A Survey of Practice and Knowledge of Refugee and Migrant Pregnant Mothers Surrounding Neonatal Jaundice on the Thailand–Myanmar Border

by Taco J. Prins,1 Margreet Trip-Hoving,1 Moo Kho Paw,1 Mar Le Ka,1 Nyo Nyo Win,1 Gay Htoo,1 Mu Kaw Hser,1 Kesinee Chotivanich,2 François Nosten,1,3 and Rose McGready1,3

1Shoklo Malaria Research Unit, Mahidol-Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, Mae Sot, Thailand
2Mahidol-Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand
3Centre for Tropical Medicine and Global Health, Nuffield Department of Medicine, University of Oxford, Oxford, UK

Correspondence: Taco J Prins, Shoklo Malaria Research Unit, Mahidol-Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, Mae Sot, Thailand. E-mail <tacojanprins@hotmail.com>

ABSTRACT

Background: In populations with a high prevalence of glucose-6-phosphate dehydrogenase deficiency, practices that can induce haemolysis need to be identified to raise awareness of preventable risks. The aim of this survey was to determine the proportion of prospective mothers using haemolytic agents and their knowledge and practice surrounding neonatal jaundice.

Methods: Pregnant mothers were invited to participate in a cross-sectional survey conducted at Shoklo Malaria Research Unit on the Thailand–Myanmar border.

Results: From 12 April 2015 to 12 June 2015, 522 pregnant women completed the survey. Mothball use in the household was reported by 41.4% (216 of 522) of prospective mothers and menthol containing products on baby skin by 46.7% (244 of 522).

Conclusion: Just over 40% of the households reported use of naphthalene-containing mothballs. Future health promotion activities that focus on reducing naphthalene mothball and menthol-containing products use have the potential to reduce rates of severe neonatal jaundice in this population.

KEYWORDS: neonatal jaundice, G6PD deficiency, health knowledge, attitudes, practice.

BACKGROUND

Neonatal jaundice is a common condition affecting 50–60% [1–5] of full-term neonates and 80% [1, 5] of preterm neonates in their first days of their life. Most of the time, serum bilirubin does not reach a high level at which it precipitates in the brain and gives neurological damage, known as acute bilirubin encephalopathy and kernicterus [6]. This is an important problem in middle- and low-income countries in South-Asia and Sub-Saharan Africa, where 73–81 per 100 000 live births develop kernicterus [7, 8], compared with only 0.4–10 per 100 000 live births.
in developed countries. In high-income countries, it is rarely associated with neonatal mortality, in contrast to low- and middle-income countries where it is still an important cause of neonatal mortality [7, 15].

Kernicterus and severe hyperbilirubinemia are strongly associated with glucose-6-phosphate dehydrogenase (G6PD) deficiency [6, 16] and can be exacerbated by haemolytic agents such as menthol and naphthalene [17–20]. Several case reports describe G6PD deficiency and severe hyperbilirubinemia in neonates [21–24], and in two of the cases most likely triggered by the use of naphthalene containing mothballs [22, 23].

Early detection and treatment are the key elements to prevent severe neonatal jaundice. An understanding of the knowledge level in a specific population can help to identify the gaps and target areas for intervention. There is also a need to raise awareness about G6PD deficiency and the danger of the use of haemolytic triggers, because this is a preventable cause of severe neonatal jaundice.

Shoklo Malaria Research Unit (SMRU) provides medical care in rural areas on the border between Thailand and Myanmar, principally for refugees and migrants from Myanmar. The incidence of G6PD deficiency is 7.2–13.7% [25, 26] in this population, and between 2008 and 2011 eight neonates died of kernicterus, four of whom were G6PD deficient [26]. There is no data available on the maternal practice and knowledge surrounding neonatal jaundice in this population and mothballs are available in the area. The primary aim of this survey was to assess mothball use among prospective mothers in the population, as this is amenable to change.

**METHODS**

**Ethical approval**

This survey was preliminary to a larger study on the aetiology of neonatal jaundice with ethical approval from the Faculty of Tropical Medicine at Mahidol University in Thailand (MUM 2014 032-01). Oxford University (OXTREC 41-14) and the Tak Community Advisory Board (TCAB-4/1/2015) gave ethical approval for the survey.

