15 years).
- Attending or inpatient at any / all NHSL acute hospital(s).

1.3 Definition of Paediatric Major Haemorrhage

Children's blood volumes vary according to size / weight [3,4]. Given their overall smaller size, children therefore generally have a smaller circulating blood volume than adults and, logically, any specific volume of blood lost represents a correspondingly greater proportion of a child's circulation than of an average adult's [3] – making timely identification of Major Haemorrhage an imperative. This is complicated by less clear scoring strategies and differing physiological response [5] to major blood loss (including late clinical manifestations or "decompensation") in paediatric, compared to adult, patients.

Categorising Major Haemorrhage in paediatric patients therefore requires consideration of both subjective and objective elements. Early senior clinician involvement is critical in identifying bleeding problems requiring transfusion support and should be considered a management priority.

Subjective definition of Paediatric Major Haemorrhage:

Clinician triggered due to either:

- Clinical picture / presentation compatible with massive blood loss.
- Clinical concern that patient is experiencing severe bleeding problems requiring immediate support with multiple transfusion components.

Objective definition of Paediatric Major Haemorrhage:

Based on estimated Total Blood Volume (TBV) [3,4] of:

Infant (< 1 year old):**90 ml / kg**

Child (≥ 1 year old): **80 ml / kg**

Paediatric Major Haemorrhage can be objectively defined as:

Rate of blood loss OR rate of blood transfusion required to maintain haemodynamic stability

≥ 3 ml / kg / minute

(~ 5% TBV per minute, leading to rapid exsanguination) [6]

OR

Total estimated blood loss OR volume of blood transfusion

≥ 15 ml / kg in < 1 hour

(approx. 20% TBV loss in <1 hour) [7]

OR

Estimated 50% of Total Blood Volume lost in < 3 hours

(whether it has been replaced or not)

OR

40 ml/kg PRCs transfused in < 3 hours

(i.e. replacement of half of a child's blood volume) [3]

1.4 Trigger for Major Haemorrhage Protocol for Paediatric Patients activation

A clinician determines that a patient fulfils any of the above subjective or objective criteria.

1.5 Roles and Responsibilities

It is imperative that everyone involved in the management of paediatric major haemorrhage is aware of their role and responsibilities.

It is the responsibility of any registered healthcare practitioner, in line with their professional body's requirements, to ensure they do not participate in any part of the process for which they have not been trained or may not be competent

Clinical Team Leader / Clinical Staff

- Identify when MHPPP activation is required (as Sections 1.3 & 1.4, above).
- Trigger MHPPP as per protocol (see site-specific actions, Appendices 9.1.1 – 9.1.3).
- Identify and assign role of Paediatric Major Haemorrhage Co-ordinator - responsible for communication (essential role for every Paediatric Major Haemorrhage).
- Be aware of NHS Lanarkshire MHPPP and other applicable local protocols.

[Continues Overleaf]

Paediatric Major Haemorrhage Co-ordinator

- Activate the MHPPP if not already done by the Clinical Team Leader / Clinical Staff.
- Act as the main point of contact between the treating clinical team and the haematological / transfusion services.
- Ensure clear communication between the labs and clinical area. Where possible, identify a single contact telephone number (DECT preferred) and keep line free for MHPPP communication.
- Ensure adequate staff available and delegate other staff roles.
- Liaise with on-call Haematologist to provide clinical information as near to real-time as possible.
- After discussion with on-call Haematologist (which may be undertaken by the Clinical Team Leader), contact Blood Bank to request nature and number of blood components required, and state level of urgency.
- Arrange initial blood tests and ensure adequate labelling – including hand-written patient details on transfusion samples.
- Check for laboratory results and co-ordinate further testing as required by the clinical team.
- Ensure an accurate log of events is kept (the actual writing can be assigned to a scribe).
- Ensure blood components are either used or returned to Blood Bank to prevent unnecessary waste.
- Ensure traceability of all blood components (i.e. complete “Blue Tags” and return to Blood Bank or inform if unit not used so it can be returned to the cold-chain).
- Hand over role of Paediatric Major Haemorrhage Co-ordinator to a specific, named person if patient is moving to another clinical area with MHPPP ongoing.
- Notify labs, switchboard and blood porter when emergency is over (stand down MHPPP).

Blood Bank

- Respond to the MHPPP activation immediately, with MHPPP becoming priority of work.
- Make contact with the clinical area and identify the blood transfusion needs. Where possible, this should be via a single contact telephone number (DECT preferred) to the Paediatric Major Haemorrhage Co-ordinator (see: “Paediatric Major Haemorrhage Co-ordinator" section, previous page).
- Supply blood and blood components as required in line with MHPPP.
- Direct the designated porter for transport of blood components.

Switchboard

- Trigger the MHPPP page cascade. State ward / clinical area and contact number.

Porters

- Designated porter to attend Blood Bank for transport of blood components and then await further instruction.

2. Activating the Major Haemorrhage Protocol for Paediatric Patients

2.1 How to activate the Major Haemorrhage Protocol for Paediatric Patients response:

All NHSL Hospital Sites:

Phone **2222**

and state:

"Activate Major Haemorrhage Protocol for Paediatric Patients"

the switchboard operator will then ask you to provide:

Patient Location

Contact Extension Number

N.B. where possible this should be the single direct contact telephone number (DECT preferred) to the assigned Paediatric Major Haemorrhage Co-ordinator (see page 6).

This triggers "speech bleep" / "fast bleep" pager alerts to:

- **Blood bank**
- **Paediatrics** (UHW only)
- **ITU/Anaesthesia**
- **General Surgery**
- **Porters**
- **HECT** (at night)

2.2 General Clinical Response Measures

The measures suggested in this document are broad in their scope and relate to the co-ordinated provision of blood components as one facet of the resuscitative measures mitigate the effects of significant loss of circulating volume.

Blood components administration should be in parallel with measures to control bleeding from its source - they are not a substitute for primary haemorrhage control.

