NEONATAL JAUNDICE – MANAGEMENT IN INFANTS <32 WEEKS

1. INTRODUCTION

- Jaundice is one of the most common conditions requiring medical attention in newborn babies.
- While the cause of jaundice in most cases is physiological, co-existing pathological causes and high levels of jaundice need to be identified because they may have serious consequences if left untreated.
- Preterm and sick infants are more vulnerable to brain toxicity from high levels of bilirubin.

2. SCOPE

- These guidelines cover the management of **unconjugated hyperbilirubinaemia <32 weeks** gestation at birth and **do not** address conjugated hyperbilirubinaemia (i.e. conjugated fraction greater than 20 µmol/L or >20% of total serum bilirubin)

3. AIM

- To provide a framework for the early identification and management of jaundice in neonates <32 weeks gestation at birth.

4. PATIENT

- Neonates.

5. STAFF

- Medical and nursing.

6. CLINICAL PRACTICE

6.1. SCREENING FOR JAUNDICE

6.1.1 All infants

- Medical or nursing staff should examine the baby for jaundice at every opportunity especially in the first 72 hours of life.
- Check for any risk factors that can significant jaundice soon after birth. These include:
    1. Previous sibling with neonatal jaundice requiring phototherapy
    2. Visible Jaundice within the first 24 hours of life.
    3. Rhesus negative babies (Setting for Rhesus isoimmunisation)
    4. O blood group mothers (setting for ABO incompatibility)
    5. Delayed cord clamping
    6. Growth restricted infants (risk of polycythemia and jaundice)
    7. Twin-twin transfusion
    8. Birth trauma (including bruising and haemorrhages)
- Transcutaneous bilirubin (TcB) **and** serum bilirubin (**commonly referred to as SBR**) – May be required every 12 hours in the first 72 hours of life and for any visible jaundice subsequently.

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6.1.2 Additional care if visible jaundice in the first 24 hours of life

- Obtain SBR urgently (within 2 hours) and record.
- Urgent medical review and investigations including review of mother's blood group and Rhesus status and infant's blood group and typing and direct anti-globulin test (DAT or direct coombs' test), Glucose-6-Phosphate Dehydrogenase (G6PD) screen and FBC to rule out haemolysis from blood group incompatibility and haemoglobinopathies.

6.2 MANAGEMENT OF HYPERBILIRUBINAEMIA

- Use SBR to determine therapy.
- **Do not subtract conjugated bilirubin from total serum bilirubin (TSB) when making decisions about the management of hyperbilirubinaemia.**
- Phototherapy (PT) is the first line treatment.
- All modes of phototherapy are safe and effective in preterm neonates.
- The effect of fibre optic devices alone may be limited by the size of the device and the surface area of skin exposed. However, our anecdotal experience suggests that it an effective and user friendly therapy particularly in preterm infants and infants with stable or not rapidly rising SBRs.

6.2.1 Starting Phototherapy

- Use PT threshold graphs to decide on phototherapy (Refer to Appendix 1-9).
- Look for any risk factors such as iso-immune haemolytic disease, G6PD deficiency, polycythaemia, asphyxia, bruising or haemorrhages, temperature instability, sepsis or acidosis.
- Consider phototherapy at **TSB levels 20 µmol/L below** thresholds shown on the graphs in infants with risk factors.
- Continuous, rather than intermittent PT is recommended. However, using clinical judgement, encourage breaks of up to 30 minutes for breast feeding, nappy changes and cuddles.
    - No need for additional fluids or feeds routinely but IV fluids/additional nasogastric enteral feeds may be needed in babies who are needing multiple light PT and:
        1. The serum bilirubin is rising rapidly (>8.5 µmol/L/hour).
        2. The serum bilirubin level is within 50 µmol/L below the threshold for exchange transfusion.
- Document the time of both commencement and cessation in the observation chart and integrated notes.

6.2.2 Type of phototherapy in the NICU

- Fibre optic PT - comprises a light generator, a fibre optic cable carrying light to a flexible light pad or blanket placed under or around the neonate.
- Light emitting diode (LED) PT - emits high intensity light in a narrow wavelength spectrum and produces minimal heat.
- Conventional PT - a single fluorescent blue light unit positioned above the neonate.
- Single light PT (15 µW/nm/cm² to 30 µW/nm/cm^2) - one unit of phototherapy light; either fluorescent, LED or fibre optic phototherapy.
- Multiple light PT (> 30 µW/nm/cm^2) - more than one light source used simultaneously.
- Use a single light PT when:
    1. The total SBR is at or just above PT threshold as plotted on the graphs
    2. The SBR is not rising rapidly
    3. The SBR is more than 50 µmol/L below the exchange transfusion threshold.

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- Use multiple light PT units to get as much skin exposure as possible if:
    1. The SBR is rising rapidly (> 8.5 µmol/L/hour)
    2. The SBR is < 50 µmol/L below the exchange transfusion treatment threshold line
    3. The SBR fails to respond to single light phototherapy (that is, the SBR is static, continues to rise, within 6 hours of starting single light phototherapy)
    4. A rapid reduction in SBR is required
- The Draeger Photo-Therapy 4000 lamp in our unit is a conventional overhead phototherapy device. The head contains four 18W folded blue fluorescent tubes in the central section and two 18W folded white fluorescent tubes, one at each end of the central section. The two white tubes may optionally be replaced by two blue tubes for enhanced treatment. Blue tubes provide the therapeutic light and the white tubes provide light to make it easier for the nurses to work with the lamp by balancing the intense blue colour. The white lights do not produce therapeutic light.
- GE Bilisoft is a fibreoptic blue LED phototherapy system. This light delivers phototherapy that meets the recommendations of the American Academy of Pediatrics including the following specifications:

Components of Phototherapy	AAP Guidelines	Bilisoft
Light Intensity	Irradiance level at least 30 µW/cm2/nm	35 (large pad) 55 (small pad)
Light Spectrum	430-490 nm wavelength	430-490nm

- Medela Bilibed: This is used on our postnatal wards and not for <32 weeks. A blue fluorescent tube is fitted into a plastic crib with a stretched plastic cover over the top for the baby to lie on. The baby is dressed in the Bilicombi baby suit and nursed on the soft plastic cover. This system delivers irradiance up to 40 µW/nm/cm^2.

6.2.3 Care during Phototherapy

- If serum bilirubin prior to starting phototherapy is within 50 µmol/L of exchange transfusion threshold, repeat serum bilirubin 4-6 hours after initiating phototherapy. Otherwise, repeat serum bilirubin every 6-24 hours depending on the severity to make sure serum bilirubin level is stable or falling.

Skin to skin	Continuous, rather than intermittent PT is recommended. However, using clinical judgement, encourage short breaks of up to 30 minutes for kangaroo care. Remove eye protection during kangaroo care.
Assessments	Document input / output - loose stools are common (dark urine and or light stools may indicate obstructive causes of jaundice). Bare weigh as necessary. Daily assessment of neonatal wellbeing should include assessment of skin integrity. Observe and record assessments 3-6 hourly in clinical record.
Monitoring	Continue cardiorespiratory monitoring as per unit policy for infants <32 weeks
Temperature	Continue temperature monitoring as per unit policy for infants <32 weeks
SBR Measurement	Repeat SBR 6 hours after commencement of phototherapy (the total SBR should be decreased by 34 µmol/L in this time period for both term and preterm neonates). Subsequent SBRs 6-24 hourly interval depending on the severity and rate of rise of SBR. If SBR is rapidly rising (> 8.5 µmol/L/hour) or continuing to rise under single light phototherapy consider changing to multiple light sources and earlier repeat of SBR. Repeat SBR 12-24 hours after phototherapy ceases.
Feeding	Feed the infant as appropriate and no need to interrupt enteral feeding in most cases.