**Study site and participants**

This descriptive cross-sectional survey was carried out in three SMRU clinics: Wang Pa (WPA), Mawker Thai (MKT) and Mae La (MLA) between 12 April 2015 and 12 June 2015. The clinics are located on the north-western border of Thailand and Myanmar, in Tak Province, and patients and healthcare workers are predominantly Karen or Burmese from Myanmar. In these populations, neonates and young infants are traditionally swaddled in baby cloths as described previously [27]. MLA clinic is located in the refugee camp, which is the home for approximately 40 000 refugees [28]. The 2.4 km² total area of the camp implies relative easy clinic access, in contrast to WPA and MKT migrant populations, which are more widely dispersed with several hours of travel required to reach the clinics.

**Study procedures**

The knowledge of the pregnant women was obtained through a questionnaire. Only pregnant women attending SMRU antenatal care and who gave written (or thumb print and declaration by a witness) informed consent were invited to participate in the survey.

The questionnaire for pregnant women consisted of 11 questions on neonatal jaundice, divided into four main subjects: recognizing neonatal jaundice, the action she would take if she had a child with neonatal jaundice, the understanding of neonatal jaundice and the use of haemolytic agents (Supplementary file 1). Mothers were tested about the recognition of neonatal jaundice by showing a picture of a neonate with jaundice. In addition, data were collected about the place of residence, parity, age and the time to travel to the clinic. The questionnaires were recorded onto the survey sheets by trained local counsellors, who could speak the local languages, Karen and Burmese, owing to low literacy rate among the population [29].

**Sample size**

There is limited data on the prevalence of maternal use of haemolytic agents in this and other regions. One study [30] from Nigeria published in 1985 reported a 45–87% prevalence of the use of haemolytic agents. Using a precision-based sample calculation,
385 women would be required to obtain the true proportion of women who use haemolytic agents with 95% confidence interval and ±10% margin of error if the estimated prevalence was in the order of 50%.

**Statistical analysis**

Data were entered in Microsoft Access for Windows 7. Data were exported to Stata 14 (Statacorp, College Station, TX) for descriptive analysis. Fisher’s exact test and the Chi-squared test were used to measure various associations with the knowledge and practice surrounding neonatal jaundice.

The level of significance was set as $p < 0.05$.

**RESULTS**

The total number of pregnant women included was 522 of which 283 (54.2%) were from MLA refugee camp and the remainder from the migrant sites: 63 (12.1%) in WPA and 176 (33.7%) in MKT (Table 1). Approximately one in three (37.6%) of the pregnant women were nulliparous. Of note, in the mothers with a previous birth, 61 (18.7%) had a child who had been admitted to special care baby unit (SCBU) because of neonatal jaundice.

Almost half, 216 (41.4%, 95% CI: 37.2–45.6), of the pregnant women reported the use of mothballs. Fewer mothers, 95 (18.2%), reported using them to store their baby cloths and blankets. The use of menthol-containing products on baby skin was high, with 244 (46.7%) of the surveyed mothers reporting use. While the majority of the pregnant women, 483 (92.5%), could recognize jaundice (Table 2) and 498 (95%) thought it was harmful, only 69 (13.2%) provided a reason (liver problem or infection) for why a baby could have jaundice. Healthcare workers were an important information source for neonatal jaundice (Table 2).

The majority of the women, 502 (96.2%), reported they would bring their baby with neonatal jaundice to the clinic and only 13 (2.5%) would use herbal/traditional treatments: eight proposed oral and five topical treatment. Herbal treatment consisted of leaves of different trees that have a special meaning for the Karen, and one mother suggested tobacco leaves.

| Table 1. Characteristics of the mothers |
|-----------------------------------------|
| Variable                                | $N\ (%)\ n = 522$ |
|-----------------------------------------|-------------------|
| Surveyed at each clinic, $n\ (%)$       |                   |
| MLA                                     | 283 (54.2)        |
| WPA                                     | 63 (12.1)         |
| MKT                                     | 176 (33.7)        |
| Age, years (mean ± SD), [range]         | 26.0 ± 6.8        |
| Age groups, $n\ (%)$                    |                   |
| <19                                     | 101 (19.4)        |
| 20–24                                   | 154 (29.5)        |
| 25–30                                   | 127 (24.3)        |
| >30                                     | 140 (26.8)        |
| Average travel time to clinic, minutes, mean ± SD [range] | 112 ± 362 [1 min–2 days] |
| Travel time, groups, $n\ (%)$           |                   |
| 0–59 min (<1 h)                         | 364 (69.7)        |
| 60–299 min (1 to < 5 h)                 | 135 (25.7)        |
| ≥300 (5 or more hours)                  | 23 (4.4)          |
| Gravida: median (25th, 75th), [range]   | 1 (1,4) [1-10]    |
| Parity: median (25th, 75th), [range]    | 1 (0,2) [0-9]     |
| Nulliparous, $n\ (%)$                   | 196 (37.6)        |
| Previous child admit for neonatal jaundice if $Pa \geq 1, n\ (%)$ | 18.7% (61/326) |