- **Control Bleeding**
  - Haemorrhage control measures may include, but are not limited to:
    - Direct external compression of the bleeding site.
    - Use of advanced haemostatic dressings (e.g. Celox).
    - Arterial tourniquet application (e.g. Combat Application Tourniquet).
    - Surgical intervention.
    - Endoscopic procedures.
    - Interventional Radiology procedures.
  - **It is beyond the remit of this document to provide any more detailed or specific recommendations with regard to these interventions. Suitably senior clinical assessment, decision making and management should be implemented as relates to the specific clinical presentation and its optimal management strategy.**

- **Gain optimal venous access.**
  - **Where this has not been achieved after two attempts, strong consideration should be given to obtaining intraosseous (IO) access.**

- **Avoid hypothermia**
  - Use warmed fluids / blood (e.g. Ranger Blood Warmer, Belmont Rapid Infuser).
  - Wrap / cover child to avoid exposure / heat loss to environment.
  - Consider use of warm forced-air blanket (e.g. “Bair Hugger”).

- **Take appropriate blood tests and send urgent laboratory requests**
  (see section 2.3, overleaf).

2.3 Immediate Blood Tests

- **Emergency Cross-match**
  - Where possible, two samples should be obtained by separate persons in accordance with the two-sample policy for blood transfusion / cross-matching. However, **this must not delay the administration of emergency blood products.**
  - ***N.B. Bottles must be hand-written only***

- **Full Blood Count (FBC)**

- **Coagulation Screen**

- **Calcium** (to be requested as part of routine Biochemistry investigations)

- **Blood Gases** (Venous acceptable at initial assessment)

- Other immediately required tests, at discretion of Clinical Team Leader, to be requested via Paediatric Major Haemorrhage Co-ordinator (see: “Paediatric Major Haemorrhage Co-ordinator", page 5).

2.4 Information Required by Blood Bank

After activation of the MHPPP as per Section 2.1 (page 7), Blood Bank will contact the treating clinical team via the provided extension number in order to ascertain:

- **Urgency of the situation.**
- **Patient location.**
- **Patient details** (minimum data set):
  - ***Conscious / capable patient***:
    - Name
    - DOB
    - Gender
    - CHI Number (or other unique identifier e.g. Temporary CHI, Major Incident ID)
  - ***Unconscious / unidentified / incapacitated patient***:
    - Gender
    - Unique patient identifier (Temporary CHI, Major Incident ID etc.)

- **Designated clinical contact person**
  - Generally this should be the assigned Paediatric Major Haemorrhage Co-ordinator (as section 1.4)
- **Contact telephone number**
  - Where possible, this should be a single direct telephone line (DECT preferred) to the Paediatric Major Haemorrhage Co-ordinator which can be kept free for the primary purpose of communication with Blood Bank.
- **Patient diagnosis** (if known) and **estimated blood loss**.
- **Likelihood of transfer of patient, and likely destination**
  - Whether another clinical area (e.g. ITU / Theatre / Endoscopy) or off-site (e.g. to Major Trauma Centre).

- **Confirm which samples have already been obtained / sent to the lab**

  e.g. Pre-Transfusion Cross-Match, FBC

- **Number and nature of blood components immediately required**.

3. Blood Component Support for Initial Treatment / Resuscitation

3.1 Recommended initial blood component treatment in Paediatric Major Haemorrhage

As described in Section 1.3, children's circulating volumes are factors of their size / weight. The potential range of sizes / weights is significant, ranging from small babies to adult-sized.

All blood components therefore should **always** be prescribed in millilitres (ml) rather than Units (as would be done for adults) to avoid volume errors. [8]

Correspondingly, appropriate infusion pumps with a Volume To Be Infused (VTBI) function should be used to ensure that the volume delivered corresponds to the volume prescribed.

Children weighing greater than approximately 50kg are at risk of volume overload from solely ml / kg dosing and reference should therefore be made to the ***maximum adult unit equivalent in any single aliquot (see table below).***

This applies to each aliquot given; not to the total volume given. The total volume of each product will, correctly, exceed this single-aliquot value when multiple / repeated aliquots are given in the context of ongoing haemodynamic instability or continuing major bleeding.

The standard aliquots to be rapidly infused (aiming ≤ 15 mins) alongside repeated clinical assessments are:

Component	Volume
Packed Red Cells (PRCs)	**20ml/kg** *(maximum of 4 Adult Units in any single aliquot)*
Fresh Frozen Plasma (FFP)	**20ml/kg** *(maximum 4 adult units in any single aliquot)*
Platelets	**15-20ml/kg** *(maximum 1 adult pool / 4 adult units in any single aliquot)*
Cryoprecipitate (Cryo)	**10ml/kg** *(maximum 2 pools in any single aliquot)*

STANDARD ALIQOUTS SHOULD BE REPEATED IF ONGOING HAEMODYNAMIC INSTABILITY OR CONCERN FOR CONTINUING MAJOR BLEEDING

3.2 Target Laboratory Values

Transfusion should be continued or aliquots repeated as required to achieve: [8]

Parameter	Target Value
Haemoglobin (Hb)	**> 80 g/L**
Platelets (Plt)	**> 75 x 10^9/L** and **> 100 x 10^9/L** if major trauma or head injury or taking anti-platelet agents.
Fibrinogen (Fib)	**> 1.5 g/L** **> 2.0 g/L** if major trauma or head injury
PT	< 1.5x midpoint of normal. (in NHSL this corresponds to **< 17 seconds**)
APTT	< 1.5x midpoint of normal. (in NHSL this corresponds to **< 41 seconds**)

Children generally have better mechanisms of physiological compensation and better tissue oxygen delivery compared to adults.

There may be select, specific clinical circumstances where, in the context of clinical stability, acceptable biochemical / acid-base markers and on the decision of senior clinicians from multiple specialties including Haematology and Paediatrics, it may be appropriate to discontinue blood component transfusion before the above targets have been achieved.

Where repeated aliquots or significant ongoing transfusion rates are required, clinicians should remain vigilant for developing signs of fluid overload.

3.3 Blood Component Availability, Dosing and Supporting Information

Packed Red Cells (PRCs)

PRCs are necessary to maintain sufficient circulating volume and haemoglobin capable of oxygen delivery to the patient's tissues.

PRCs are stored as liquid at a cooled temperature and are readily available for use on all three acute sites.

PRCs should be used to maintain a target Haemoglobin (Hb) > 80 g/L

The recommended dose in children is 20ml/kg

N.B. The maximum volume to be administered in a single aliquot is 4 adult units – this corresponds approximately to a body weight of 50 kg.

Further aliquots can be administered if required after reassessment of the clinical need for ongoing transfusion.

There are three levels of 'matching' of PRCs. The most rapidly available components are, while still safe, the least well-matched to the patient's own blood.

