Caring for children with cerebral malaria: insights gleaned from 20 years on a research ward in Malawi

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Summary Clinicians treating patients with severe malaria in endemic areas confront a variety of challenges inherent to resource-poor settings, but it is possible to provide excellent care. The basic requirements, in addition to a thorough clinical examination of the patient, include assessing parasitaemia; determining anaemia (via haematocrit or haemoglobin); estimating blood glucose and lactate concentrations; establishing and maintaining i.v. access; measuring oxygen saturation and providing supplemental oxygen when necessary; grouping, cross-matching and transfusing blood. This paper provides practical information on determining the Blantyre Coma Score, collecting cerebrospinal fluid and measuring the opening pressure, and administering controlled volumes of i.v. fluids. Included is a narrative protocol describing the approach to patients with cerebral malaria used on the research ward at the Queen Elizabeth Central Hospital in Blantyre, Malawi.

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1. Introduction

Clinicians treating patients with severe malaria in endemic areas confront a variety of challenges inherent to resource-poor settings: laboratory capacities are limited, so assessment of electrolytes, liver function and renal function is rare; clinical supplies (cannulas, i.v. tubing, burettes) may not always be in stock; and staffing levels are often low. Nevertheless, it is possible to provide excellent care. The discussion that follows provides practical information for clinicians in malaria-endemic areas who are caring for children with cerebral malaria. It does not include a discussion of specific antimalarial drug treatment protocols.

2. Guide to techniques

2.1. Determining depth of coma

The Blantyre Coma Score is one of the best clinical indicators of the severity of cerebral malaria in children; fully conscious children would score 5, while children who do...
not respond at all to painful stimuli score 0. Mortality rates increase significantly when the score is 2 or less.¹

The Blantyre Coma Score can be assessed quickly at the bedside, is reproducible² and requires no equipment or electricity. There are three elements: motor (possible scores 0, 1, 2), verbal (possible scores 0, 1, 2), and eye movements (possible scores 0, 1).

2.1.1. Blantyre Coma Score: motor response
The first step is to apply firm pressure to a fingernail bed and observe the response. If there is no response or if the patient extends his/her arm, the score for the motor response is 0. If the patient withdraws, pressure is then applied to the sternum or the supraorbital ridge. If the patient can localize the painful stimulus by actually moving it away s/he scores 2; if s/he can only withdraw, the score for the motor element is 1.

2.1.2. Blantyre Coma Score: verbal response
It is important to listen to the verbal response while applying painful stimuli. No response at all is scored as 0. A moan or an abnormal cry receives a score of 1, and a normal cry or appropriate speech (in children who are old enough to talk) is scored as 2.

2.1.3. Blantyre Coma Score: eye movements
This can only be assessed in patients who are alert enough to open their eyes. Shine a bright light into the eyes or use a visual threat to determine whether or not the patient can see. If s/he is able to close his/her eyes to avoid a bright light, or to blink in response to threat, then provide a moving visual target, e.g. the face of the examiner, to see if the patient is able to follow a moving object. Patients who can track a moving object receive a score of 1; those who cannot are scored as 0.

The most common pitfall in determining the Blantyre Coma Score is applying insufficient pressure; the recommended approach is to apply slowly increasing pressure, stopping when the patient responds or when the examiner can apply no more pressure.

2.2. Performing a lumbar puncture
Bacterial meningitis can masquerade as cerebral malaria, and the only way to exclude meningitis is to examine the cerebrospinal fluid (CSF).

Many clinical sites in sub-Saharan Africa use a simplified method for lumbar punctures (LP) (Figure 1). The patient is placed in the left or right lateral recumbent position, and the interspace between L3 and L4 is identified (directly beneath the iliac crest). The skin is cleaned thoroughly with cotton swabs soaked in alcohol, and the sheath surrounding the spinal cord is pierced by a 21 gauge, 1.5″ needle. A flexible manometer can be used to measure opening pressure, and then the CSF can be collected either from the manometer itself (lowered) or directly from the needle. Once the needle is removed the puncture site can be covered with a dressing.

Figure 1  Measuring the opening pressure using a ‘flexible manometer’, i.e. a scalp vein needle. The critical element in this technique is the connector that links the No. 1 (1.5″, 21-gauge) needle inserted into the spinal canal with the scalp vein/butterfly needle (A). The connector has a membrane on one end to receive the scalp vein/butterfly needle and a Luer lock on the other, to screw onto the No. 1 needle. First the needle is placed in the spinal canal (B). Once the free flow of cerebrospinal fluid (CSF) is established the Luer lock is attached to the needle, the distal end of the scalp vein/butterfly needle is uncapped and the long tubing is held vertically. When the CSF level equilibrates and fluctuates with respiration its height is measured with a tape measure and recorded (C).
Figure 2 Controlling the infusion rate of i.v. fluids can be accomplished without an infusion pump by intercalating a ‘drip chamber’, or burette, between the 1 l bag of i.v. fluids and the i.v. tubing which connects to the i.v. catheter in the patient (A). The calculated volume of fluids (generally 2 h worth) is placed in the chamber and tape is affixed to the side noting the start time, the end time and, to assist the staff, the time at the halfway point (B). Staff can tell, at a glance, if the fluids are infusing at the appropriate rate. This approach can also be used for blood transfusions.