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Position	Infants can be nursed in any position as per unit developmental care policy.
Skin care	Lotions or lubricants should not be used. Monitor for skin breakdown from increased faecal loss.
Eye care	Eye protective mask/patches are mandatory for conventional light therapy (check placement). Even if the neonate's eyes will not be directly exposed to BiliBed or fibre optic treatment lights, eye protection is preferred. Remove eye masks at feeds and check for eye discharge and conjunctivitis.
Surface area exposed	Ensure PT is applied to the maximum area of skin. Position phototherapy device according to manufacturer's instructions. Remove clothing but leave the nappy on for phototherapy.
CAUTIONS	**Do NOT use a BiliBed in a humidicrib.** **Do NOT turn the humidicrib off during phototherapy.** **Plastic heat shields are no longer recommended for use.** **If using Draeger 4000 lamp, it may be necessary to decrease humidicrib temperature to prevent overheating.**

6.2.4 Ceasing phototherapy

- Consider stopping PT once SBR has fallen below the PT threshold and clinically stable.
- Measure SBR 12-24 hours after ceasing PT to rule out significant rebound.

6.2.5 Contraindications to phototherapy

- Neonates with congenital porphyria.
- Family history of porphyria.
- Concurrent treatment with photosensitising drugs.

6.2.6 Intravenous Immunoglobulin (IVIG)

- Intravenous immunoglobulin (IVIG) acts by blocking antibody site and preventing the destruction of sensitised erythrocytes. IVIG contains pooled IgG extracted from the plasma of over 1000 blood donors.
- Use IVIG (500 mg/kg over 4 hours) as an adjunct to PT in cases of Rhesus or ABO haemolytic disease when SBR continues to rise rapidly (e.g. by >8.5 µmol/L/hour).
- IVIG should only be given with the consent of the neonatologist on-call.
- IVIG is a blood product, so written consent should be obtained from parents.

6.2.7 Exchange Transfusion

Use a double volume exchange transfusion to treat babies:

- Whose SBR indicates its necessity according to treatment threshold graphs and/or
- With clinical features and signs of acute bilirubin encephalopathy

In infants who have not been on PT at the time of SBR measurement:

- Commence multiple light PT with IV hydration while preparing for exchange transfusion
- Repeat SBR after approximately 4 hours prior to commencing exchange transfusion
- If SBR falls below exchange transfusion threshold, do not commence exchange transfusion but continue PT

NEONATAL JAUNDICE – MANAGEMENT IN INFANTS <32 WEEKS cont'd

During Exchange transfusion:
- Do not stop PT if possible
- Do not use albumin priming
- Do not routinely administer intravenous calcium

Following exchange transfusion:
- Continue PT
- Measure SBR within 2 hours and manage according to threshold graphs

7. DOCUMENTATION
- Integrated notes
- Observation Chart
- Neonatal Jaundice Threshold Graphs <32 weeks
- NICUS database

8. EDUCATIONAL NOTES
- Approximately 60% of term and 80% of preterm babies develop jaundice in the first week of life, and about 10% of breastfed babies are still jaundiced at 1 month of age.
- In most infants including preterm, jaundice is attributed to neonatal physiology with no underlying disease.
- Neurotoxicity of bilirubin: When the level of serum **unconjugated** bilirubin exceeds the binding capacity of albumin, the excess unbound bilirubin crosses the blood-brain barrier, resulting in neuronal injury.
- Prematurity, low birthweight and clinical complications, such as sepsis, acidosis and asphyxia have an increased risk of bilirubin neurotoxicity.
- The exact level of bilirubin to induce neurotoxicity is contested. Preterm infants have been observed to develop kernicterus at relatively lower TSB levels 170-206µmol/L (10-18mg/dL) (Watchko & Maisels, 2003).
- The goal of management is to lower the concentration of circulating bilirubin.
- Phototherapy is the recommended first line treatment. It employs blue wavelengths of light which are absorbed by dermal and subcutaneous bilirubin, inducing a fraction of the pigment to undergo photochemical reactions. These reactions alter the structure of bilirubin to make it less lipophilic and can be excreted in bile or urine without the need for conjugation (Maisels & McDonagh, 2008).
- The response to PT depends on a number of factors including clinical circumstance, gestational and post-natal age, birthweight, cause of jaundice, initial bilirubin level, light dosage and spectral emission. A decrease of 6-20% of the initial bilirubin level can be expected in the first 24 hours of standard phototherapy. Other studies have also observed higher reductions of 32-50% by varying spectral irradiance and configuration of standard phototherapy units (Maisels, 2001).
- However, a reduction in TSB levels alone is not adequate to substantiate a clear relationship between phototherapy and kernicterus as it is not simple a function of TSB but involves an interaction with the blood-brain barrier (Hansen, 2010).

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- RCT comparing PT against a control group found no statistically significant differences in neurodevelopmental outcomes at 1 and 6 years of age (Brown, 1985; Okwundu, Okoromah & Shah, 2013). Similarly, Morris, 2008 conducted a comparison of aggressive vs conservative PT in ELBW infants and found no significant difference in the rate of death or neurodevelopmental impairments. However, aggressive PT reduced the rate of neurodevelopmental impairment and significantly reduced the mean peak TSB level. This reduction was offset by a 5% increase in risk of death (34% vs 29%) with aggressive PT in infants weighing 501-750 grams. While it was not statistically significant, a post-hoc analysis estimated a 93-99% probability that mortality was increased in this subgroup. The mechanism is unclear but evidence suggest an oxidative injury as these infants have gelatinous, thin skin which readily transmits light. The antioxidant properties of bilirubin are also reduced in aggressive PT (Morris et al, 2008; Arnold, Pedroza & Tyson, 2014).
- Recommendations on PT thresholds vary across the regions and more of consensus view than thoroughly evidence based.
- **UK NICE Guidelines (NICE, 2016)** for PT for preterm infants were based on a longstanding and common approach simple formula
    - bilirubin in µmol/L = (gestational age × 10) − 100

- UK NICE Guidelines used this formula for babies aged 72 hours or older. The threshold levels during the first 72 hours were determined by drawing a straight line from a level of 40 µmol/L (the upper limit of normal for the umbilical cord blood bilirubin) at 0 hour of age to the formula-based level at 72 hours. From 72 hours of age, the line is horizontal.
- **American Academy of Paediatrics (AAP) Guidelines**: The AAP guideline provides age-specific bilirubin treatment thresholds for only 3 risk groups, and suggested that practitioners individualise treatment decisions according to actual gestational age (Newman, Kuzniewicz, Lijestrand, Soora, McCulloch & Escobar, 2009).
- **NICHD Network Recommendations** (Maisels, Watchko, Bhutani & Stevenson, 2012):

Gestational Age (Week)	**Initiation Total Serum Bilirubin (mg/dL; *µ*mol/L)**	
	Phototherapy	*Exchange Transfusion*
$<28^{+0}$	5-6; 85-102	11-14; 187-238
$28^{+0} – 29^{+6}$	6-8; 102-136	12-14; 204-238
30^{+0}-31^{+6}	8-10; 136-170	13-16; 221-272
32^{+0}-33^{+6}	10-12; 170-204	15-18; 255-306
34^{+0}-35^{+6}	12-14; 204-238	17-19; 289-323

* Lower range of TSB levels used for infants with risk factors e.g. lower gestational age, serum albumin <2.5g/dL, rapidly rising TSB levels suggestive of haemolytic disease, clinically unstable infants

- **Norwegian Guidelines** (Bratlid, Nakstad & Hansen, 2011): The Norwegian Guidelines use birth weight as a measure of prematurity instead of gestational age. There is no treatment indication defined during the first 24 hours as health newborns without haemolytic jaundice rarely present with visible jaundice at this time.

