Platelet Use in Paediatrics and Neonates

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1. I'm not a Paediatrician
2. Dr Helen New is the expert on all things paediatrics and platelets (she wrote the guidelines) so she can follow up on difficult questions
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3. I'm not going to discuss IUT
4. Not all hospitals follow national guidelines

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Rules

More rules in paediatric transfusion than in adults –

- Age of blood
- Age of the child
- Type of surgery
- Weight of the child
- Plasma sourced from outside the UK
- MBFFP v SDFFP
- Apheresis platelets
UK Paediatric Platelet Guidelines

PLUS Local guidelines
BSH: Guidelines on transfusion for fetuses, neonates and older children

• 2016 BSH guideline; previously published in 2004
• “Although there has been little evidence on which to base paediatric clinical transfusion decisions in the past, there have been a number of studies and national audits published over recent years that contribute to decision-making in this area. In addition there have been changes to other guidance, including the management of neonatal jaundice (NICE, 2010) and the requirement for cytomegalovirus (CMV) seronegative components”
• Long guideline (91 pages…..)
Neonates

- Transfusion triggers for neonates vary depending on the clinical context including their gestational age at birth
- Usual definition of a neonate <28 days but if EDD not known then may change (e.g. GOSH neonate defined as <6 months)
- In NICU most transfusions given to <32 weeks gestational age (NCA 2010)
- Guidelines tend to be the same whether pre-term or term
- Audits have shown most platelet transfusions are given as prophylaxis in the absence of bleeding
Neonatal thrombocytopenia

- Common problem amongst neonates on NICU
- Most platelets are given for prophylaxis not bleeding
- Varied thresholds, dose and follow-up
- Very little evidence
  - moderate thrombocytopenia (50-150 x 10^9/l) not detrimental (RCT Andrew et al, 1993)
  - unclear < 50 x 10^9/l
PlaNeT Studies

- **PlaNeT-1**
  - observed current practice and outcomes
  - 169 neonates; platelets < 60 x 10⁹/L
  - most transfusions prophylactic & to preterm neonates (Stanworth et al, 2009)

- **PlaNeT-2**
  - a randomised controlled trial of platelet transfusion thresholds
  - 25 vs 50 x 10⁹/L

Needed more information so I asked Dr Simon Stanworth
Neonatal thrombocytopenia

Prevalence: 1 - 5% of all infants
25% NICU admissions
5-10% severe thrombocytopenia

Thrombocytopenia

Outcomes & Bleeding

Premature at risk neonate

Platelet transfusions

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Platelet transfusions
- Use as prophylaxis

Results PLaNeT-1

- For 338/415 (81%) transfusions the main recorded reason for transfusion was low platelet count (prophylaxis)
- Many platelet transfusions were given as prophylaxis often well after ‘risk period’ for major haemorrhage has passed
- Variability in platelet counts pre-transfusion between 25 – 50 x10⁹/L

PlaNeT-1 Study Group, Pediatrics, 2009
25 or 50!

Platelets for Neonatal Transfusion Study-2 (PlaNeT-2/Matisse)
A randomised trial of platelet transfusion thresholds
PlaNeT-2/MATISSE trial

- Define optimal and safe platelet transfusion support for severely thrombocytopenic pre-term neonates
- Compare clinical outcomes in neonates randomised to maintain platelet counts at or above either $25 \times 10^9$/L or $50 \times 10^9$/L
- [www.planet-2.com](http://www.planet-2.com)
PlaNeT-2/MATISSE trial

- Randomisations: many challenges
- But study recruitment now complete
- Data currently being analysed
## Neonatal platelets

<table>
<thead>
<tr>
<th>Platelet Count (x $10^9/l$)</th>
<th>Indication for platelet transfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25</td>
<td>Neonates with no bleeding (including neonates with NAIT if no bleeding and no family history of ICH)</td>
</tr>
<tr>
<td>&lt;50</td>
<td>Neonates with bleeding, current coagulopathy, before surgery, or infants with NAIT if previously affected sibling with ICH</td>
</tr>
<tr>
<td>&lt;100</td>
<td>Neonates with major bleeding or requiring major surgery (e.g. neurosurgery)</td>
</tr>
</tbody>
</table>