$Pa = parity.$

Knowledge and practice were compared between nulliparous and parous women, and mothers who had a child with neonatal jaundice or not (Table 3). The proportion of women who used sun exposure, traditional treatment and menthol-containing cream or ointment was significantly lower in nulliparous women. A significantly higher proportion of mothers with experience of neonatal jaundice in a former pregnancy were able to provide reasons for the cause of jaundice in comparison to parous mothers without this history (Table 3).

**DISCUSSION**

The reported use of mothballs included 40% (95% CI: 37.2–45.6) of the pregnant population, and one in five mothers reportedly used them to store baby cloths and blankets. Reassuringly, most mothers could recognize jaundice, and if recognized also reported that they would bring their infant to the
Table 2. Knowledge and practice surrounding neonatal jaundice of the mothers

|                                | Yes n (%) | No n (%) | Do not know n (%) |
|--------------------------------|-----------|----------|-------------------|
| Use mothballs in the house     | 216 (41.4)| 306 (58.6)| NA                |
| Use mothballs to store baby cloths/blankets | 95 (18.2) | 427 (81.8) | NA                |
| Use menthol-containing cream/ointments on the baby skin | 244 (46.7)| 278 (53.3)| NA                |
| Recognize jaundice (from photo) | 483 (92.5)| 39 (7.5) | NA                |
| Identify why jaundice can occur | 69 (13.2) | 453 (86.8)| NA                |
| Learned about neonatal jaundice from: |          |          |                   |
| Family friends                 | 141 (27.0)| NA       | NA                |
| Midwife/healthcare workers     | 338 (65.9)| NA       | NA                |
| Traditional birth attendant    | 1 (0.2)   | NA       | NA                |
| Nobody                         | 36 (6.9)  | NA       | NA                |
| Action if baby is jaundiced (>1 answer possible) |          |          |                   |
| Come to the clinic             | 502 (96.2)| NA       | NA                |
| Sun exposure                   | 73 (14.0) | NA       | NA                |
| Herbal/traditional treatment   | 13 (2.5)  | NA       | NA                |
| More breastfeeding             | 18 (3.5)  | NA       | NA                |
| Nothing                        | 2 (0.4)   | NA       | NA                |
| Think jaundice can be harmful  | 498 (95.4)| 23 (4.4) | 1 (0.2)           |
| Understand consequence of jaundice |          |          |                   |
| Nothing happens                | 128 (24.5)| 368 (70.5)| 26 (5.0)         |
| Baby become sick               | 500 (95.8)| 13 (2.5) | 9 (1.7)           |
| Baby become handicapped        | 435 (83.3)| 39 (7.5) | 48 (9.2)          |
| Baby can die                   | 446 (85.4)| 36 (6.9) | 40 (7.7)          |

With the introduction of the SCBU in 2008, SMRU started to treat neonatal jaundice with phototherapy, instead of using sun exposure [26]. The prior use of sun exposure could explain why mostly multiparous mothers still believe that it is a good option. The use of sun exposure has been reported previously from other surveys in South-East Asia [36, 37]. The advantage of using filtered sunlight for the treatment of neonatal jaundice has also been tested [38, 39] with studies showing it is effective, inexpensive and safe, if correctly monitored. One study [40] demonstrated no inferiority of sunlight compared with phototherapy, acknowledging that this was in neonates with bilirubin levels <15 mg/dl.
As sunlight is still reportedly used by some moth-
ers, it is likely that the acceptability of filtered sun-
light would be high; however this strategy would not
be sufficient to treat severe jaundice.

As naphthalene is insoluble in water, it is difficult
to wash it out of the cloths or blankets [20]. A pre-
ventive public health initiative to inform the popula-
tion of the danger to neonates of mothballs used for
storage of cloths and blankets, and menthol-contain-
ing creams, is essential. This initiative should occur
during antenatal clinics and in the community and
should also address shop owners of clothes shops. A
national ban on naphthalene-containing products, as
is the case in the European Union since 2008 [20],
would be the ideal scenario for neonates in the fu-
ture. However, governance and enforcement among
marginalized populations are weak. In addition,
under humid conditions and crowded settings such
as refugee camps there are few alternatives for stor-
age that keep insects from the clothes.