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- **Royal Hospital for Women Jaundice threshold graphs**
  - Our new graphs for infants <32 weeks GA have been introduced in February 2017.
  - Only change from the previous graphs: PT threshold at 0 hours of age was moved up from 40 to 60 µmol/L and then straight line was drawn to the PT threshold at 72 hours of age.

Short-Term Side Effects of PT

- Neonate-Parent Interaction: Phototherapy separates neonates from mothers, which may interfere with establishing parent-child bonding. (Xiong, Qu, Cambier & Mu, 2011).
- Dehydration: There is an acute change in the thermal environment of infants, leading to insensible water loss, hypothermia/hyperthermia and dehydration. Impaired water and electrolyte absorption induces phototherapy-associated diarrhoea, increasing intestinal fluid losses. Close monitoring and fluid supplementation is recommended for newborns, especially low birth weight infants. Phototherapy can also lead to hypocalcaemia due to increased urinary calcium excretion and disruption of calcium homeostasis by light inhibiting pineal secretion of melatonin. Covering the head by applying a hat reduces the incidence of hypocalcaemia, especially in preterm neonates (Yurdakok, 2011).
- Patent Ductus Arteriosus: It is hypothesised that light penetrating the chest wall of preterm infants can cause the relaxation of aortic smooth muscle, thus preventing the closure of or reopening ductus arteriosus. A study on ELBW infants undergoing phototherapy had a significantly increased incidence of PDA compared to those not undergoing phototherapy [76% vs 53%]. It was also reported that more than 50% of small preterm infants had reopening of a closed ductus arteriosus after phototherapy (Yurdakok, 2011).
- Retinal Damage: As photon absorption is increased during blue light exposure, the retina is more susceptible to light-induced apoptosis. To prevent this, the infant's eyes should be protected by eye pads or head shields.
  There is some evidence suggesting an association between phototherapy and retinopathy of prematurity (ROP). A retrospective study found that infants with ROP had a significantly longer duration of phototherapy than those without (Xiong et al, 2011).
- Oxidative Stress: Bilirubin is an endogenous anti-oxidant. At moderate levels, it scavenges reactive oxygen species, reduces oxidant-induced cellular injury and attenuate oxidation stress. In term neonates, total bilirubin up to 20 mg/dL has a positive correlation with total antioxidant capacity and negative correlation with malondialdehyde, an important marker of lipid peroxidation. It has been suggested that PT induces the release of reactive nitrogen and oxygen species, and photolysis products that are cytotoxic. In term and late-preterm infants, phototherapy leads to lower Total Antioxidant Capacity levels and increase oxidative stress index (OSI).
  While this has the propensity to cause DNA damage, there have not been any widespread consequences. As a precaution, gonadal shielding is recommended (Yurdakok, 2011).
- Bronze Baby Syndrome (BBS): BBS is characterised by brown discolouration of skin, serum and urine. It is a rare complication in neonates with raised conjugated bilirubin level. While BBS subsides after discontinuation of phototherapy, it may be an additional risk for developing kernicterus (Yurdakok, 2015).
- Infants with cholestatic jaundice have developed rare purpuric and bullous eruptions, possibly attributable to sensitisation by accumulating porphyrins (Maisels & McDonagh, 2008).

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Long-Term Side Effects of PT

- Allergic Diseases: A recent systematic review showed a significant increase in the odds of asthma [OR 4.26] and allergic rhinitis [OR 5.37] after neonatal phototherapy. The exact mechanism is unknown but could involve abnormalities in Th-2/Th-1, cytokine levels, impaired bilirubin antioxidant defence and increased eosinophilic cationic protein levels after PT (Yudakok, 2015).
- Cancer: Wickremasinghe et al, 2016 found that phototherapy was associated with an increased risk of cancer in the first year after birth, although the absolute risk increase is small. Newman et al also explored an association between phototherapy and childhood cancer and found that PT was no longer significant when adjusted for potential confounders. In vivo experiments on neonates have demonstrated DNA damage, alterations in cytokine levels and evidence of oxidative stress after treatment with phototherapy. These conditions are implicated in the pathogenesis of cancer, providing a potential mechanism for causality (Wickremasinghe et al, 2016).

Exchange transfusion thresholds for babies less than 38 weeks of gestation

- For preterm babies, UK-NICE Guidelines use a simple formula (bilirubin in µmol/L = gestational age × 10) that has been in use for many years. The threshold levels during the first 72 hours of life were determined by drawing a straight line from 80 µmol/L at birth to the formula-based level at 72 hours.

Bilirubin Encephalopathy or Kernicterus

- Clinically, kernicterus presents as follows:
    - Stage 1: Poor Moro Reflex, decreased tone, lethargy, poor feeding, vomiting, high-pitched cry.
    - Stage 2: Opisthotonus, seizures, fever, rigidity, oculogyric crises, paralysis of upward gaze.
    - Stage 3: Spasticity is decreased at about 1 week of age.
    - Stage 4: Late sequelae include spasticity, athetosis, deafness, mild mental retardation, paralysis of upward gaze and dental dysplasia

Other therapies

- Albumin - The use of albumin is not currently recommended and there is insufficient evidence to support its routine use as an adjunct therapy prior to exchange transfusion.
- Other therapies - Do not use any of the following to treat hyperbilirubinemia: Agar, barbiturates, charcoal, cholestyramine, clofibrate, D-penicillamine, metalloporphyrins.

9. RELATED POLICIES/PROCEDURES/CLINICAL PRACTICE LOP

- Exchange Transfusion
- NSW Health 2016. Doc Number GL2016_027. Neonatal Jaundice - Identification and management in neonates ≥32 weeks gestation

10. RISK RATING

- Medium

11. NATIONAL STANDARD

- Standard 12: Provision of Care.

