Things going well

- Incredibly dedicated staff. Hungry to learn, and committed to high quality patient care. Chenla's doctors do not treat cases as futile. Team works very well together, and supports each other.
- Education sessions are well attended by physicians as well as nursing staff.
- Hospital is staffed 24/7, and care happens around the clock, including active management overnight.
- Humidifiers are now part of each ventilator setup, which is very important.
- Lots of CPAP machines available, and have compressors to allow blended O2
- Lots of IV pumps for precision administration of IV fluids and medications in the smallest and sickest patients. This is an improvement from my last visit in 2019 where there seemed to be a shortage of IV pumps.
- Able to take care of very sick patients, most of whom present late in their disease course.
- Since 2021, XR quality has improved significantly.
- NICU is improved compared to last visit in 2019, but still quite cramped.

Areas to improve: NICU/ICU focused

- Hand Hygiene:
    - There are sinks available at Chenla Kratie, but there are communal towels which do not feel particularly clean.
    - In Mondulkiri, baskets of clean cloths are available, but not in Kratie. The sink basins are small and it is difficult to wash hands without bumping against sink bowl or faucet.
    - In new building, better handwashing stations with high visibility, clean towels and good signage encouraging all staff and family members to wash hands would be great.
- Xray
    - Quality of films has improved tremendously in the past couple years.
    - Would be good to have consistent patient positioning and ensure equipment can be appropriately moved out of the way so the emitter can be in the same plane as the patient (warming arms over the warming tables get in the way)
    - Additional sets of lead for MDK and Kratie would be great for assisting with patient positioning.
    - It would be good to get staff comfortable being around the XR machine.

- Monitors in NICU are very loud, and alarms are so frequent that many are ignored.
    - Can we either decrease the volume or create targeted alarms for when SpO2 is out of range? This will decrease alarm fatigue, and once done consistently will encourage people to actually attend to the alarms they hear.
    - I played with monitors at Mondulkiri and have some instructions on setting SpO2 and HR limits, and turning off the pulse rate alarms (Appendix 1)

- While humidifiers are attached to every ventilator, they are not consistently used. The reason for reticence seems to be increased condensation in the circuit and ETT that can lead to acute decompensation.
    - Lack of in-line (closed) suctioning means that it takes quite a bit of time to suction and rescue these patients.

    - Climate control for ICU and closed suctioning system for ventilated patients would be tremendously helpful to prevent rain-out, and allow for routine preventative suctioning.

- It seems that many times the first blood gas after intubation is severely acidotic.
    - I wonder whether there may be circumstances that automatically trigger more of a workup – i.e. high FiO2 on CPAP triggers a blood gas and CXR to evaluate next best steps before the patient decompensates.

- Ventilator management strategies are quite variable from provider to provider. I think that the staff would benefit from more in-depth education on parameters that effect ventilation and oxygenation – weaning FiO2, weaning pressures, setting initial i-time, and adjusting i-time.
    - If we can get a respiratory therapist who is pediatric trained out here to evaluate ventilator setups, could be very high-yield. I will see if I can recruit someone from my institution.
    - Most patients are set to have an itime of 0.45-0.55. This, to me, seems quite long for neonates with high respiratory rates and increases risk for breath-stacking/air-trapping. I would encourage an itime range of 0.25-0.35 in neonates – this is standard for us in the NICU. Gwen also thought a shorter iTime might be a helpful strategy.
    - I have also seen patients where the ventilator has been adjusted several times, but there is no blood gas to evaluate the clinical effect.
    - Overall, I think that patients on ventilators would benefit from closer blood gas and XR monitoring, and the staff that I have spoken to would like more training on ventilator management.
    - An exercise that the staff could try is the OPENPediatrics Ventilator Simulator (https://learn.openpediatrics.org/pages/24/simulators). Perhaps one of the senior doctors could try the different modules that go through ventilator setup, parameters for ventilation, etc. and see if this would be a useful tool for the junior doctors who are less comfortable with ventilator management.

- Pulse oximetry is used continuously on most patients, but there are some cases where an infant receiving CPAP and high FiO2 is not on continuous POx, for reasons unclear.