- **Emergency Group O Negative ("O Neg")**
  - Immediately available from each of the three blood bank fridges or from satellite emergency blood fridges (e.g. Maternity Blood Fridge at University Hospital Wishaw).

- **Group Specific**
  - Available from blood bank once the patient's blood group is known.
  - Units compatible to the patient's ABO group are selected but not fully cross-matched for other parameters.
  - Typically available in approximately 15 minutes.

- **Fully Cross-Matched**
  - Available from blood bank once the patient's blood group is known and further compatibility testing between a selected unit and patient's own plasma has been performed.
  - Typically available in approximately 45 minutes but may be significantly longer if the patient has red cell antibodies.

Treating clinical teams should aim to administer better matched blood components as the resuscitation continues and either Group Specific or Fully Cross-Matched components become available.

The role of the Paediatric Major Haemorrhage Co-ordinator is vital in communicating and liaising between the clinical team and Blood Bank to ascertain the most appropriate component with respect to the urgency of transfusion vs the real-time availability of better-matched components.

The number of PRC units requested is dependent on the rate and volume of blood loss observed in conjunction with clinical observations and, if time allows, laboratory parameters. Typically, 4-6 units of PRCs are requested initially with further requests of 2-4 units at a time dependent on on-going blood volume loss (**Note:** Section 3.1 RE: Administration of Blood Components by millilitre volume).

Packed Red Cell units are red cells suspended in SAG-M (Saline, Adenine, Glucose, Mannitol). These units contain almost no plasma or platelets and are considered deficient for the purposes of replacing these components.

Fresh Frozen Plasma (FFP)

FFP is used to empirically replace clotting factors lost through haemorrhage and/or correct established coagulopathy.

Units are stored frozen and require up to 30 minutes to issue.

FFP should be used to maintain both PT ratio and APTT ratio < 1.5

The recommended replacement dose in children is 20ml/kg

(see also: Section 3.3 Empirical component administration, and component ratios. Page 18)

N.B. The maximum volume to be administered in any single aliquot is 4 adult units – this corresponds approximately to a body weight of 50 kg.

A unit of FFP typically contains around 275mls. An appropriate number of units should be requested depending on the required volume for a particular child.

(**Note:** See also: Section 3.1 RE: Administration of Blood Components by millilitre volume).

Platelets

Used to replace platelets lost through haemorrhage and/or correct an established thrombocytopenia (including through platelet consumption) and/or platelet dysfunction.

They are stored in a liquid state at room temperature and no additional preparation is required.

Platelets should be used to maintain platelet count > 75 x 10^9/L

and

> 100 x 10^9/L for major trauma, head injury or patients taking anti-platelet agents

The recommended replacement dose in children is 15 – 20 ml/kg

(see also: Section 3.3 Empirical component administration, and component ratios. Page 18)

N.B. The maximum volume to be administered in any single aliquot is one adult pool or 4 adult units – this corresponds approximately to a body weight of 50 kg.

Typically, platelets are provided in one pool of approximately 300ml (corresponding to 4 adult units). An appropriate number of pools should be requested commensurate with the required platelet dose for a particular child.

One dose (15 – 20 ml / kg) would be expected to generate an increase in the patient's platelet count of approximately 5 - 10 x 10^9/L.

N.B - Additional platelet pools may need to delivered from SNBTS Edinburgh or Glasgow by emergency courier.

Cryoprecipitate

An adjunctive blood component principally to replace low fibrinogen levels. Large volumes of FFP will often adequately replace fibrinogen levels on their own; however, if the fibrinogen level is deemed particularly low or has failed to improve adequately with FFP then Cryoprecipitate is a good source of fibrinogen replacement.

Cryoprecipitate is also stored frozen and will require up to 40 minutes to thaw.

Cryoprecipitate should be used to maintain Fibrinogen > 1.5g/L

and

> 2g/L for major trauma or head injury

The recommended replacement dose in children is 10ml/kg

N.B. The maximum volume to be administered in any single aliquot is 2 adult pools – this corresponds approximately to a body weight of 50 kg.

Note: Availability of additional blood components:

- Additional blood components including FFP, platelets and cryoprecipitate are available on request at all three acute sites.
- FFP and cryoprecipitate are stored in a frozen state and require to be thawed prior to use (minimum 30 minutes).
- Platelets are frequently held as stock on all three sites however it may be necessary for them to be delivered urgently from SNBTS by emergency courier.

3.4 Empirical component administration, and component ratios

It is acknowledged that in some situations the rate of haemorrhage and the dynamic progression of clinical pathologies can be sufficiently rapid that by the time laboratory coagulation test results are available, they are no longer representative of the patient's current condition.

In these circumstances the use of additional components should be empirical and judicious based on volume of blood lost, volume of PRCs anticipated to be used and the anticipated time to achieving haemorrhage control. [9]

The PROPPR Trial [10] showed improved mortality for patients treated with 1:1:1 PRC:FFP:Plt ratio compared to those treated with 2:1:1. However, this trial did not include children and the efficacy of a 1:1:1 ratio has not been specifically proven in children.[9] In line with published adult guidance, however, the use of a 1:1:1 ratio in the MHPPP is targeted towards paediatric patients with a high risk of early coagulopathy (most likely major trauma).

- In patients with a **low risk of early coagulopathy** (e.g. GI bleeding, most surgical / orthopaedic intra-operative bleeding), empirical component administration for paediatric patients should generally be given in the ratio:

  Two Aliquots PRCs : One Aliquot FFP : One Aliquot Platelets

  (2:1:1)

  *(e.g. a 30kg child who receives approx. 600ml PRCs (**two** 10ml/kg aliquots) to restore circulating volume should also receive 300ml FFP (**one** 10ml/kg aliquot) and 300ml Platelets (**one** 10ml/kg aliquot) if using a 2:1:1 ratio (as 600:300:300 ratio = **2:1:1**).*

- Where there is large volume blood loss with a **high risk of early coagulopathy** (e.g. Major Trauma) in paediatric patients, strong consideration should be given to empirical blood component administration in the ratio:

  One Units PRCs : One Unit FFP : One Unit Platelets

  (1:1:1)

  *(e.g. a 30kg child who receives approx. 600ml PRCs (**two** 10ml/kg aliquots) to restore circulating volume should also receive 600ml FFP (**two** 10ml/kg aliquots) and 600ml platelets (**two** 10ml/kg aliquots) if using a 1:1:1 ratio (as 600:600:600 ratio = 2:2:2 = **1:1:1**).*

3.5 Special requirements in the setting of Paediatric Major Haemorrhage.

Paediatric patients should ideally receive blood with appropriate special requirements (e.g. CMV-Negative if < 1 year old. Irradiated Blood etc.), but only if these are readily available as the patient clearly must not incur an excessive delay in transfusion that could lead to morbidity and mortality in a major haemorrhage situation simply waiting for blood fulfilling special requirements to become available.