REFERENCES

1. NSW Health 2016. Doc Number GL2016_027. Neonatal Jaundice - Identification and management in neonates ≥32 weeks gestation.
2. American Academy of Pediatrics (AAP) Subcommittee on Hyperbilirubinaemia. (2004). Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. Pediatrics, 114(1), 297-316.
3. Arnold, C., Pedroza, C., & Tyson, J. (2014). Phototherapy in ELBW newborns: Does it work? is it safe? the evidence from randomized clinical trials. . Seminars in Perinatology, 38(7), 452-464.
4. Arnolda, G., New, H., Trevisanuto, D., Thin, A., Thein, A., Defechereux, T., et al. (2015). Risk factors for acute bilirubin encephalopathy on admission to two myanmar national paediatric hospitals. Maternal Health, Neonatology and Perinatology, 1, 22.
5. Arun, T., Bhat, V., & Joseph, N. (2012). Association between peak serum bilirubin and neurodevelopmental outcomes in term babies with hyperbilirubinemia. The Indian Journal of Pediatrics, 79(2), 202-206.
6. Banks J, Montgomery, D., Coody, D., & Yetman, R. (1996). Hyperbilirubinemia in the term newborn. Journal of Pediatric Health Care, 10(5), 228-230. doi:http://dx.doi.org.wwwproxy0.library.unsw.edu.au/10.1016/S0891-5245(96)90010-3
7. Cashore W. (1980). Free bilirubin concentrations and bilirubin-binding affinity in term and preterm infants. Journal of Pediatrics, 96(3), 521-527.
8. Horn A, Kirsten G, Kroon S, Henning P, Moller G, Adhikari M, et al. (2006). Phototherapy and exchange transfusion for neonatal hyperbilirubinaemia. South African Medical Journal, 96(9), 819-824.
9. Maisels J. (2001). Phototherapy - traditional and nontraditional. Journal of Perinatology, 21(1), S93-S97.
10. Maisels MJ, Watchko JF, Bhutani VK, Stevenson DK. (2012). An approach to the management of hyperbilirubinemia in the preterm infant less than 35 weeks of gestation. Journal of Perinatology, 32(9), 660-664.
11. Maisels MJ. (2009). Neonatal hyperbilirubinemia and kernicterus — not gone but sometimes forgotten. Early Human Development, 85(11), 727-732.
12. Maisels MJ, McDonagh A. (2008). Phototherapy for neonatal jaundice. The New England Journal of Medicine, 358(9), 920-928.
13. Morris BH, Oh W, Tyson JE, Stevenson DK, Phelps DL, O'Shea TM, et al. (2008). Aggressive vs. conservative phototherapy for infants with extremely low birth weight. N Engl J Med, 359(18), 1885-1896.
14. Newman T, Kuzniewicz M, Liljestrand P, McCulloch C, Escobar G. (2009). Numbers needed to treat with phototherapy according to american academy of pediatrics guidelines. Pediatrics, 123(5), 1352-1359.
15. NICE. (2016). Jaundice in newborn babies under 28 days. Retrieved 07/05, 2016, from https://www.nice.org.uk/guidance/cg98
16. Okwundu C, Okoromah C, Shah P. (2013). Prophylactic phototherapy for preventing jaundice in preterm or low birth weight infants. Evidence-Based Child Health: A Cochrane Review Journal, 8(1), 204-249.
17. Porter M, & Dennis B. (2002). Hyperbilirubinaemia in the term newborn. American Family Physician, 65(4), 599-606.
18. Hansen TW. (2010). Phototherapy for neonatal Jaundice—Therapeutic effects on more than one level? Seminars in Perinatology, 34(3), 231-234.
19. Society of Hospital Medicine (SoHM). (2010). Neonatal jaundice. Journal of Hospital Medicine, 5(S2), 25-26.
20. Watchko J, Maisels MJ. (2003). Jaundice in low birthweight infants: Pathobiology and outcome. Archives of Disease in Childhood - Fetal & Neonatal Edition, 88(6), F455-F458.
21. Wickremasinghe A., Kuzniewicz M, Grimes B, McCulloch E, Newman T. (2016). Neonatal phototherapy and infantile cancer. Pediatrics, 137(6)
22. Woodgate, P., & Jardine, L. (2011). Neonatal jaundice. British Medical Journal Clinical Evidence, 2011
23. Xiong T, Qu Y, Mu D. (2011). The side effects of phototherapy for neonatal jaundice: What do we know? what should we do? European Journal of Pediatrics, 170(10), 1247-1255.
24. Yudakok M. (2015). Phototherapy in the newborn: What's new? Journal of Pediatric and Neonatal Individualized Medicine, 4(2).

Feb 2017 : replaced RHW LOP Neonatal Jaundice – Unconjugated Hyperbilirubinemia Management
And also added to RHW LOPs : NSW Health GL2016-027 : Neonatal – Jaundice Identification and Management in Neonates ≥32 weeks gestation

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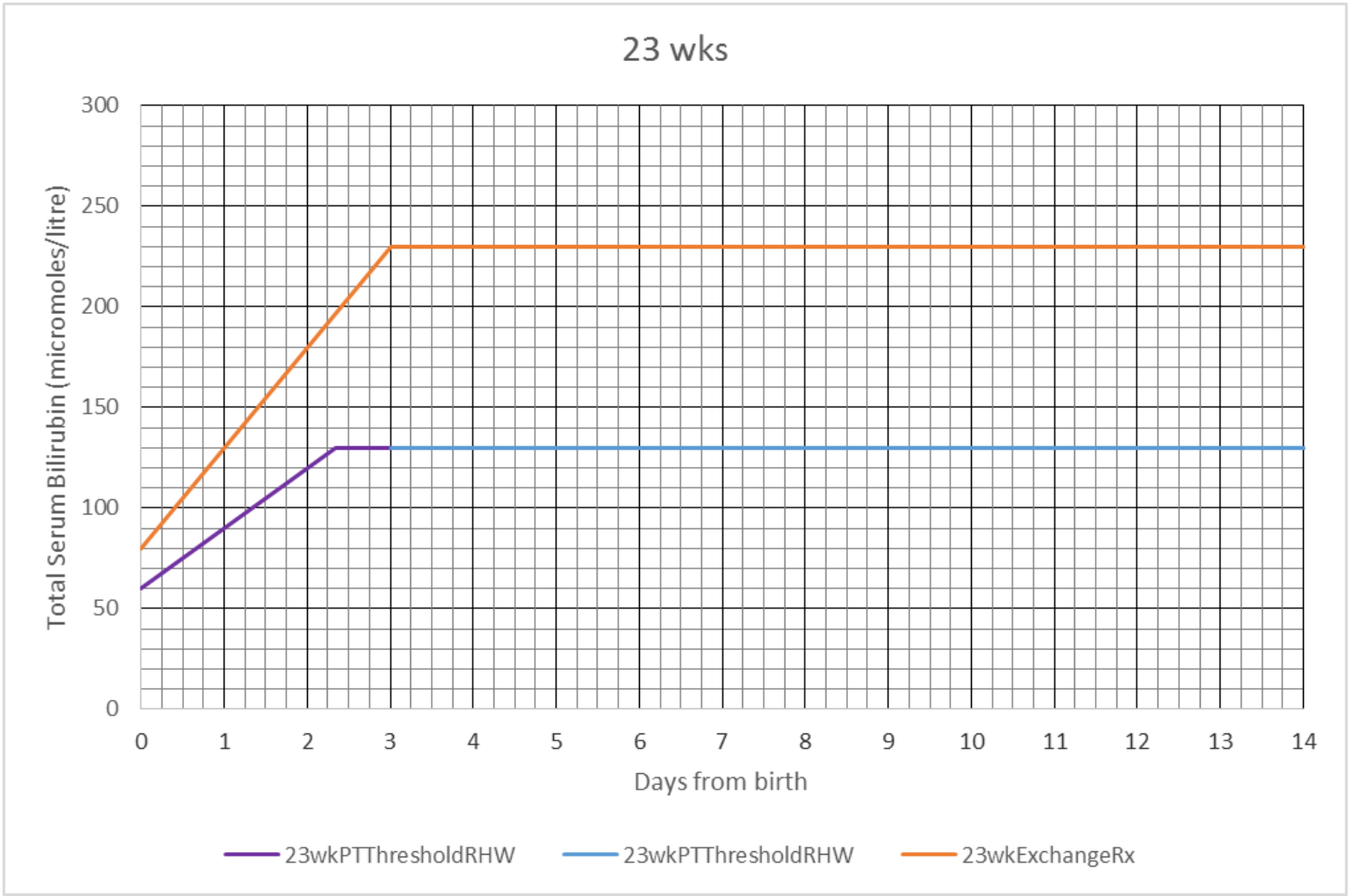
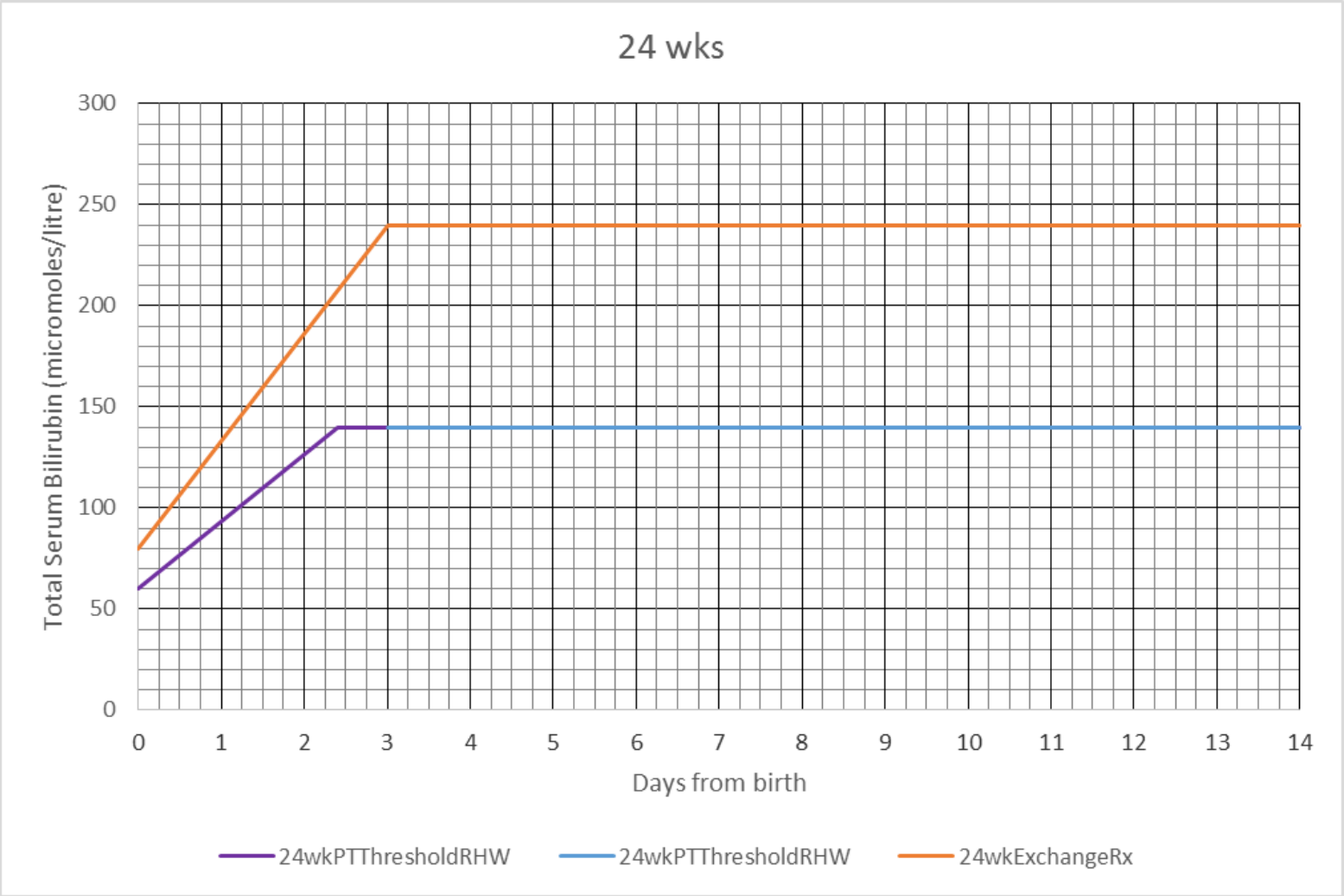
Due for Review	28/02/2020	