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Neonatal platelet recommendations

1. For preterm neonates with very severe thrombocytopenia (platelet count below 25 x10⁹/L) platelet transfusions should be administered in addition to treating the underlying cause of the thrombocytopenia (Grade 2C)

2. Consider IVIg in NAIT refractory to platelets negative for HPA-1a/5b antigens or if antigen-matched platelets are unavailable (1C)
NAIT

• It is recommended all suspected NAIT is discussed with the haematologist
• NAIT results most commonly from maternally derived anti-Human Platelet Antigen (HPA) 1a or 5b platelet antibodies
• As shown previously bleeding history affects platelet trigger for transfusion
• UK Blood Services stock platelets negative for HPA-1a/5b antigens, antibodies to which are responsible for over 90% of cases
• Pre & post transfusion platelet counts are required for increment review
• Monitor for IVH
Older Children

- Most platelets are given to PICU, haem-onc and cardiac surgery patients
- Prophylactic platelets are common in post BMT patients
- Despite reviewing the literature the guideline states – “is insufficient evidence in children to significantly change recommendations made in the previous BCSH guidelines”
- Platelet thresholds are suggested dependant on clinical situation
### Older children

<table>
<thead>
<tr>
<th>Platelet count ($x 10^9$/l)</th>
<th>Clinical situation to trigger platelet transfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>Irrespective of signs of haemorrhage (excluding ITP, TTP/HUS, HIT)</td>
</tr>
<tr>
<td>&lt; 20</td>
<td>Severe mucositis</td>
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<tr>
<td></td>
<td>Sepsis</td>
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<tr>
<td></td>
<td>Laboratory evidence of DIC in the absence of bleeding*</td>
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<tr>
<td></td>
<td>Anticoagulant therapy</td>
</tr>
<tr>
<td></td>
<td>Risk of bleeding due to a local tumour infiltration</td>
</tr>
<tr>
<td></td>
<td>Insertion of a non-tunneled central venous line</td>
</tr>
<tr>
<td>&lt; 40</td>
<td>Prior to lumbar puncture**</td>
</tr>
<tr>
<td>&lt; 50</td>
<td>Moderate haemorrhage (e.g. gastrointestinal bleeding) including bleeding in association with DIC</td>
</tr>
<tr>
<td></td>
<td>Surgery, unless minor (except at critical sites)</td>
</tr>
<tr>
<td></td>
<td>- including tunneled central venous line insertion</td>
</tr>
<tr>
<td>&lt; 75 -100</td>
<td>Major haemorrhage or significant post-operative bleeding (e.g. post cardiac surgery)</td>
</tr>
<tr>
<td></td>
<td>Surgery at critical sites: central nervous system including eyes</td>
</tr>
</tbody>
</table>

**note:** routine screening by standard coagulation tests not advocated without clinical indication; for laboratory evidence of DIC

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**Lumbar Puncture**

- Suggested: < 40 Prior to lumbar puncture
- Caveat: It is accepted that prior to lumbar puncture some clinicians will transfuse platelets at higher counts (e.g. 50 x 10⁹/L) in clinically unstable children, non ALL patients, or for the first LP in newly-diagnosed ALL patients to avoid haemorrhage and CSF contamination with blasts, or at lower counts (≤ 20 x 10⁹/L) in stable patients with ALL, depending on the clinical situation
- These practices emphasise the importance of considering the clinical setting and patient factors
Recommendations

1. Given a lack of studies in paediatrics, recommendations for platelet transfusions in critically ill children or those with haematological/oncological malignancies who develop severe thrombocytopenia are drawn from the wider adult literature and recommendations (2C).