In the setting of Paediatric Major Haemorrhage, delaying transfusion to await delivery of Special Requirement blood from a regional SNBTS Centre is likely to be inappropriate.

3.6 Bleeding Disorders

Patients with a known bleeding disorder (e.g. Haemophilia or von Willebrands) - whether inherited or acquired – who present with bleeding or trauma (even minor trauma in those with severe Haemophilia) will often require urgent haemostatic treatment (e.g. coagulation factor infusion).

Patients with any bleeding disorder who are registered with the West of Scotland Haemophilia Centre (Adult Centre at GRI and Paediatric Centre at RHC) should carry an NHS-issued card stating their diagnosis, baseline factor level and usual treatment component.

Clinical advice should be sought from the Haemophilia Centre at GRI (Mon-Fri, 8:30am – 4:30pm), or if out of hours, the on-call Haematologist at GRI. In the context of a Paediatric Major Haemorrhage, this liaison should be undertaken by the NHSL Haematologist on-call following discussion with the MHPPP Co-ordinator or the Clinical Team Leader.

Useful Contacts at Glasgow Royal Infirmary:		
Haemophilia Centre	0141 211 4840	*Mon-Fri. 0830-1630.*
Haematology Registrar	0141 211 4000 Page 13733	*Mon-Fri. 0900-1700*
Haematology Registrar on-call	via GRI switchboard 0141 211 4000	*Out of hours.*

All hospitals within the Greater Glasgow and Clyde Health Board can find summary details of the patient's bleeding disorder and their preferred treatment on Clinical Portal, under 'Care Plan - MDT plan' - this is also available to most hospitals in the West of Scotland via the **Regional Portal** link on the patient's NHSL Clinical Portal pages .

4. Additional Interventions

- **Tranexamic Acid (TXA)**
  - The CRASH-2 study reported a reduction in mortality for patients with haemodynamic instability as a result of **trauma** who were given Tranexamic Acid (TXA) according to the following protocol within 3 hours of injury.
  - TXA for this indication is recommended by the Royal College of Paediatrics and Child Health. [11, 12, 13, 14]

The loading dose of Tranexamic Acid for children is 15mg/kg (maximum 1g) diluted in a convenient volume of Sodium Chloride 0.9% or Glucose 5% and infused / injected intravenously over 10 minutes.

Followed by continuous intravenous infusion
of 2mg/kg/hr (maximum 125mg/hr)
for a minimum of 8 hours
or longer if bleeding continues.
(to maximum infused dose of 1g. Ignore loading dose in this calculation**).**

[Continues overleaf]

- **Calcium (as Calcium Gluconate 10%)**
  - Calcium is an essential physiological electrolyte and has important functions within the coagulation cascade.[15]
  - Though frequently cited as caused by chelation due to citrate preservative in PRCs, this is rare in previously healthy children whose rapid hepatic metabolism clears the citrate before it significantly affects serum calcium levels.[16]
  - The association of hypocalcaemia with major trauma and massive transfusion, and its corresponding correlation with poorer outcomes is recognized; [17] [18] but more recent studies have also noted a similar association with *hyper*calcaemia.[19] Whether this relates to the biochemical effect of elevated calcium levels or is a confounding factor of more severe injury / tissue damage is unclear.
  - It is therefore considered that empirical calcium replacement in children **is not currently recommended for the sole indication of major haemorrhage / massive transfusion.**
  - Recognizing the potential for hypocalcaemia associated with major trauma and massive transfusion, measurement of serum calcium should be undertaken as part of the initial laboratory / blood gas investigations and repeated frequently with blood gas samples through the course of, and in the hours following, a major haemorrhage resuscitation / massive transfusion.
  - Where laboratory or near-patient blood gas testing has biochemically proven a significant hypocalcaemia (Ca^{2+} < 1.0 mmol/L), this should be corrected to reduce the risk of arrhythmia and ensure optimal functioning of the coagulation cascade.

Severe hypocalcaemia (Ca2+ < 1.0 mmol/L) should be corrected using Calcium Gluconate 10%

The recommended correction dose in children using Calcium Gluconate 10% is 0.5 ml / kg (maximum 20 ml) infused / injected intravenously over 10 minutes. [20]

- **Cell Salvage**
  - Use where appropriate and available.

- **Recombinant Factor VIIa (rVIIa)** (e.g. NovoSeven)
  - There is no evidence of beneficial effect for rVIIa outside of its licensed use in patients with Haemophilia under the specialist advice of a haematologist. [21]
  - **The routine use of rVIIa in major haemorrhage is therefore not recommended** and it should only be considered when other treatment options are exhausted, the patient will clearly exsanguinate, and with the advice of the on-call Haematologist.
  - It should also be noted that even this constitutes an "off-label" application when used in paediatric patients.

- **Fibrinogen concentrates** (e.g. Riastap)
  - These are currently unlicensed drugs in the setting of acquired hypofibrinogenaemia as seen in major haemorrhage and associated coagulopathy. In some centres in the UK these are used in place of cryoprecipitate.
  - Their use is NHSL is limited and **it is not currently recommended that they be used in place of cryoprecipitate.**

- **Reversal of Anticoagulation**
    - Anticoagulant prescription / use is rare in the paediatric population and its use implies significant, specific underlying pathology. Reversal is therefore likely to have more significant clinical implications than in equivalent adult patients.
    - The decision to reverse anti-coagulation should be made jointly between a senior member of the treating clinical team, the on-call Consultant Haematologist and, where possible within an acceptable timeframe, a senior member of the patient's own specialist clinical team.
    - **Such discussions should, however, not delay the administration of blood components – nor should they delay anticoagulant reversal where there is a clear threat to life from exsanguination.**

For the purposes of clinical awareness and treatment planning the following drugs / doses are considered within the scope of this document however, the relevant British National Formulary (BNF) entry or Summary of Product Characteristics (SPC) should be consulted regarding the specifics of their clinical use:

- **Prothrombin Complex Concentrate** (e.g. Beriplex)
    - These are typically used in the setting of rapid reversal of the anticoagulation effect of Warfarin or other coumarin anticoagulants and are considered more appropriate than FFP in these circumstances.
    - The specific Prothrombin Complex Concentrate dose is calculated based on current INR and patient weight.
    - The on-call Consultant Haematologist will assist in calculating the required dose.