Appendix 1. Jaundice Threshold Graphs at 23 weeks gestation at birth



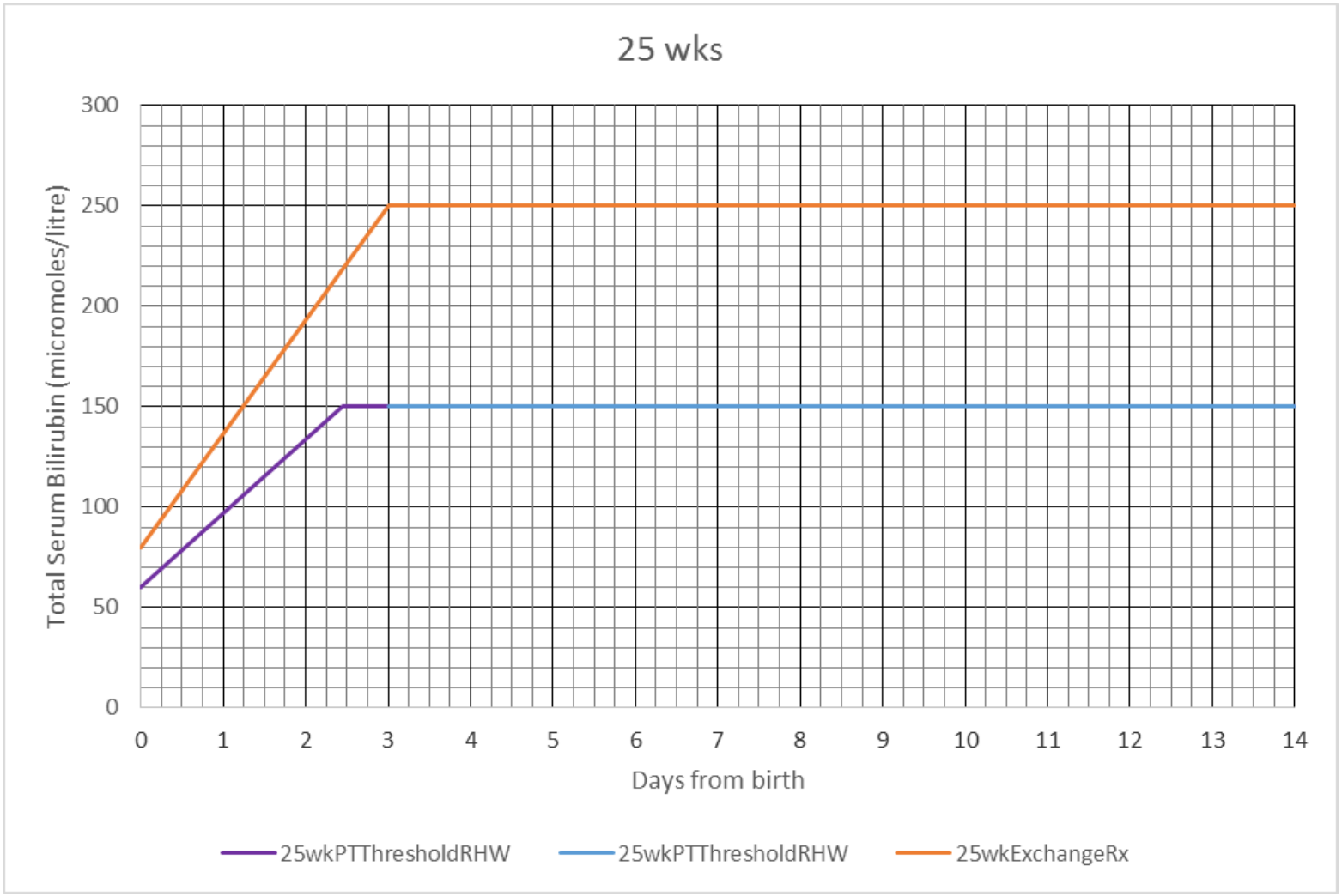
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 2. Jaundice Threshold Graphs at 24 weeks gestation at birth



