

Brief Report

Rectal pH in Well and Unwell Infants

by Claudia Turner,^{1,2,3} Naw Aye Mya Thein,¹ Paul Turner,^{1,2,3} François Nosten,^{1,2,3} and Nicholas J. White^{1,2,3}

¹Shoklo Malaria Research Unit, Mae Sot 63110, Thailand

²Mahidol-Oxford Tropical Medicine Research Unit, Bangkok 10400, Thailand

³Centre for Tropical Medicine, University of Oxford, Oxford OX3 7LJ, UK

Correspondence: Claudia Turner, Shoklo Malaria Research Unit, Mae Sot 63110, Thailand. E-mail: <claudia@tropmedres.ac>.

Summary

Prompt antibiotic treatment for infants with sepsis has the potential to save lives. A rectal formulation of an antibiotic could be used at a village level before referral to hospital. The development of such a preparation needs to take into account the rectal pH of infants that will affect drug partitioning and absorption. Rectal pH measurements were taken in 100 well and 45 unwell infants. We also measured rectal pH in 14 infants sequentially over the course of their illness. The mean rectal pH was 6.75 with no significant difference in well or unwell infants. The mean (95% CI) rectal pH of well neonates was significantly lower than that of older infants (>28 days): 6.47 (6.29–6.65) vs. 6.90 (6.68 to 7.12) $p = 0.003$.

Background

Each year 10 million children <5 years of age die, the majority from infectious diseases [1, 2]. Many deaths could be prevented if appropriate treatment, such as a broad spectrum antibiotic, could be administered early on in the course of the illness. Children in the developing world are at most risk because of poor healthcare systems and distance from facilities able to provide medical care [3]. Many infants, and in particular neonates, die at home before medical care can be given. Community-based health care workers have been shown to be effective at teaching mothers to recognize unwell infants and those in need of treatment [4]. However, availability and technical expertise to initiate treatment such as parental antibiotics is often impossible to introduce and maintain at a village level. A large multicentre study looking at pre-referral malaria treatment showed that a rectal

suppository of artesunate given at the time of referral significantly reduced death and disability in patients who lived hours away from the nearest health facility [5]. If a rectal formulation of a broad spectrum antibiotic could be developed, it could be deployed in the community and would have the potential to reduce early deaths in infants from sepsis. In order to develop such a preparation that would rely critically on rectal absorption, the milieu of the rectum and in particular the pH must be known. There is very little information on the rectal pH of adults and children in the literature. A German study described the rectal pH in 100 well children undergoing elective surgery: children up to the age of 14 years were examined but no neonates were included. The paper reported a mean pH of 9.6 with a surprisingly wide range of results (7.2–12.1) [6]. Previously, Bitterman *et al.* studied the rectal pH in humans and dogs: they determined that the mean pH was 7.9 (SD 0.07) in 121 healthy adults [7].

The aims of the current study were to determine the rectal pH of well and unwell infants from birth up to 1 year of age.

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Methods

Maela Camp for displaced persons is located in North West Thailand in the hills adjoining the Myanmar border, the Shoklo Malaria Research Unit (SMRU) clinic provides care for unwell infants as well as follow up for infants after discharge from

TABLE 1
Comparison of rectal pH in well infants aged ≤ 28 days and infants aged > 28 days

	Well neonatal (≤ 28 days) $n = 50$	Well infant (> 28 days) $n = 50$	
Mean (95% CI)	6.47 (6.29–6.65)	6.90 (6.68–7.12)	$p = 0.003$