2. As pragmatic guidance, it is suggested that for most stable children prophylactic platelet transfusions should be administered when the platelet count is below $10 \times 10^9$/L, excluding patients with ITP, TTP/HUS, and HIT who should only be transfused with platelets for life-threatening bleeding (2B).
Shared Care Haem-Onc protocol

Platelet Transfusion Guidelines

Haematology/Oncology patients at presentation/on treatment
(Children with chronic non-malignant thrombocytopenia excluded)

Platelet count < 10 x 10^9/L

- Yes → Transfuse
- No

Platelet count < 20 x 10^9/L and either:
  - Febrile/septic
  - Platelet count likely to fall to below 10 x 10^9/L before next check. For GOSH patients only: platelet count needs to be > 20 x 10^9/L prior to lumbar puncture or trephine biopsy (recommendation for RMH & UCLH patients remains same as previous)

- Yes → Transfuse
- No

Platelet count < 30 x 10^9/L and either:
  - Child has brain tumour or retinoblastoma (or pre-trephine at RMH and UCLH)

- Yes → Transfuse
- No

Platelet count < 50 x 10^9/L and either:
  - Bleeding, coagulopathy/on heparin or due lumbar puncture (UCLH) or surgery (e.g. line insertion/removal, not neuro/eyes)

- Yes → Transfuse
- No

Platelet count < 100 x 10^9/L and either:
  - Life-threatening bleeding
  - Bleeding at critical site (lungs/CNS) or due surgery to brain/spine/eyes

- Yes → Transfuse
**Significant Bleeding**

- Significant bleeding is typically considered at grades 2-4 (Stanworth et al, 2014; NICE, 2015).

- Although the WHO bleeding scale is more commonly used for clinical research in adults, BSH suggest that a pragmatic modification may be used to help guide transfusion decisions based on bleeding risk, taking into account the types of bleeding and changes in haemodynamic parameters appropriate for neonatal and paediatric patients in different clinical situations.
Major haemorrhage

- All guidance largely extrapolated from adult practice
- Trauma bleeding is relatively rare in children
- Surgical bleeding (e.g. cardiac surgery) more common
- 50kg seems to be an accepted cut-off point between adult bleeding algorithm and paediatric
- As in adults platelets are given as part of the major haemorrhage protocol
- 1:1 ratio e.g. 20mls/kg RBC:FFP
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Consider platelets 15 ml/kg
**NICE guidance aimed at patients over 1 year old and adults**

- Patients who are not bleeding or having invasive procedures or surgery
- Offer prophylactic platelet transfusions to patients with a platelet count below $10 \times 10^9$ per litre who are not bleeding or having invasive procedures or surgery, and who do not have any of the following conditions:
  - chronic bone marrow failure
  - autoimmune thrombocytopenia
  - heparin-induced thrombocytopenia
  - thrombotic thrombocytopenic purpura
8% all SHOT reports relate to paediatrics

Fiona Regan speaking at 14.30 so not going to dwell on SHOT data
Reactions

• 23% of the reaction reports to SHOT were paediatric

• The proportion of FAHR (febrile, allergic & hypotensive) reactions (previously classed as ATR) for *platelets* is always high for paediatrics (primarily allergic)

• Awareness that plasma rich components (platelets & plasma) are associated with a higher proportion of allergic and anaphylactic reactions should be considered when considering prophylactic transfusions
Paediatric reaction type by component 2017

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Paediatric SHOT cases comprise all reports for patients under 18 years of age, subdivided by recipient age groups: neonates are ≤3 days; infants are aged between 28 days and 1 year old; children are over 1 year to less than 16 years; and also those aged 16 to ≤18 years.

Paediatric cases make up approximately 8% of the total reported to SHOT. They are disproportionately represented in the error categories: incorrect blood component transfused, wrong component transfused (IBCT-WCT), IBCT-specific requirements not met (IBCT-SRMN), and avoidable, delayed or undertransfusion (ADU). This partly reflects the increased complexity of paediatric transfusions. Neonates and children are vulnerable patient groups and may have special transfusion requirements.