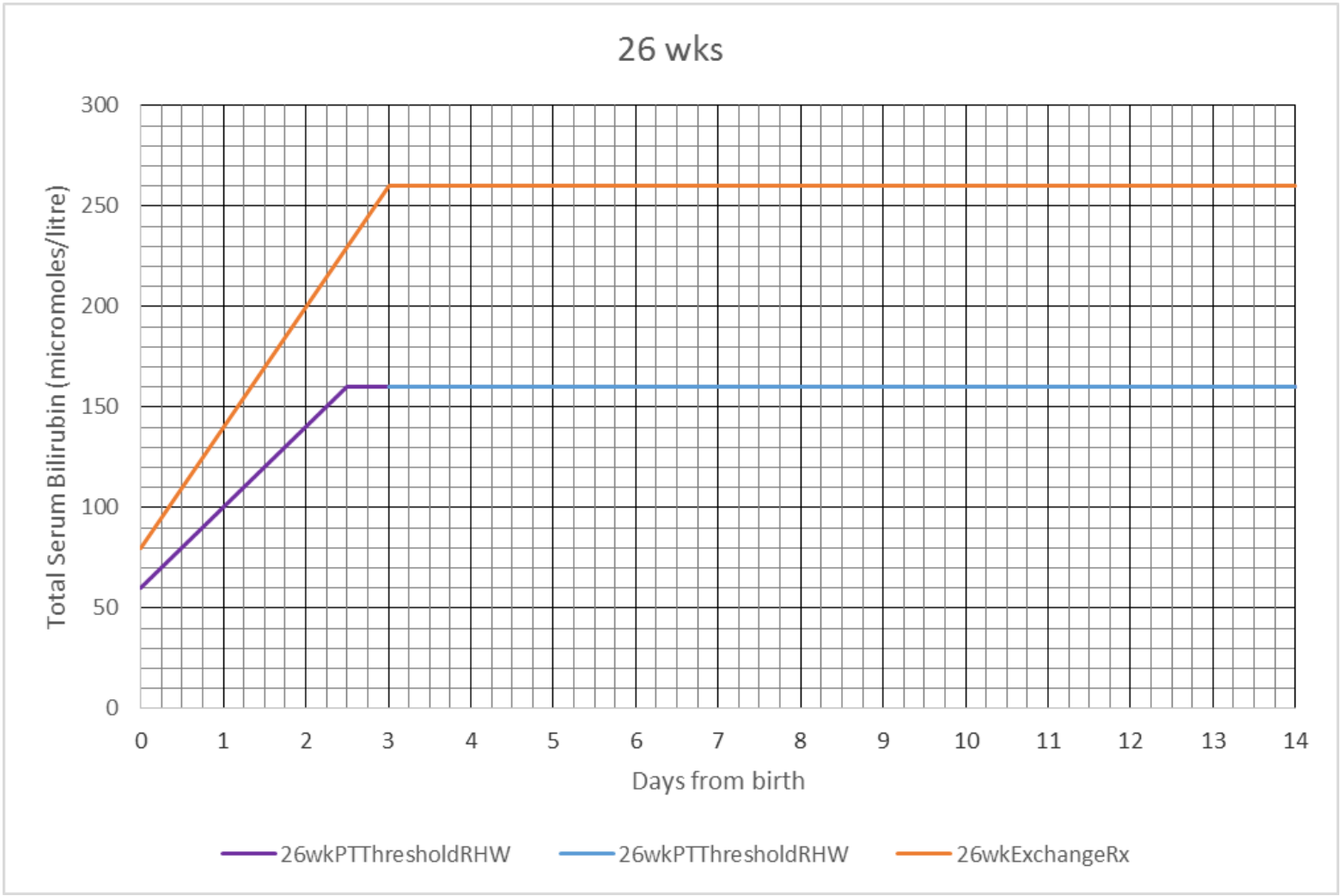
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 3. Jaundice Threshold Graphs at 25 weeks gestation at birth



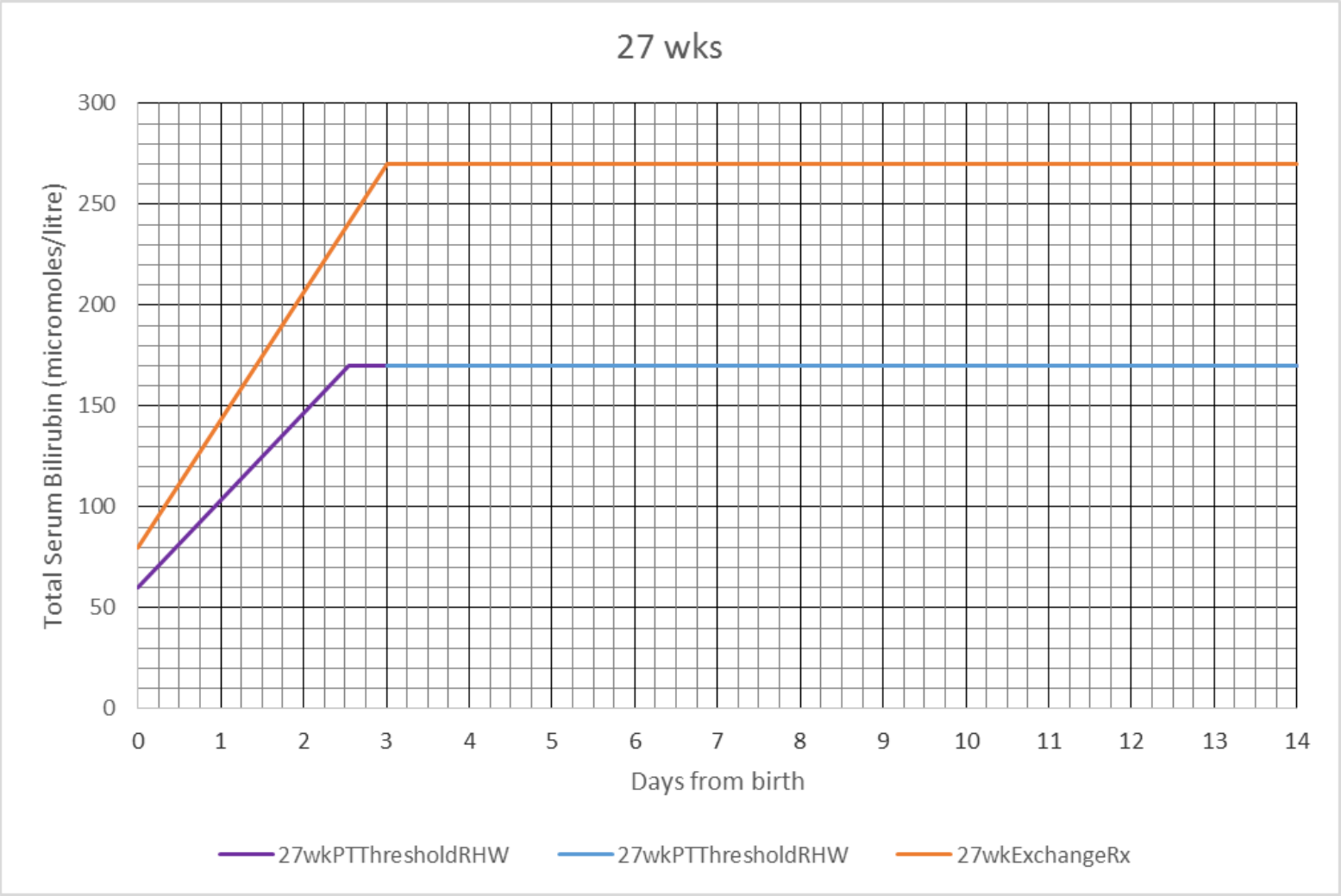
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 4. Jaundice Threshold Graphs at 26 weeks gestation at birth