2.3. Examining the optic fundi

The standard clinical case definition of cerebral malaria (see below) is incorrect about 25% of the time according to an autopsy-based study. The most reliable clinical indicator of the cerebral sequestration of parasitized erythrocytes (the histological hallmark of cerebral malaria) is the presence of one or more elements of malarial retinopathy: white-centred haemorrhages, vessel changes and whitening. Malarial retinopathy is best appreciated in eyes that have been fully diluted with mydriatics, and examined with a direct ophthalmoscope (which provides magnification) and an indirect ophthalmoscope (which provides a three-dimensional perspective as well as a wider field of view). These examinations are routine for trained ophthalmologists, but non-ophthalmologist clinicians can learn to recognize these features too, and the technique has proven useful in identifying patients with true cerebral malaria.

2.4. Administering intravenous fluids and medications

Patients with severe malaria generally require i.v. fluid support until they are able to swallow reliably. Most hospitals in malaria-endemic areas do not have infusion pumps and most have only 1 l bags of i.v. fluids available. It is possible to work out the number of drops/minute that would be required to deliver the desired amount of fluid each hour from a 1 l bag, but it is nearly impossible to monitor fluid delivery as there are no volume indicators on a 1 l bag of i.v. fluid, and there is a real risk of delivering too much fluid to a patient.

The research ward at the Queen Elizabeth Central Hospital in Blantyre, Malawi has developed a simple method of monitoring i.v. fluid administration involving intercalating a burette, or ‘drip chamber’, between the patient and the 1 l bag. A known amount of i.v. fluid (generally 2 h worth) is placed in the chamber, the chamber is labelled with tape, the drip rate is set, and then any member of the clinical team can tell, at a glance, if the infusion is proceeding as scheduled (Figure 2).

3. The Blantyre approach to managing paediatric patients with cerebral malaria

On admission, patients should be examined for alternative causes of fever and coma. Note temperature, pulse rate and rhythm, respiratory rate and rhythm, blood pressure, oxygen saturation, Blantyre Coma Score, capillary refill, degree of pallor, pupillary response to light, blood glucose, blood lactate, haemoglobin/haematocrit and parasitaemia. Instil mydriatics and examine the optic fundi when both eyes are fully dilated.

Intravenous access should be established immediately in patients who are hypoglycaemic. Administer 50% dextrose (1 ml/kg) and recheck the blood glucose after 15 min. Boluses of 50% dextrose (1 ml/kg) are repeated until the patient is normoglycaemic. If more than two doses are needed, consider increasing the glucose concentration in the maintenance i.v. fluids.

If the patient is convulsing on admission, attention should be focused on stopping the convulsions. This may require the use of antipyretics and i.v. glucose as well as anticonvulsants.
Figure 3 This flowchart contains most of the information needed to monitor the clinical progress of children with cerebral malaria. Medications, i.v. fluids and blood transfusions are recorded on a separate sheet on the research ward at the Queen Elizabeth Central Hospital in Blantyre, Malawi.
If there are no clinical contraindications to a LP, one should be performed to exclude concomitant meningitis. If there is evidence of papilloedema on ocul fundus examination or if the patient is too unstable for an LP, presumptive treatment for meningitis should be started.

At this point it should be possible to determine if the patient meets the standard clinical case definition of cerebral malaria: Blantyre Coma Score of 2 or less, *Plasmodium falciparum* parasitaemia of any density and no other obvious cause of coma (hypoglycaemia, meningitis or a post-ictal state). Oxygen saturation <90% is rare in patients with severe malaria but, when present, the patient should be treated with exogenous oxygen; this is generally most affordable when provided by an oxygen concentrator via a nasal cannula. Hypoxemia should raise the suspicion of a concomitant lower respiratory tract infection. Blood should be collected for grouping and cross-matching as soon as possible in patients with severe malarial anaemia who require transfusion, and the blood for transfusion should be administered as soon as it is available.

While patients are unconscious, six-hourly assessments of vital signs and the Blantyre Coma Score permit the early detection of common complications. If the coma score decreases after the start of treatment, investigations should focus on the possibility of fits, hypoglycaemia or worsening anaemia. While patients are unconscious, six-hourly assessments of parasitaemia, haemoglobin/haematocrit, glucose and lactate allow for rapid recognition of potential complications, and can be coordinated with subsequent doses of antimalarial drugs.

The use of a one-page flow chart containing all the vital information may help to simplify management decisions (Figure 3).

On the research ward in Blantyre nurses make the two-hourly observations and administer medications. Clinicians make ward rounds twice each day and a clinician is available at all times to re-assess children if/when their clinical condition changes.

Using this approach the overall mortality rate for children meeting the standard clinical case definition of cerebral malaria is 17.8%. For children admitted with a Blantyre Coma Score of 2 it is 10.4%, for those with a coma score on admission of 1 it is 16.7%, and for of those with a coma score on admission of 0 it is 34.2% (unpublished observations).

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References