In 2013, the United Nations Refugee Agency relo-
cated approximately 40 000 refugees; approximately
2000 refugees from MLA were relocated all over the
world [41]. G6PD deficiency is present in many coun-
tries, in some, principally owing to the migration of
people, and so, understanding the practice of the
mothers and their use of haemolytic agents can be
useful to reduce adverse outcomes for the neonate
[22]. Basic services on the Thailand–Myanmar border
for mothers and babies provided by local trained
healthcare staff have significantly improved maternal
[42] and neonatal care [26, 43]. As this study suggests
that the information on neonatal jaundice comes
mainly from healthcare workers, it is important the in-
formation that is passed on is correct.

Developing neonatal jaundice educational pro-
gramme targeting mothers, with an emphasis on
avoidance of use of mothballs and menthol-contain-
ing creams in the newborn would help in raising
awareness and the prevention of neonatal jaundice in
the population.

Limitations
We were only able to survey women attending ante-
natal care services who may differ from women who

| Variable                          | Nulliparous (n = 196) | Parous* (n = 326) | Parous prior history neonatal jaundice (n = 61) | Parous no history neonatal jaundice (n = 265) | p-value |
|-----------------------------------|-----------------------|-------------------|-----------------------------------------------|-----------------------------------------------|--------|
| Recognize jaundice (from photo)   | 180 (91.8)            | 303 (92.9)        | 58 (95.1)                                     | 245 (92.5)                                    | 0.641  |
| Identify why jaundice can occur   | 21 (10.7)             | 48 (14.7)         | 22 (36.1)                                     | 26 (9.8)                                      | <0.001 |
| Action if baby is jaundiced       |                       |                   |                                               |                                               |        |
| Sun exposure                      | 16 (8.2)              | 57 (17.5)         | 18 (29.5)                                     | 39 (14.7)                                     | 0.003  |
| Herbal/traditional treatment      | 0 (0)                 | 13 (4.0)          | 3 (4.9)                                       | 10 (3.8)                                      | 0.716  |
| Think jaundice can be harmful     | 187 (95.4)            | 311 (95.4)        | 59 (96.7)                                     | 252 (95.1)                                    | 0.419  |
| Understand consequence of jaundice|                       |                   |                                               |                                               |        |
| Nothing happens                   | 56 (28.6)             | 236 (72.4)        | 10 (16.4)                                     | 62 (23.4)                                     | 0.113  |
| Baby become handicapped           | 159 (81.1)            | 276 (84.7)        | 56 (91.8)                                     | 220 (83.0)                                    | 0.317  |
| Baby can die                      | 160 (81.6)            | 286 (87.7)        | 57 (93.4)                                     | 229 (86.4)                                    | 0.590  |
| Use mothballs in the house        | 89 (45.4)             | 127 (39.0)        | 26 (42.6)                                     | 101 (38.1)                                    | 0.515  |
| Use mothballs to store baby       | 35 (17.9)             | 60 (18.4)         | 13 (21.3)                                     | 47 (17.7)                                     | 0.516  |
| clothes/blankets                  |                       |                   |                                               |                                               |        |
| Use menthol containing cream/     | 30 (15.3)             | 214 (65.6)        | 43 (70.5)                                     | 171 (64.5)                                    | 0.377  |
| ointments on the baby skin        |                       |                   |                                               |                                               |        |

Parous: parity ≥ 1. Bold values indicates a p-value < 0.05.
do not attend such services. Another possibility is that women in the survey gave an answer that they believed they should do rather than what they do in practice. Nevertheless, the findings are not unexpected and largely consistent with published data.

The strengths of the study include the large sample size, good representation of mother’s ages and detailed questions on practice, which suggest the results are robust enough to advocate for education in the clinic and community.

CONCLUSION

It is concerning that many expectant mothers in these marginalized populations still report use of mothballs and menthol-containing products, including 18% acknowledging the use of naphthalene to store cloths and blankets for the neonate. While pregnant women are able to recognize neonatal jaundice and have high knowledge of possible complications, most are unware of the causes of neonatal jaundice. Raising awareness of preventable risk factors among prospective mothers and the community, in particular about the risk of haemolytic agents, is an urgent public health priority in populations with a high incidence of G6PD deficiency, with potential to reduce jaundice-related neonatal morbidity and mortality.

SUPPLEMENTARY DATA

Supplementary data are available at Journal of Tropical Pediatrics online.