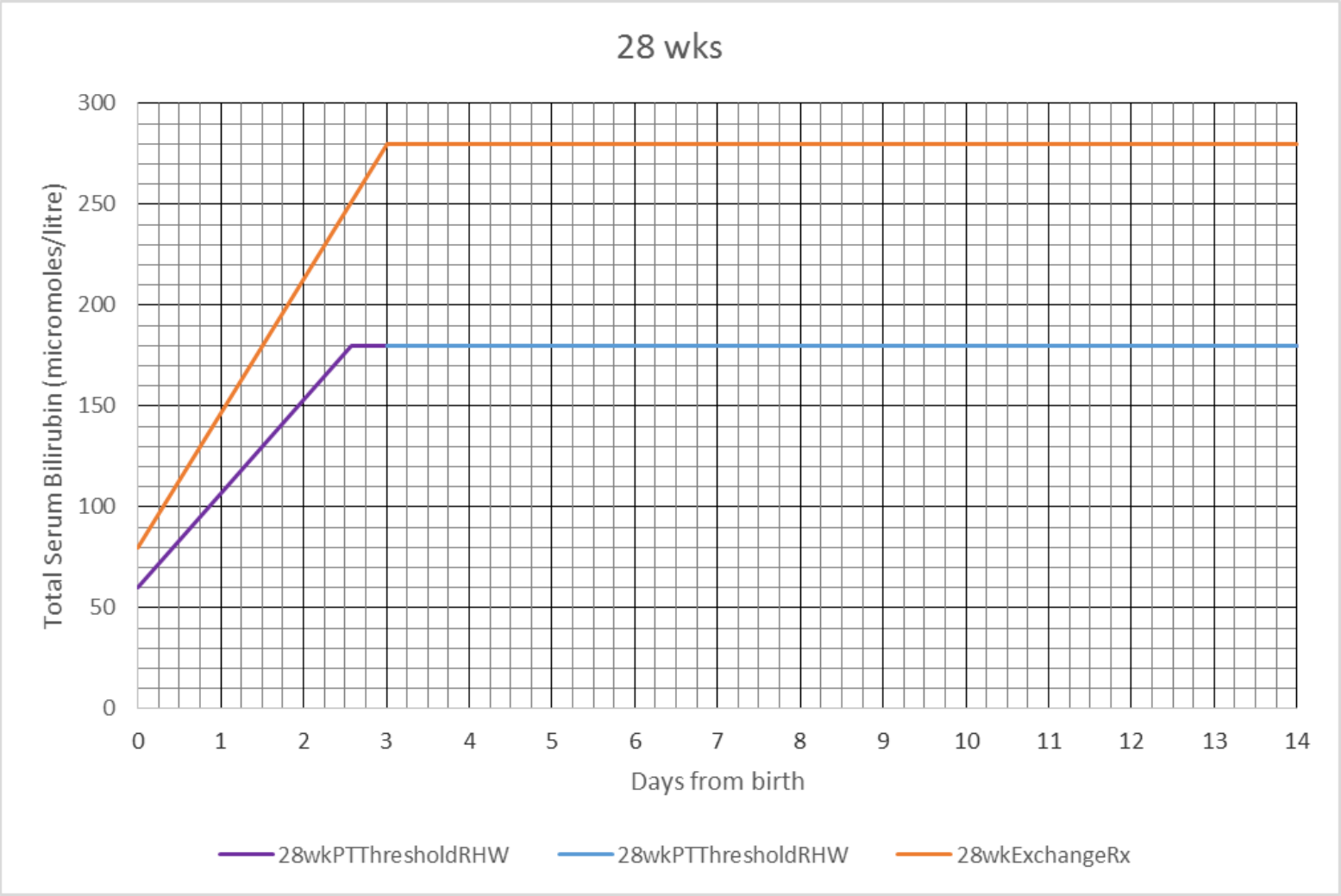
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 5. Jaundice Threshold Graphs at 27 weeks gestation at birth



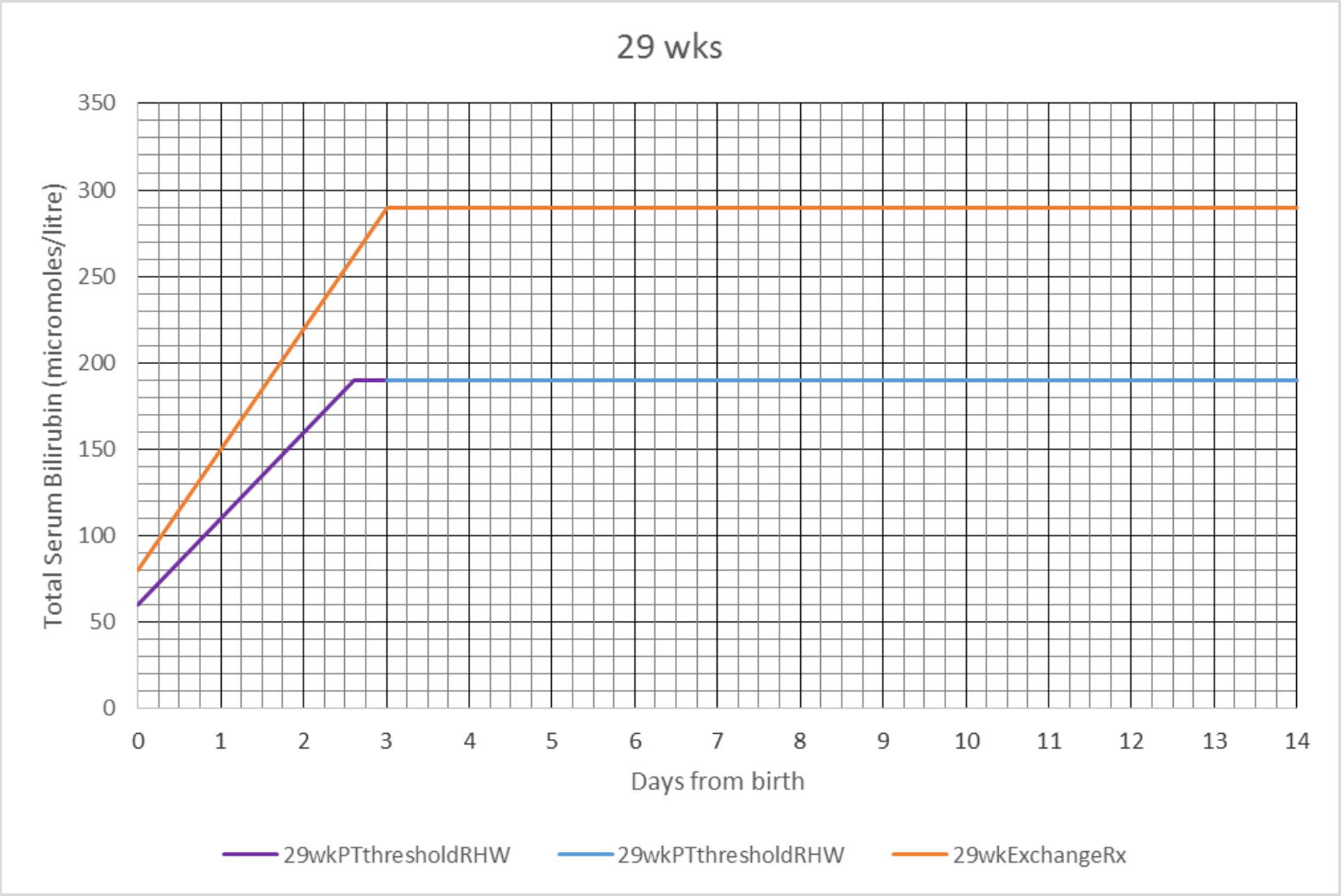
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 6. Jaundice Threshold Graphs at 28 weeks gestation at birth