- No surfactant available. The decision to stock/utilize surfactant is not an easy one, as it is a very expensive, but it is an incredibly useful and life-saving resource – see mortality review summary comments below.

- Ants in bassinets – seen fairly frequently; climate control/new building may help prevent this.

- Thermoregulation for neonates continues to be challenging. Many neonates are hypothermic. Radiant warmers are adjusted manually, not utilizing servo control regularly.
    - No use of incubators for smallest babies (infection concern with previous incubator use)
        - Could utilize polyethylene wraps or bags to assist with thermoregulation in smallest patients.

- Not enough space to provide Kangaroo Mother Care in Kratie – would be nice to have larger bed spaces that can facilitate KMC in new building.

- Therapeutic hypothermia – passive head cooling is done for cases of HIE with goal temperature of 35-36. While this is probably a safe range with limited side effects, cooling somewhat deeper may be beneficial (34.5-35.5?)

    - It is unclear what the diagnostic criteria for cooling are, and what the protocol is for taking care of patients during TH. (frequency of temperature monitoring, routine labs during hypothermia, etc)
    - Literature suggests no real difference between head and body cooling, but that body cooling trends towards more stable temperatures.

- Management of neonatal Jaundice:
    - Diapers on preemies are huge, but are supplied by family. This is probably ok for the most part, but need to make the diapers as small as possible when patients are receiving intensive phototherapy.
    - Rather than using blue drapes to cover infants during phototherapy, consider switching to something reflective like white drapes. This will increase efficacy of phototherapy
    - There seems to be hesitation regarding exchange transfusion.
        - Any infant with acute bilirubin encephalopathy symptoms on presentation should be prepared for an exchange transfusion as soon as possible, though getting blood at off-hours can be very challenging.
    - I sense that the staff is not comfortable with this procedure, nor do they feel that this could be beneficial or life-saving, but it absolutely can be and is worth doing.
        - Consider a procedure workshop to train staff and increase comfort with this procedure. Would be a fun exercise to look through the Chenla supply room and figure out how to do it with the equipment we have on hand. (see http://sugarprep.org/pearls for Dr. Slusher's resource-limited adaptation for exchange transfusion)
        - I'd be happy to help with this workshop the next time I am in town, if no one is available to do so sooner.

Lab: There are certain diagnostic tests that could be helpful for the care of these children.

- CRP or procalcitonin (some trendable inflammatory marker). Currently CRP is available at Mondulkiri, but not Kratie.
- Serum total and direct bilirubin – this is critical, as phototherapy interferes with accuracy of TcB readings. Seems like we can get these at Chenla but they're not routinely collected. I'm unclear on the barrier to this.
- Thyroid function studies are not available at Mondulkiri, but feel important to have available.
- CSF studies
- Microbiology studies - unlikely to happen, but if we're making a wish list…

Emergency

- Stabilization area is quite small with just one bed, and located directly adjacent to NICU. When stabilizing a sick patient, this can get very busy/loud, and the position adjacent to NICU is not ideal. No privacy for these patients.
- Stabilization area does not have dedicated CPAP generator. Unable to easily provide PEEP for babies being stabilized without providing PPV. Supposedly ambu bags do have PEEP valves, but this was not utilized for the 29 week infant I saw in respiratory distress. CPAP was not applied until the neonate was admitted to their bedspace in NICU.
- No available colorimetric ETCO2 devices (pedi-cap) or ETCO2 monitors to help confirm ETT placement prior to XR.

Labor Room/OT

- It is a long walk/run to get from Labor/OT to CCH ED. While some stabilizations are performed on Maternity, it seems that the majority occur after the patient is brought to CCH. This means that the infants are at least several minutes old by the time they arrive in ED. Establishing ventilation sooner is paramount to improving neonatal outcomes

- If there is an option for regular HBB or NRP trainings with LR/OT staff (q6-12 months) with more frequent skills checks, this could improve pre-Chenla resuscitation.