Neonates are often intensively transfused and are especially vulnerable to potential adverse effects of transfusion, having immature immune and metabolic systems, and are still undergoing rapid development.

Acute side effects from transfusion may be greater for children than for adults, as a single unit of transfused blood with the potential to cause harm may represent a much greater proportion of their blood volume than in an adult.

Consideration of long-term side effects of transfusion for children is particularly important, as the majority will live for several decades afterwards.

In general paediatric wards, the transfusion of blood and blood components is not common, and this may result in reduced awareness of transfusion-related hazards.

Components provided for transfusion to children less than one year of age have a particular specification, with additional safety features including being from a donor who has given blood (and been tested) at least once before, is CMV negative, Hbs negative and Kell negative (see 2016 BSH guidelines for further details). Red cells for neonatal exchange and intratertiary transfusions have a haematocrit that must fall between strictly defined limits. Laboratory information technology systems should be set up that they are able to automatically flag age-related specific requirements.

Because of their small size, children, especially neonates, need smaller volumes of blood than adults. In the UK, small volume 'pedi-packs', where (usually) six small packs of red cells or four small packs of platelets are produced from a single adult-sized donation. These packs provide enough blood for a typical neonatal transfusion and at the same time ensure that red cell transfusions can come from the same donor over a period of several weeks.

It may be that in an emergency, delay while waiting for an exact specification would be harmful to the patient and the risk of delay must be balanced against clinical need — an acceptable substitute component may have to be used and there should be pre-agreed local policies in place, but use of non-irradiated, non-leucodepleted maternal blood is NEVER an option.

Neonates should not be retransfused with an adult O D-negative red cells unless there is no available pedi-pack. Mitigations put in place by hospitals to reduce the chance of selecting the incorrect component by clinical staff include having neonatal and adult red cell units placed in containers with visual identifiers to help staff distinguish between them. (Image supplied by Rachel Moss).
Positive Patient Identification

• Risk of confusion over maternal and baby samples
• Multiple births (especially using consecutive identification numbers)
• Babies without first names
• Failure to apply wristbands
• Removal of wristbands by children and/or parents
• During procedures or wristbands not accessible during surgery
Components

• Standard platelets: Pooled in PAS
• Paediatrics-
  – Apheresis where possible
  – Slightly reduced risk of vCJD
  – Maximum 1 ADT
• Neonates/infants
  – Neonatal donors
  – Split packs – approx. 55mls
Platelet groups

<table>
<thead>
<tr>
<th>Patient's ABO Group</th>
<th>ABO Group of Plasma Components to be Transfused</th>
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<tbody>
<tr>
<td></td>
<td>Platelets</td>
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<td></td>
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<tr>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>1\textsuperscript{st} choice</td>
<td>A, B or AB</td>
</tr>
<tr>
<td>2\textsuperscript{nd} choice</td>
<td></td>
</tr>
<tr>
<td>3\textsuperscript{rd} choice</td>
<td>B†</td>
</tr>
<tr>
<td>4\textsuperscript{th} choice</td>
<td>O†</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
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<tr>
<td>1\textsuperscript{st} choice</td>
<td>AB</td>
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<tr>
<td>2\textsuperscript{nd} choice</td>
<td>AB</td>
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<td>3\textsuperscript{rd} choice</td>
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<td>1\textsuperscript{st} choice</td>
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<td>3\textsuperscript{rd} choice</td>
<td>O</td>
</tr>
<tr>
<td>4\textsuperscript{th} choice</td>
<td>O</td>
</tr>
</tbody>
</table>

† Tested and negative for HT antibodies

If a patient requires HLA-matched platelets, HLA match usually takes precedence over ABO group.