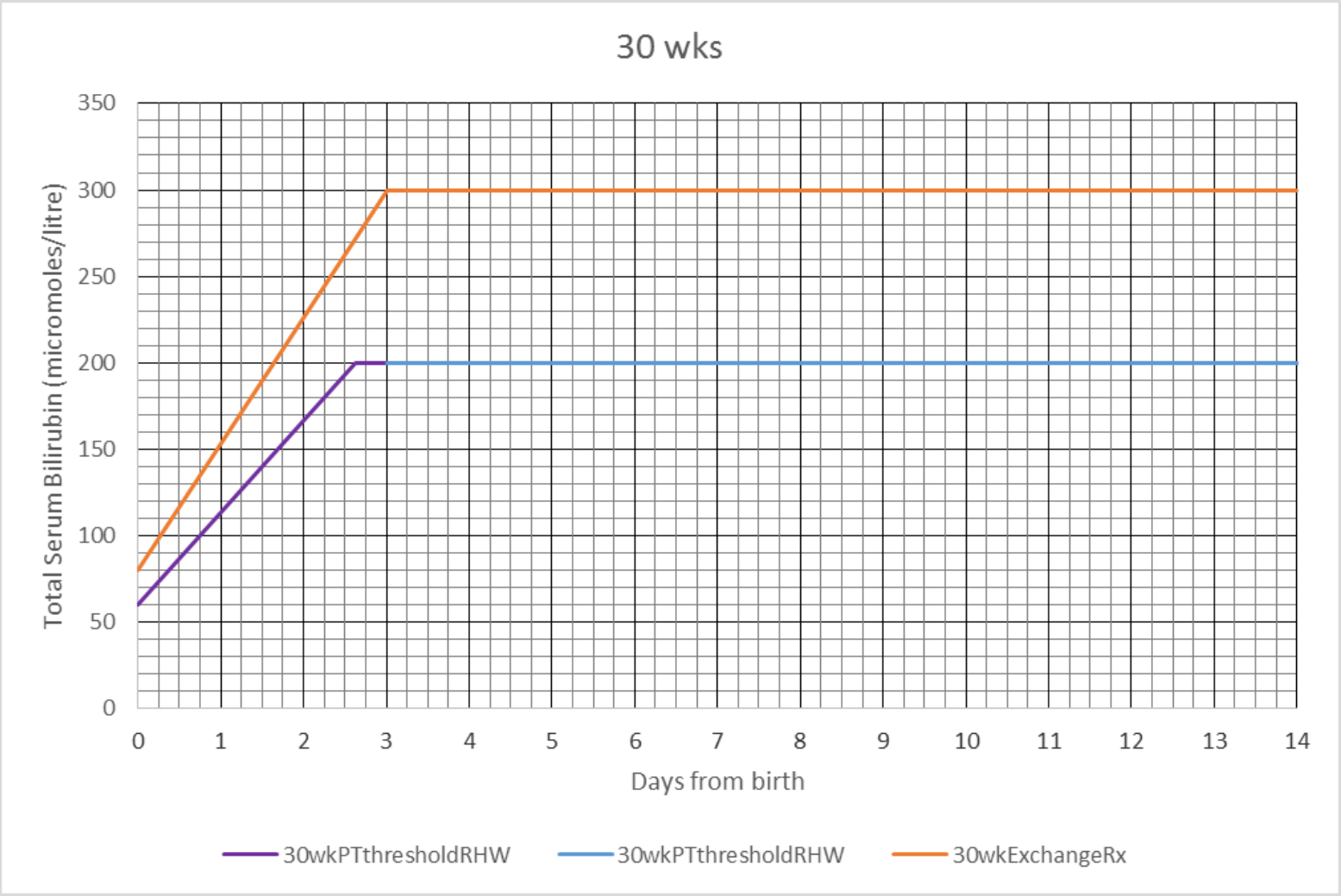
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 7. Jaundice Threshold Graphs at 29 weeks gestation at birth



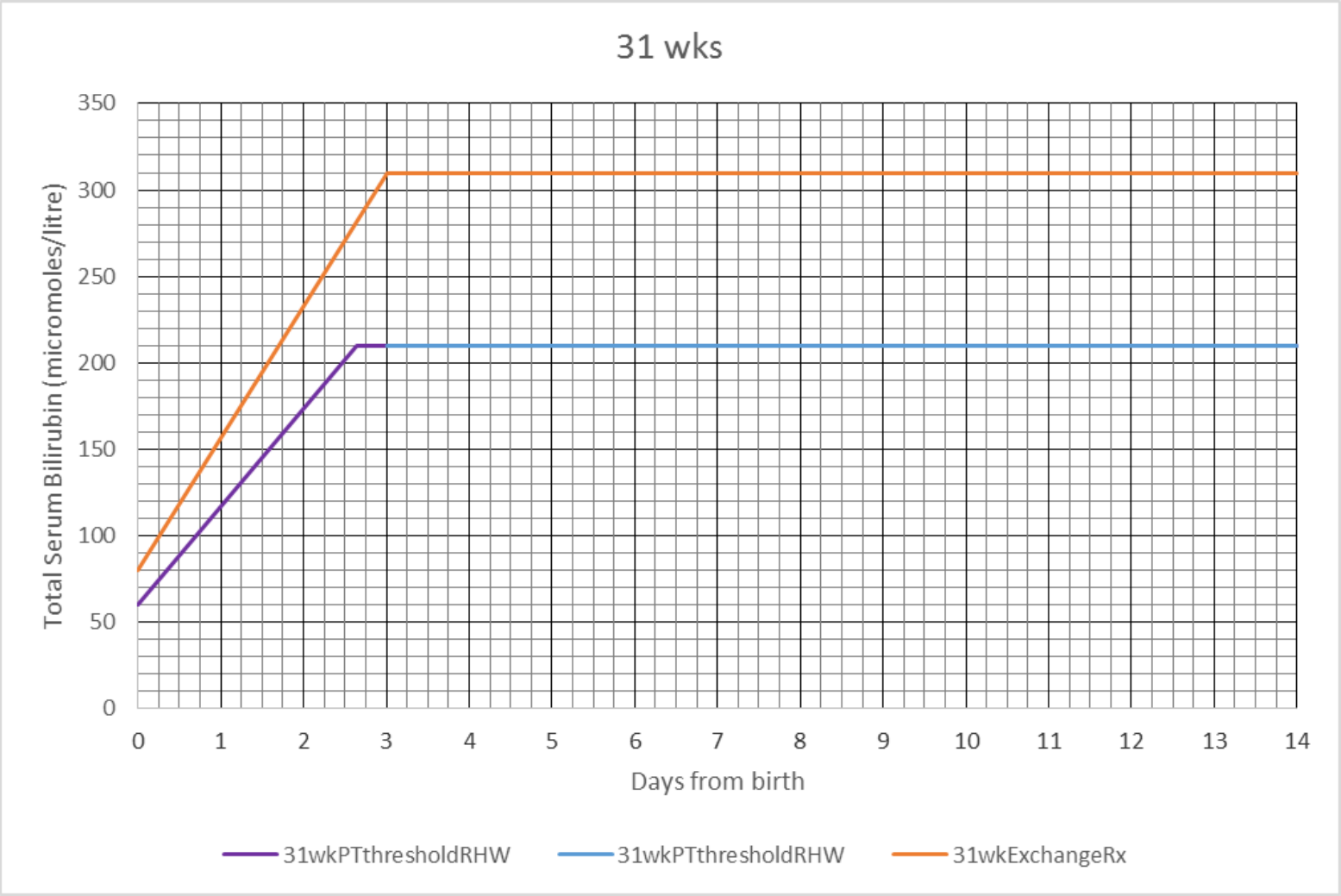
*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 8. Jaundice Threshold Graphs at 30 weeks gestation at birth



*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.

Appendix 9. Jaundice Threshold Graphs at 31 weeks gestation at birth



*It is an option to start PT at SBR 20-40 µmol/L below the thresholds in the presence of risk factors including isoimmune haemolytic disease, G6PD deficiency, IUGR, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, bruising or haemorrhages.