ACKNOWLEDGEMENTS

The authors want to thank the staff of the SMRU and in particular the counsellors in the clinics for their help with the interview. We also appreciate the pregnant women sharing parts of their daily lives with us.

FUNDING

TJP self-funded his final year medical elective at SMRU. SMRU is part of the Wellcome Trust Mahidol University Oxford Tropical Medicine Research Program funded by the Wellcome Trust (WT-106698). The funding bodies had no role in the design, collection, analysis or interpretation of data, nor in the writing or submission of the manuscript for publication. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

REFERENCES

1. Egube BA, Ofili AN, Isara AR, et al. Neonatal jaundice and its management: Knowledge, attitude, and practice among expectant mothers attending antenatal clinic at University of Benin Teaching Hospital, Benin City, Nigeria. Niger J Clin Pract 2013;16:188–94.
2. Burke BL, Robbins JM, Bird TM, et al. Trends in hospitalizations for neonatal jaundice and kernicterus in the United States, 1988-2005. Pediatrics 2009;123:524–32.
3. Young T, Clinical I, Study S. Clinical signs that predict severe illness in children under age 2 months: a multicentre study. Lancet 2008;371:135–42.
4. Olusanya BO, Ogunlesi TA, Slusher TM. Why is kernicterus still a major cause of death and disability in low-income and middle-income countries? Arch Dis Child 2014;99:1117–21.
5. Jardine LA, Woodgate P. Neonatal jaundice. BMJ Clin Evid 2011;pii:0319.
6. Kaplan M, Bromiker R, Hammerman C. Severe neonatal hyperbilirubinemia and kernicterus: are these still problems in the third millennium? Neonatology 2011;100:354–62.
7. Bhutani VK, Zipursky A, Blencowe H, et al. Neonatal hyperbilirubinemia and Rhesus disease of the newborn: incidence and impairment estimates for 2010 at regional and global levels. Pediatr Res 2013;74(Suppl. 1):86–100.
8. Olusanya BO, Osibanjo FB, Slusher TM. Risk factors for severe neonatal hyperbilirubinemia in low and middle-income countries: a systematic review and meta-analysis. PLoS One 2015;10:e0117229.
9. Brooks JC, Fisher-Owens SA, Wu YW, et al. Evidence suggests there was not a “resurgence” of kernicterus in the 1990s. Pediatrics 2011;127:672–9.
10. Ebbesen F. Recurrence of kernicterus in term and near-term infants in Denmark. Acta Paediatr 2000;89:1213–17.
11. Ebbesen F, Andersson C, Verder H, et al. Extreme hyperbilirubinemia in term and near-term infants in Denmark. Acta Paediatr 2005;94:59–64.
12. Dani C, Poggi C, Barp J, et al. Current Italian practices regarding the management of hyperbilirubinaemia in preterm infants. Acta Paediatr Int J Paediatr 2011;100:666–9.
13. Gotink MJ, Benders MJ, Lavrijsen SW, et al. Severe neonatal hyperbilirubinemia in the Netherlands. Neonatology 2013;104:137–42.
14. Manning D, Todd P, Maxwell M, et al. Prospective surveillance study of severe hyperbilirubinemia in the newborn in the UK and Ireland. Arch Dis Child Fetal Neonatal Ed 2007;92:F342–6.
15. Olusanya BO, Emokpae AA, Zamora TG, et al. Addressing the burden of neonatal hyperbilirubinemia in countries with significant glucose-6-phosphate dehydrogenase deficiency. Acta Paediatr 2014;103:1102–9.
16. Badejoko BO, Owa JA, Oseni SB, et al. Early neonatal bilirubin, hematocrit, and glucose-6-phosphate dehydrogenase status. Pediatrics 2014;134:e1082–8.

17. Li a. M, Hui J, Chik KW, et al. Topical herbal medicine causing haemolysis in glucose-6-phosphate dehydrogenase deficiency. Acta Paediatr 2002;91:1012.

18. Cappellini M, Fiorelli G. Glucose-6-phosphate dehydrogenase deficiency. Lancet 2008;371:64–74.

19. Mangat C, Inoue S, Saah E, et al. Acute haemolytic anaemia and myolysis due to G6PD deficiency. BMJ Case Rep 2014;2014 pii: bcr2014203631. DOI: 10.1136/bcr-2014-203631.

20. Soghoian S, Nyadedzor C, Ed Nignpense B, et al. Health risks of using mothballs in Greater Accra, Ghana. Trop Med Int Heal 2012;17:135–8.