- There is no covered walk between LR/OT and CCH, so neonates who need to be admitted to CCH are exposed to the weather (heat, rain, wind, etc), as there is no transport incubator.
    - A new building in closer proximity/connected to LR/OT would make transfer of neonates from maternity to CCH much more efficient. Would also be good to have a well equipped stabilization area for these neonates in both LR and OT. It sounds like there is supposed to be equipment there, but sometimes it is not available or has been used by maternity staff.

- Concern from staff that supplies are not always consistently available at OT/LR. May be nice to have standard "airway/neo resuscitation" boxes that we can bring to LR/OT at all clinical sites. For suggested list of equipment/supplies see Appendix 2.

Globally

- The system is very dependent on Chanthou right now, and while the staff love him and feel that he is a very good and supportive boss, it is difficult to have so much hinge off of one person. As the organization grows, there need to be more doctors in administrative positions – associate medical directors, or clinical directors at each hospital, more people involved in onboarding and training junior doctors.
- It may be beneficial for scalability of the organization and onboarding of junior doctors to develop a "Chenla Manual" of guidelines and protocols for commonly seen disease processes.
- In addition to standardizing a curriculum for junior doctors so it is not entirely dependent on Chanthou. May be beneficial to develop a trackable list of competencies for junior doctors to accomplish to progress to senior doctor status.
- Staff currently primarily use AHC guidelines, so we can build Chenla's guidelines off of what already exists.

Mondulkiri – 3/20-3/22 – short trip

- Very nice spaces for patient care overall, climate controlled. NICU has large bed spaces allowing adequate room between patients.
    - Would suggest encouraging KMC on the unit – procurement of comfortable chairs that can be available at bedsides would promote this.
    - Like Kratie, alarms are very loud. See Appendix 1 for instructions on getting rid of the audible pulse rate and for setting low/high SpO2 and HR alarms. Perhaps Lihak could champion this to standardize between units as part of nursing training?

- There is no light-box for reviewing x-rays, but the quality of imaging seems good.
    - I requested a cross-table lateral film on a patient, and was told that we cannot – additional training of XR technicians could increase utility of the test.

- ED is small and far from ICU. Varun suggested considering moving ICU to where the storage room, and I agree that this could be a very good idea.
    - Perhaps utilize the space at the back of OPD and current ICU as replacement store-rooms?

- Long walk from Chenla to Maternity or OT, and location team is called to depends on which alarm sounds, however staff did not seem to have the sense of urgency that I had about going to assess the baby. It took approximately 3 minutes to leave the Chenla area (initially left with ambu bag, but realized halfway there that the mask was too large.. went back, but couldn't find neonatal mask..), we went to OT and baby was ultimately fine, but those minutes could make a big difference.

    - At Labor Room, there is a radiant warmer and suction machine, but very little space in which to utilize the equipment. There is a supply cabinet, but few supplies in it.
    - In OT, there is no dedicated neonatal resuscitation space, but there is a peri-operative ante-room outside of the operating theater that could be converted from a storage space to a neo resuscitation area. I toured the LR and OT with the hospital director, and he was amenable to outfitting the anteroom as a neo resuscitation space.
    - Again, availability of an airway box that lives in the emergency area and can be quickly grabbed on the way to maternity/OT would be helpful.

- Junior staff seem to feel uncomfortable here, as they are not as well supported as at Chenla – remote support from senior doctors. I worry that this could lead to staff burnout, and difficulty maintaining/scaling up operations here, but this is only based on working with a very small subset of doctors and may not be representative of the larger staff.

Steung Treng Neonatal Care Unit – 3/23/2023

- I met with Dr. Chhayheng, and one of the neonatal nurses during this visit. It was Dr. Chhayheng's first shift, and the nurse has been working there for 2 months. They were very nice and took the time to show me around, demonstrate equipment and identify lacking resources.

- The unit is supposedly staffed by a doctor 24/7 who splits responsibility between NCU and OPD. There is a mechanism in place in which the team can be called to LR or OT when an infant is in distress. The maternity center is not too far from the NCU. I did not see a resuscitation area in the labor room, and was unable to tour the OT. Dr. Chhayheng was not sure what equipment is available for neonatal resuscitation as this was his first shift.