The initial dose of Beriplex is typically 25-50 Units / kg (max. 5000 units total) to administered at a rate not exceeding 3 Units/kg/min.

In the setting of major haemorrhage relating to Warfarin:

Vitamin K 30 micrograms / kg should also be administered

(maximum 10 mg)

- **Protamine**
  - Used in the reversal of anticoagulation with unfractionated heparin.
  - If the patient has developed major haemorrhage whilst receiving an intravenous heparin infusion, the infusion should be stopped and Protamine given IV.
  - The required dose will be influenced by a number of factors including APTT and preceding infusion rate.
  - The on-call Consultant Haematologist will assist in calculating the required dose.

1mg of Protamine neutralizes 100 units of unfractionated heparin.

Protamine should be administered at a rate not exceeding 5mg/minute to a maximum dose of 50mg.

- **Idarucizumab** (e.g. Praxbind)
  - Specifically for reversal of the anticoagulant effect of Dabigatran.
  - It is not for use in reversal of other DOACs.
  - Idarucizumab has not been tested in, nor is it licenced for, paediatric patients – however, there is case-reported use in children for Dabigatran overdose.[22]
  - Idarucizumab is available via pharmacy on all three acute sites.
  - Dosing information is contained within the Summary of Product Characteristics and the on-call Haematologist will assist with dosing in the context of Major Haemorrhage.

- **Andexanet Alfa** (e.g. Andexxa, Ondexxya)
  - Specifically for reversal of the anticoagulant effects of Rivaroxaban or Apixaban (Apixaban not currently licenced in the UK for children).
  - Andexanet Alfa has not been tested in, nor is it licenced for, paediatric patients – however, there is case-reported use in children.[23]
  - The dose of Andexanet Alfa in children, according to the case report, needs to be extrapolated from the licensed adult dosing algorithm and is dependent on a number of factors including anticoagulant drug and dose and timing of last dose prior to reversal.
  - A dosing algorithm is contained within the Summary of Product Characteristics and the on-call Haematologist will assist with calculation the context of Major Haemorrhage.

5. Management of Immediate Complications

The following complications should be anticipated and managed appropriately in patients receiving multiple units of blood components:

- **Acute Transfusion Reaction (ATR)**
  - Potentially the most serious complication of blood transfusion, particularly in the context of the MHPPP where administration of components is likely to be rapid.
  - Given the severity of a patient's clinical condition usually required to precipitate MHPPP activation, it is likely that the patient will be in a continuously monitored area. However, where this is not the case, continuous ECG, SpO_2 and NIBP monitoring should be implemented alongside frequent observation of Respiratory Rate and Temperature while the patient is moved to a suitable critical care area.
  - Extra vigilance is required as some symptoms of ATR (tachycardia, tachypnoea, hypotension) can mimic the body's response to haemorrhage and it may be difficult to clinically distinguish ATRs from ongoing blood loss.

    Features of an ATR which are **unlikely** to be seen as *early* responses in Major Haemorrhage are:

Fever	**Itch**
Rash (including urticaria / hives)	**Flushing / vasodilation**

  - If there is concern regarding a minor ATR, consideration should be given to reducing the rate of infusion if this is clinically possible.
  - **If there is concern for a Major Acute Transfusion Reaction - or if in doubt - then any hanging blood components (including their attached giving sets) should be disconnected from the patient and fresh units infused so as to maintain the required high rate of blood component replacement which may be life-saving.**
  - Thereafter, the potential reaction-precipitating components should be set aside and returned to the Blood Bank for further investigation.
  - Knowledge relating to ATR recognition and initial management is an essential component of competence for credentialling in blood component administration and is covered in the NHSL LearnPro blood transfusion modules – **which all staff involved in the administration of blood components must hold.**
  - Further information on management is available in the NHS Lanarkshire Blood Transfusion Manual, available via FirstPort (Search: "Blood Transfusion Manual").

- **Hypothermia**
  - Monitor temperature frequently
  - **Keep patient physically warm and use fluid warmers / heated forced-air blankets (e.g. Bair Hugger).**

- **Hyperkalaemia**
  - Monitor serum potassium at regular intervals.
  - **Where required, use standard local protocols for treatment of hyperkalaemia** (e.g. Salbutamol, Calcium Gluconate, Insulin + Dextrose, Bicarbonate).
  - See NHSL Hyperkalaemia Guideline – available via FirstPort, the NHSL Guidelines website (https://rightdecisions.scot.nhs.uk/nhsl-guidelines) and the NHSL Guidelines app.

- **Acidosis**
  - Monitor acid-base status at regular intervals (H^+ concentration / pH, lactate).
  - Correct as required.

- **Hypocalcaemia**
  - Monitor serum Calcium at regular intervals.
  - There is insufficient evidence to support the routine, empirical administration of Calcium in the context of Paediatric Major Haemorrhage.
  - If ECG changes or clinical evidence of hypocalcaemia (e.g. paraesthesia, tetany, carpopedal spasm) give **10ml of 10% Calcium Gluconate over 10 minutes.**
  - **Repeat if required** until clinical features and ECG changes resolve.

6. De-Activation of Major Haemorrhage Protocol for Paediatric Patients Response

De-activation of the Major Haemorrhage Protocol for Paediatric Patients is at the discretion of the Clinical Team Leader in charge of the patient's care. This is known as "Standing Down" the Major Haemorrhage response.

It is essential that, whenever the clinical emergency has ended, that the Paediatric Major Haemorrhage Co-ordinator or the Clinical Team Leader inform Blood Bank. This allows Blood Bank staff to begin procedures to minimise wastage and prioritise other work (there may be another Major Haemorrhage event occurring simultaneously on the same site).

It is an essential responsibility of the lead clinician or Paediatric Major Haemorrhage Co-ordinator to "Stand Down" the major haemorrhage response to minimise wastage and allow lab staff to prioritise other work.