Group B or AB platelets may not be available. However, the use of group O platelets for non-O patients should be avoided as much as possible. Platelets should be compatible for D.
Apheresis Platelets Myth Buster

Which platelets MUST be apheresis?
1. Human Leucocyte Antigen / Human Platelet Antigen (HLA/HPA) selected platelets for a named patient
2. Platelets for intra-uterine and neonatal transfusions
3. Platelets from an IgA deficient donor
   For IgA deficient patients order by arrangement with an NHSBT Consultant

Platelet changes • Change in provision of apheresis platelets

Are apheresis platelets preferred in children and young people?
Those born after 1/1/96 may benefit from apheresis platelets to reduce the risk of variant Creutzfeldt-Jakob Disease (vCJD). The evidence to support this is very low quality. If this would delay treatment or the patient is at an increased risk of an allergic reaction pooled platelets which are suspended in Platelet Additive Solution (PAS) should be used.

Platelet changes • Change in provision of apheresis platelets • BSH Clinical guidelines

Risk of HLA sensitisation from platelets
The TRAP study shows no significant difference in the rate of alloimmunisation between apheresis and pooled platelets. Both apheresis and pooled platelets are leucodepleted reducing the risk of HLA sensitisation.

What about cytomegalovirus (CMV)?
CMV negative blood is rarely required.
Do not order CMV negative components unless the patient requires them
• Intra-uterine transfusions
• Neonates up to 28 days post expected date of delivery
• Elective transfusions during pregnancy (not during labour or delivery)
DO NOT DELAY EMERGENCY TRANSFUSION IF CMV NEGATIVE COMPONENTS ARE NOT AVAILABLE

Cytomegalovirus Tested Blood Components • CMV Factsheet

Myth: “Apheresis platelets should be used for patients who are not demonstrating a good post-transfusion platelet increment.”
Fact: There is no benefit from giving randomly selected apheresis platelets in these cases. Instead, take an immediate platelet increment (10-30mins post transfusion) after administering ABO matched platelets. If the increment result is poor, perform investigations for HLA-antibodies

Clinical guidelines • Slichter SJ et al • TRAP study

Myth: “Apheresis platelets are a better component than pooled platelets and should be held as stock.”
Fact: NHSBT does not recommend holding apheresis platelets as stock unless this is to support a children’s hospital.

Platelet changes • Change in provision of apheresis platelets

Myth: “Apheresis platelets cause fewer allergic reactions.”
Fact: There is evidence that apheresis platelets are likely to cause more allergic reactions. Allergic reactions are usually caused by plasma proteins therefore pooled platelets suspended in a 70:30 PAS:plasma ratio rather than apheresis platelets suspended in 100% plasma are preferred in patients at an increased risk.

SHOT
ABO & RhD

- In Paediatrics all children receive RhD matched platelets – RhD positive platelets are very rarely given to males under the age of 18 (& never to females)
- The use of group O apheresis platelets for non group O neonates and children is not recommended because of the risk of haemolysis
Special requirements

- Irradiated cellular components are supplied for fetal transfusions and specific recipient groups (at GOSH all platelets irradiated)
- CMV negative 28 days post EDD
- All cellular blood components of fetal/neonatal/infant specification for use up to 1 year of age are currently CMV negative

Dr Colin Brown speaking on HLA matched platelets at 13:45 so not discussing them
Platelet prescribing

- **10 – 20 mls/kg** up to a maximum of 1 ADT
- Administered over 30-60 minutes (10–20 mls/kg/hr)
- Double doses rarely required

**BSH Recommendations**

1. Prescription for paediatric transfusion should be in mL unless there are local risk-assessed protocols for prescribing in units for older children, *and the maximum volume should not be greater than prescribed for adults (1C).*

2. As for recommendations in adults a second sample collected at a different time should be tested for confirmation of the ABO group of a first time patient prior to transfusion unless secure electronic patient identification systems are in place, as long as this does not delay urgent transfusion (1C)
Guideline Bookmarks

Transfusion of Blood Components for Neonates

This summary guidance should be used in conjunction with the 2016 BSH Guidelines.