21. Costa S, De Carolis MP, De Luca D, et al. Severe hyperbilirubinemia in a glucose-6-phosphate dehydrogenase-deficient preterm neonate: could prematurity be the main responsible factor? Pediatr Diagn Ther 2009;24:440–3.

22. Christensen RD, Yaish HM, Wiedmeier SE, et al. Neonatal death suspected to be from sepsis was found to be kernicterus with G6PD deficiency. Pediatrics 2013;132:e1694–8.

23. de Gurrola GC, Araúz JJ, Durán E, et al. Kernicterus by glucose-6-phosphate dehydrogenase deficiency: a case report and review of the literature. J Med Case Rep 2008;2:146.

24. Washington EC, Ector W, Abboud M, et al. Hemolytic jaundice due to G6PD deficiency causing kernicterus in a female newborn. South Med J 1995;88:776–9.

25. Bancone G, Chu CS, Somsakchaicharoen R, et al. Characterization of G6PD Genotypes and Phenotypes on the Northwestern Thailand-Myanmar Border. PLoS One 2014;9:e116063.

26. Turner C, Carrara V, Aye Mya Thein N, et al. Neonatal intensive care in a karen refugee camp: a 4 year descriptive study. PLoS One 2013;8:e72721.

27. White AL, Carrara VI, Paw MK, et al. High initiation and long duration of breastfeeding despite absence of early skin-to-skin contact in Karen refugees on the Thai-Myanmar border: a mixed methods study. Int Breastfeed J 2012;7:19.

28. The Border Consortium. http://www.theborderconsortium.org/resources/key-resources/ (30 September 2015, date last accessed).

29. Carrara VI, Hogan C, De Pree C, et al. Improved pregnancy outcome in refugees and migrants despite low literacy on the Thai-Burmese border: results of three cross-sectional surveys. BMC Pregnancy Childbirth 2011;11:45.

30. Familusie J, Dawodu A. A survey of neonatal jaundice in association with household drugs and chemicals in Nigeria. Ann Trop Paediatr 1985;5:219–22.

31. Ogunlesi TA, Abdul AR. Maternal knowledge and care seeking behaviors for newborn jaundice in Sagamu, Southwest Nigeria. Niger J Clin Pract 2015;18:33–40.

32. Ogunfowora OB, Daniel OJ. Neonatal jaundice and its management: knowledge, attitude and practice of community health workers in Nigeria. BMC Public Health 2006;6:19.

33. Owa JA, Ogunlesi T. a. Why we are still doing so many exchange blood transfusion for neonatal jaundice in Nigeria. World J Pediatr 2009;5:51–5.

34. Ezeaka CV, Ugwu RO, Mukhtar-yola M, et al. Pattern and predictors of maternal care-seeking practices for severe neonatal jaundice in Nigeria: a multi-centre survey. BMC Health Serv Res 2014;14:1–10.

35. Olusanya BO, Ogunlesi TA, Kumar P, et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr 2015;15:1–12.

36. Boo NY, Gan CY, Gian YW, et al. Malaysian Mothers’ Knowledge & Practices on Care of Neonatal Jaundice. Med J Malaysia 2011;66:239–43.

37. Le LT, Partridge J, Tran BH, et al. Care practices and traditional beliefs related to neonatal jaundice in northern Vietnam: a population-based, cross-sectional descriptive study. BMC Pediatr 2014;14:264.

38. Slusher TM, Vreman HJ, Olusanya BO, et al. Safety and efficacy of filtered sunlight in treatment of jaundice in African neonates. Pediatrics 2014;133:e1568–74.

39. Slusher TM, Olusanya BO, Vreman HJ, et al. Treatment of neonatal jaundice with filtered sunlight in Nigerian neonates: study protocol of a non-inferiority, randomized controlled trial. Trials 2013;14:1–10.

40. Slusher TM, Olusanya B, Vreman H, et al. A randomized trial of phototherapy with filtered sunlight in African neonates. N Engl J Med 2015;315:115–24.

41. The Border Consortium. Programme report July–December 2013. 2013.

42. McGreedy R, Boel M, Rijken MJ, et al. Effect of early detection and treatment on malaria related maternal mortality on the north-western border of Thailand 1986-2010. PLoS One 2012;7:e40244.

43. Luxemburger C, White NJ, ter Kuile F, et al. Beri-beri: the major cause of infant mortality in Karen refugees. Trans R Soc Trop Med Hyg 2003;97:251–5.