7. Inter-hospital Transfer

It may be necessary to transfer a patient with ongoing bleeding to another hospital (particularly now in the context of the Major Trauma Network) and sometimes blood is transferred along with the patient.

This process should involve the blood bank staff and is covered in laboratory SOP LP-1819 'Collection, Delivery and Transport of Blood.'

8. Audit

Activations of the MHPPP will be audited by the local Hospital Transfusion Committee, so that defects in the process can be identified, rectified and reflected back to all staff involved in paediatric major haemorrhage response for the purposes of education and quality improvement.

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Appendices

1. Governance Information for Guidance Document

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Version Number:	1.2
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Responsible Person (if different from lead author)	• **Dr Andrew Fyfe** Consultant in Haematology and Transfusion Lead

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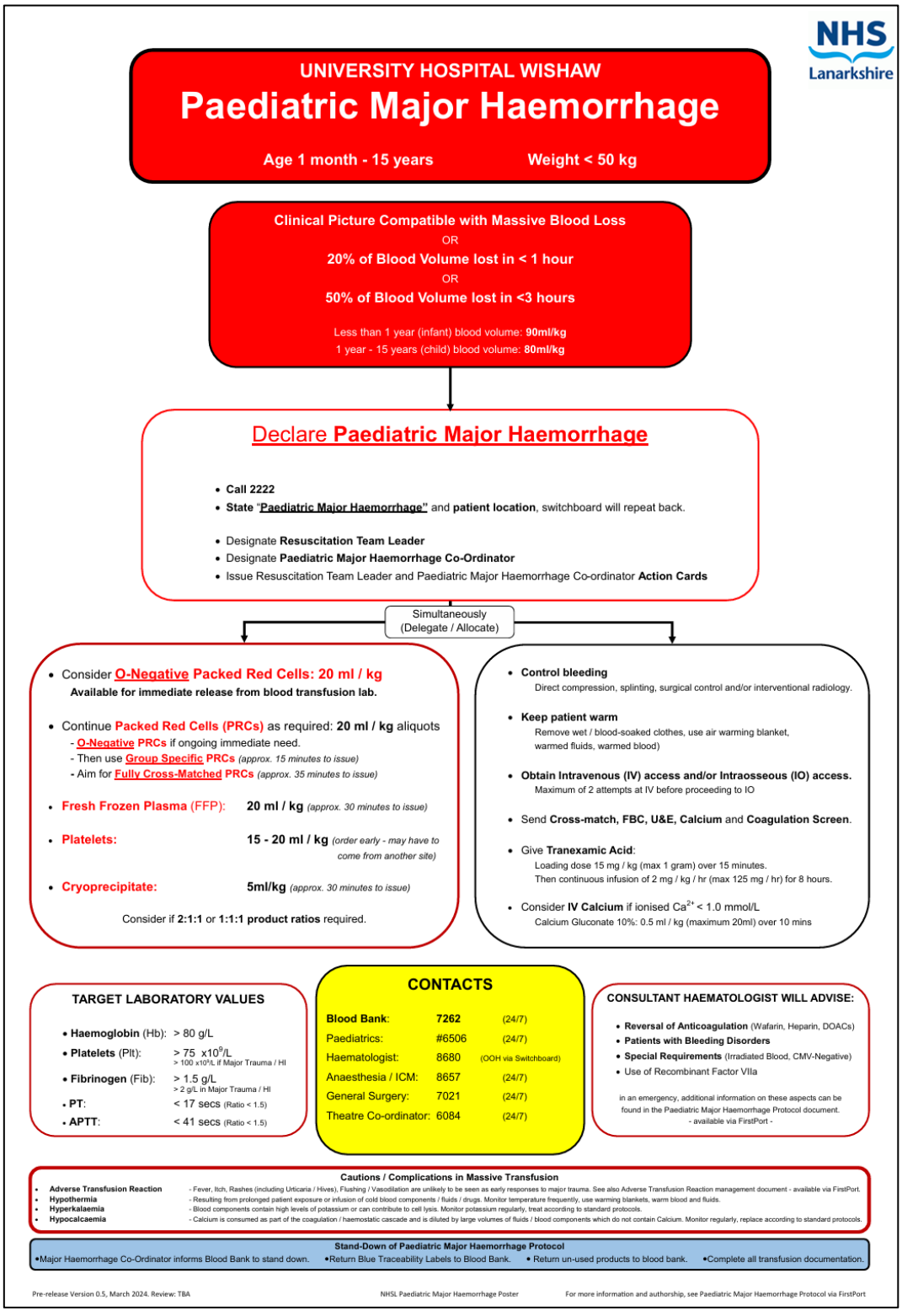
CHANGE RECORD			
Date	**Lead Author**	**Change**	**Version No.**
28/02/2025	C Moultrie	Minor alterations to format. Corrected typographical error.	1.01
03/03/2025	C Moultrie	Updated Guidelines Links	1.05
01/05/2025	C Moultrie	Re-formatted for NHSL Guidelines publication	1.1
		.	