Red cells for top-up transfusions
- Studies support restrictive transfusion thresholds.

Suggested transfusion thresholds for preterm neonates

<table>
<thead>
<tr>
<th>Postnatal age</th>
<th>Ventilated</th>
<th>On oxygen</th>
<th>Off oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st 24 hours</td>
<td>&lt;120</td>
<td>&lt;120</td>
<td>&lt;120</td>
</tr>
<tr>
<td>week 1 (days 1-7)</td>
<td>&lt;120</td>
<td>&lt;100</td>
<td>&lt;100</td>
</tr>
<tr>
<td>week 2 (days 8-14)</td>
<td>&lt;100</td>
<td>&lt;95</td>
<td>&lt;95</td>
</tr>
<tr>
<td>week 3 (days 15 onwards)</td>
<td>&lt;100</td>
<td>&lt;95</td>
<td>&lt;95</td>
</tr>
</tbody>
</table>

*Table applies to very premature babies (<32 weeks), for later preterm babies the values for babies off oxygen may be used. It is accepted that climate may use up to 80 g/L depending on clinical situation.

**NIPPV = non-invasive positive pressure ventilation.
- Generally transfuse 15 mL/kg for non-bleeding neonates.
- Where the term or preterm neonate does not require resuscitation, undertake delayed cord clamping.
- Minimise phlebotomy where possible, using small volume samples.
- Ensure that paediatric solutions are available for emergency use by maternity and neonatal units.
- Transfuse red cells for large volume neonatal and infant transfusion before the end of Day 5.

Transfusion rate: 5 mL/kg/hr.

Transfusion of Blood Components for Infants and Children

This summary guidance should be used in conjunction with the 2016 BSH Guidelines.

Red cells
- Acute haemolytic anaemia
  - Use Hb threshold of 70 g/L in stable non-oticergic patients.
  - In non-bleeding infants and children, generally aim for a post-transfusion Hb of no more than 20 g/L above the threshold.
  - Monitor blood sampling and base near patient testing when possible.

Surgery (non-cardiac)
- Major pre-op non-invasive anaesthesia.
- Use a peri-op Hb threshold of 90 g/L in stable patients without major morbidity or bleeding.
- Consider transfusion in all children undergoing surgery at risk of significant bleeding.
- Consider cell salvage in all children at risk of significant bleeding where transfusion may be required.

Transfusion volume calculation and prescribing
- Volume to transfuse = W 2 / T

The formula provides a guide to the likely rise in Hb following transfusion for non-bleeding patients.
- Prescription should be in millilitres not units.
- Normal maximum volume for red cell top-up transfusion is 1 unit.
- Transfusion rate: 5 mL/kg/ hr (usual rate max 150 mL/hr).

Fresh frozen plasma and cryoprecipitate
- Correction of minor acquired abnormalities in non-bleeding patients (excluding DIC)
  - FFP should not be administered to non-bleeding children with minor prolongation of the PT/PTT including prior to surgery unless to critical site.
  - Cryo should not be routinely administered to non-bleeding children with decreased fibrinogen including pre-op unless fibrinogen < < 1 g/L, for surgery at risk of significant bleeding or to critical site.
  - Disseminated intravascular coagulation
  - FFP may be beneficial in children with DIC who have a significant coagulopathy (PT/PTT > 1.5 times) whether normal range or fibrinogen < < 1 g/L associated with clinically significant bleeding or to primary procedure.
  - Cryo may be given if the fibrinogen is < < 0.5 g/L despite FFP or in conjunction with FFP for very low or rapidly falling fibrinogen.
  - Make sure that packs of fibrinogen if available.

Typical transfusion volumes: FFP 15-20 mL/kg, cryo 5-10 mL/kg, rate 10-20 mL/kg/h.
Thank You

Acknowledgments to Dr Helen New & Dr Simon Stanworth

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