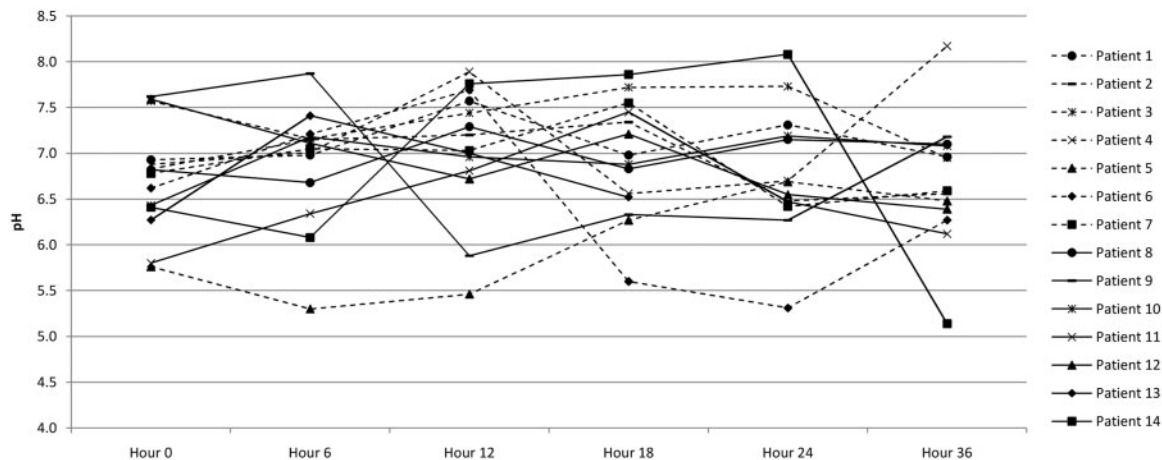


FIG. 1. The rectal pH of 14 unwell infants during their hospital admission.

hospital. Vital sign measurements are routinely taken at these visits and include a rectal temperature for all children < 1 year. Over a 6-month period infants presenting to the clinic had a rectal pH measurement taken at the same time as the rectal temperature was taken. These infants were categorized as being an unwell neonate (≤ 28 days), well neonate, unwell infant (29–365 days) or a well infant. Concurrently, infants (0–365 days) who were unwell and required admission had sequential rectal pH measurements taken (at the same time as a rectal temperature was taken) over the course of their illness.

The pH was taken using a Beckman Coulter pH 410 handheld pH/mV meter with a calomel-pHree sealed glass probe. For measurement, the non-lubricated probe was inserted 2 cm into the rectum and kept *in situ* until a stable pH reading was obtained. The probe was cleaned with 70% isopropanol between measurements and was calibrated on a daily basis.

Student's *t*-test was used to compare mean pH values between the groups. The Wilcoxon Signed-rank test was used to compare longitudinal changes in pH within an individual.

Results

For the cross sectional survey rectal pH measurements were taken from 145 infants. The median age

of the infants was 83 days (range 0–366 days) and 59% were male. The mean rectal pH was 6.75 (95% CI 6.63–6.87). The pH was not significantly different between well and unwell infants: the mean pH in the 100 well infants was 6.69 (95% CI 6.55–6.83) and in the 45 unwell infants 6.88 (95% CI 6.64–7.12) ($p = 0.15$). However, rectal pH was significantly lower in infants ≤ 28 days compared with those > 28 days (Table 1).

Fourteen infants who were admitted to the in-patient department had sequential rectal pH measurements taken during their hospital stay (Fig. 1). There was no significant change in rectal pH from hour 0 (admission) to hour 12, 24 and 36 within the individuals ($p = 0.11, 0.92$ and 0.81 , respectively).

Conclusions

We showed that the mean intrarectal pH in infants was 6.75 and that this did not change significantly during an illness episode. The intrarectal pH was significantly lower in neonates compared with older infants. We found a similar mean rectal pH to that described previously in healthy adults despite obvious differences in diet [7]. There has been only one previous study looking at the rectal pH of children and infants. In this study, the investigators studied well infants and children and did not include neonates [6]. There were methodological differences

between the studies which may account for the difference in results. In our study infants were not under anaesthesia and a digital exam was not performed prior to the pH measurement, both of which may alter the normal pH of the rectum, and may explain the much lower variance in recorded values in the present study. An example of the relevance of our findings is that artesunate has been shown to be unstable in acidic conditions [8]. Reassuringly none of the study infants were found to have a low intrarectal pH, supporting the use of rectal artesunate formulations in infancy.

These results will assist in the development of rectally formulated drugs for pre-referral use in resource-limited settings.

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