2. Major Haemorrhage Protocol for Paediatric Patients: Site-specific Posters

2.1 University Hospital Wishaw – MHPPP Overview Poster

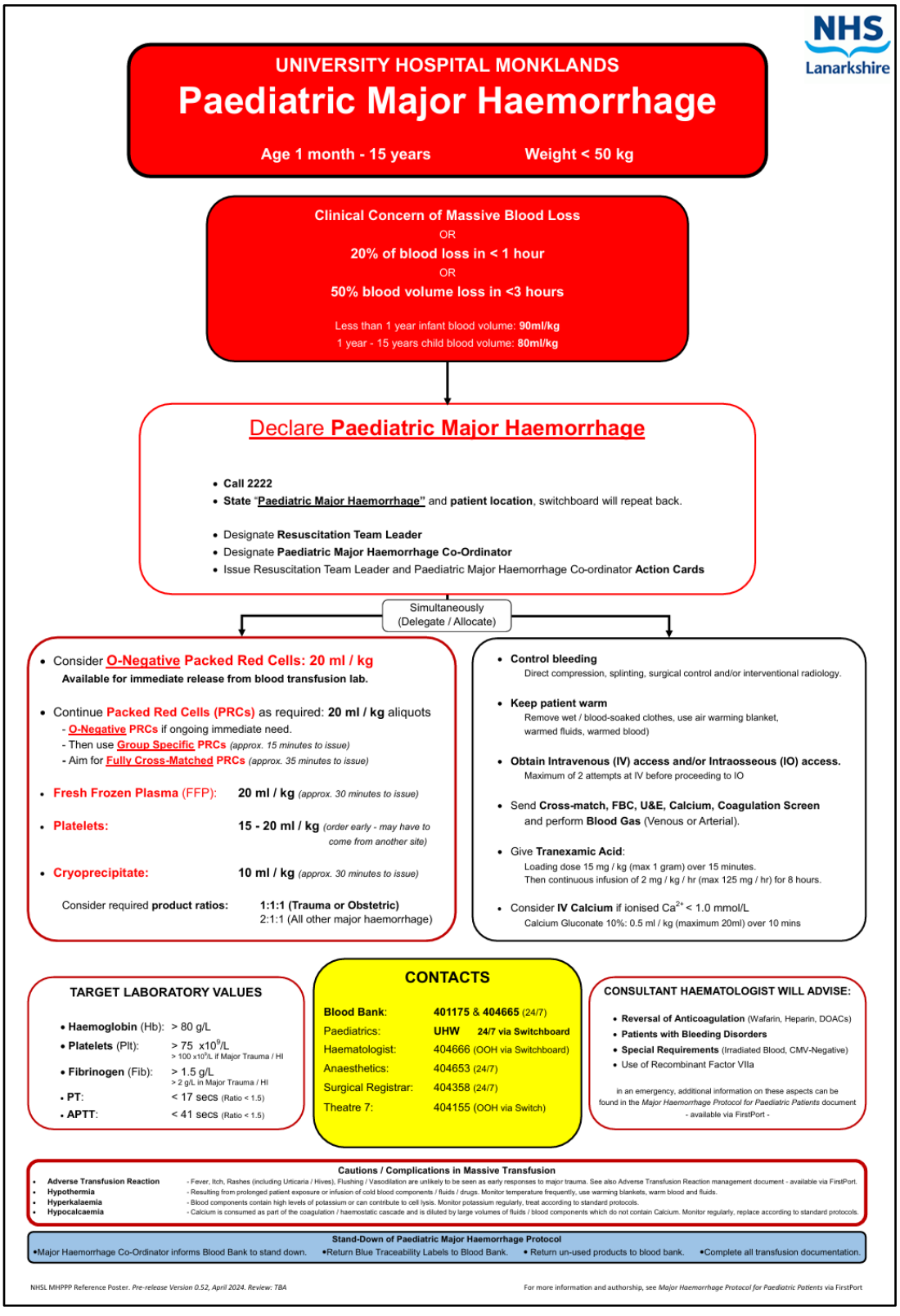
- Readability is designed around A2-size printing.
- Full-size poster file available as PDF on FirstPort.



Lead Author	Dr L Summers / Dr C Moultrie / Dr L Young	Date approved	June 2025 (ADTC)
Version	1.1	Review Date	June 2028

2.2 University Hospital Monklands – MHPPP Overview Poster

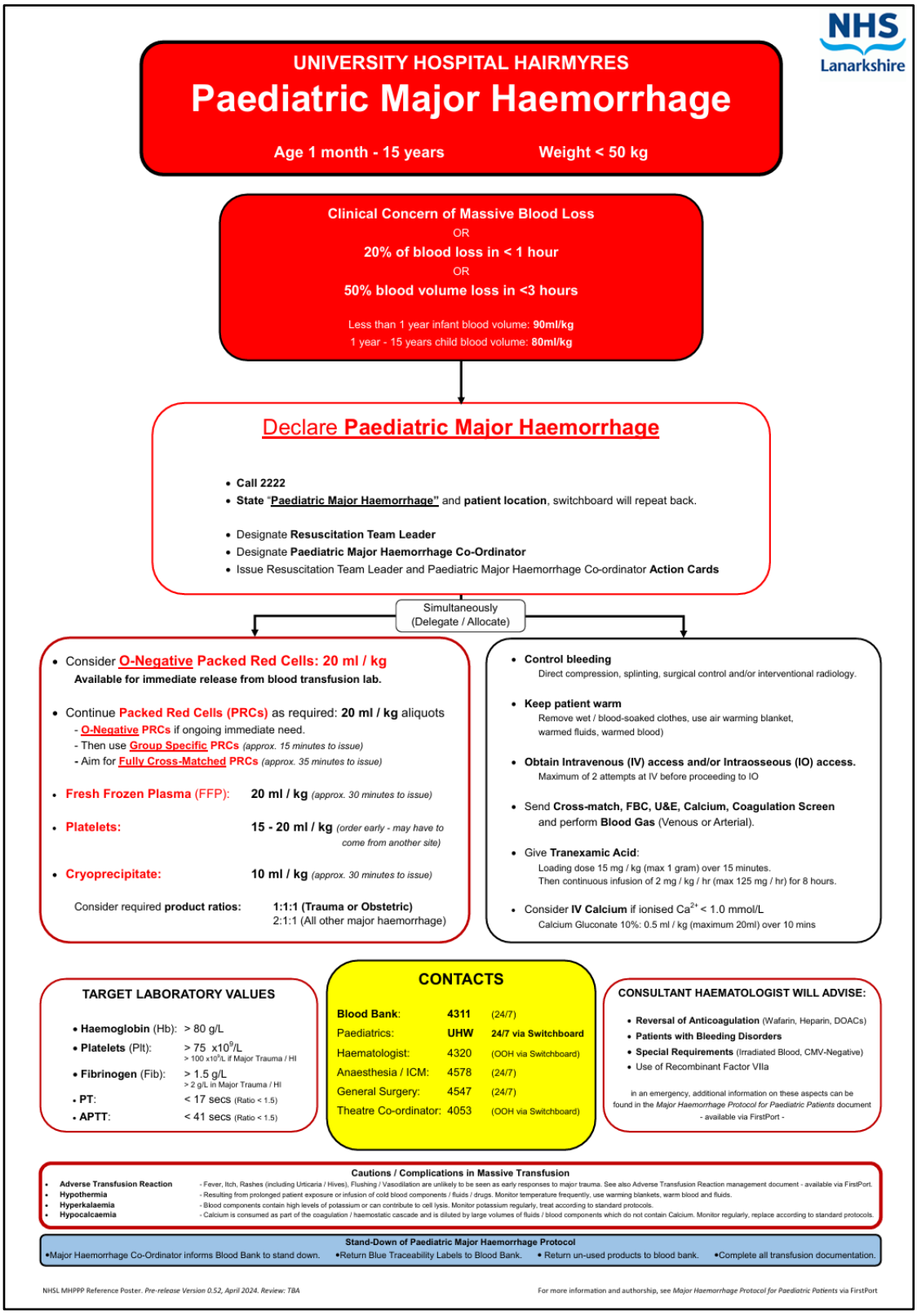
- Readability is designed around A2-size printing.
- Full-size poster file available as PDF on FirstPort.



Lead Author	Dr L Summers / Dr C Moultrie / Dr L Young	Date approved	June 2025 (ADTC)
Version	1.1	Review Date	June 2028

2.3 University Hospital Hairmyres – MHPPP Overview Poster

- Readability is designed around A2-size printing.
- Full-size poster file available as PDF on FirstPort.

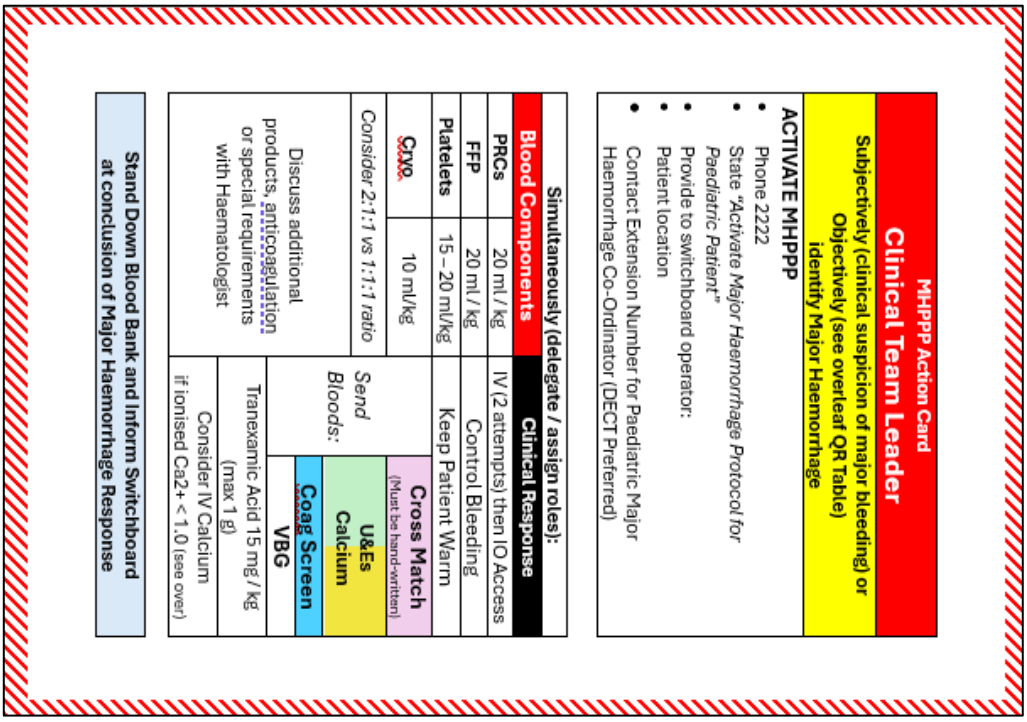


Lead Author	Dr L Summers / Dr C Moultrie / Dr L Young	Date approved	June 2025 (ADTC)
Version	1.1	Review Date	June 2028

3. Major Haemorrhage Protocol for Paediatric Patients –Action Cards for All NHSL Sites

2.2.1 Clinical Team Leader Action Card / Aide-Memoire (All Sites)

- To be used as a double-sided card when printed A6-size.
- PDF File available on FirstPort - formatted for double sided printing on A4 to be cut to A6 size and laminated.



MHPPP Action Card

Clinical Team Leader

Subjectively (clinical suspicion of major bleeding) or Objectively (see overleaf QR Table) identify Major Haemorrhage

ACTIVATE MHPPP

- Phone 2222
- State *"Activate Major Haemorrhage Protocol for Paediatric Patient"*
- Provide to switchboard operator:
- Patient location
- Contact Extension Number for Paediatric Major Haemorrhage Co-Ordinator (DECT Preferred)

Simultaneously (delegate / assign roles):

Blood Components		Clinical Response
PRCs	20 ml / kg	IV (2 attempts) then IO Access
FFP	20 ml / kg	Control Bleeding
Platelets	15 – 20 ml/kg	Keep Patient Warm
Cryo	10 ml/kg	Cross Match (Must be hand-written)

Consider 2:1:1 vs 1:1:1 ratio

Send Bloods:

- U&Es
- Calcium
- Coag Screen
- VBG

Discuss additional products, anticoagulation or special requirements with Haematologist

- Tranexamic Acid 15 mg / kg (max 1 g)
- Consider IV Calcium if ionised Ca2+ <1.0 (see over)

Stand Down Blood Bank and Inform Switchboard at conclusion of Major Haemorrhage Response

Infant (< 1 yo): Total Blood Volume = **90 ml / kg**
Child (>= 1yo): Total Blood Volume = **80 ml / kg**

Indicators of Paediatric Major Haemorrhage
Rate of blood loss OR rate of blood transfusion >= 8 ml / kg / min
Total estimated blood loss OR volume of blood transfusion >= 15 ml / kg in < 1 hour
Estimate 50% Total Blood Volume loss in < 3 hours
40 ml / kg PRCs transfused in < 3 hours

Additional Drugs / Products	
Calcium Gluconate 10%	0.5 ml / kg (max 20 ml)
Beriplex	25 – 50 Units / kg (max 5000 Units)
Vitamin K	30 micrograms / kg

Target Values	
Haemoglobin (Hb)	> 80 g/L
Platelets (Plt)	> 75 x 10^9/L > 100 x 10^9/L if major trauma, HI or anti-platelets.
Fibrinogen (Fib)	> 1.5 g/L > 2.0 g/L if major trauma or HI
PT	< 17 seconds (Ratio < 1.5)
APTT	< 41 seconds (Ratio < 1.5)

2.2.2 Paediatric Major Haemorrhage Co-ordinator Action Card / Aide-Memoire (All Acute Sites)

- To be used as a double-sided card when printed A6-size.
- PDF File available on FirstPort - formatted for double sided printing on A4 to be cut to A6 size and laminated.