- Overall, the building is nice. It has a clean and new appearance, but there are quite are signs of disrepair. The NCU has space for 4 patients with decently large bed spaces. There is an adjacent observation room where the infants are observed, but I was not clear on what distinguishes this space from post-partum, or whether they are the same.
    - Two of the 3 fans in the NCU were broken, and several of the overhead lights were burnt out. It is uncomfortably hot in the unit without good air circulation,
        - Many of the babies have "fevers". I worry that the environment will trigger too much use of antibiotics when the actual problem is that babies have a hard time tightly regulating their temperatures.

- The unit has nice equipment, but I am not sure when the last time any of it was cleaned. The nurse couldn't tell me what the cleaning schedule is, and they mentioned that only one staff member is capable of cleaning the CPAP machine.

- Equipment list:
    - 2 cardiorespiratory monitors, but one is broken.
        - Additional pulse oximeters (at least one), but no neonatal flex-wrap probes.
    - 1 dolphin bCPAP machine with 1 extra circuit/chamber. The circuit attached to the machine has lots of condensation in it and it is unclear when it was last cleaned or used.
    - 1 suction machine
    - 1 Incubator and 2 radiant warmers. Mattress on the unused warmer is stained.
        - Oxygen tanks and ambu bags at each bedside, with masks attached (new?)
    - 2 IV pumps for fluid administration, but no syringe pumps.
    - 2 phototherapy units, 1 transcutaneous bilirubinometer – I did not check irradiance, nor general function of the units.

- Infection Prevention and Control measures are unclear. To quote Dr. Chhayheng "IPC is not good".

- List of Wants from staff:
    - Administrative support: better charting tools like growth charts, Ballard scales, bilirubin curves. Really they need a computer with a printer and a copier, and an administrator to help keep all of this running.
    - Educational support – some of the doctors have had additional Neo training at AHC, but not all. A basic neonatal curriculum for all doctors at the NCU with telephone support from a senior doctor at Kratie could be very helpful.
    - Xray – there is no portable XR machine, and the technicians in the XR unit are not comfortable with pediatric or neonatal patients and will refuse.
    - Better utilization of space. There does not appear to be a good system in place for storage of equipment. The unit feels cluttered with unused equipment
    - Better labs:
        - Some basic labs are available, but not consistently. Electrolytes inconsistently. CRP sometimes. Total and direct bilirubin cannot be checked. No blood gas machine. Unclear whether they have a glucometer.

- Overall Impressions:
    - This unit needs a manager. Someone who can ensure that medical equipment and facility stays clean and functional, supplies and equipment are organized, and that there are the right charting tools available.
    - The space would benefit from climate control – at a bare minimum, fix the fans, but aircon would be better. This will benefit the patients, as I believe many infants may be receiving antibiotics for fevers that are environmental. This will also help the comfort of the staff.
    - I would not run ventilators here, at least not for a while. It may be beneficial to have one for stabilization. It makes me nervous though, and maybe we should have intubation supplies and the patient would need to be manually ventilated until they could be transported. I'm not sure what the right answer is here.
    - The unit needs better supplies –
        - a portable XR would be great and could also be used for pediatrics,
        - pulse oximeters should have neonatal probes,
        - monitors and other equipment should be in working order and ready for patient use at all times.
        - A blood gas machine would add basic point of care labs
        - Total/direct bilirubin.
        - CRP could be helpful too.
    - The physician I spoke with thought that additional education and training in neonatal care would be beneficial at least for him. It sounds like the two other physicians working in that unit have done some additional neonatal training with AHC

Review of Neonatal Deaths 2021-2022:

I conducted a review of 36 neonatal deaths that occurred between 2021 and 2022. While many of these deaths can be attributed to late presentation and advanced stage of disease at time of presentation, a few themes emerged. Please see associated excel sheet for brief narrative summary of each death.

1. Many infants are brought to CCH with HIE due to poor antepartum care or lack of resuscitation at birth.
    a. Improving resuscitation training and pre-hospital care at the sites where babies are delivered would be the best possible intervention for this.

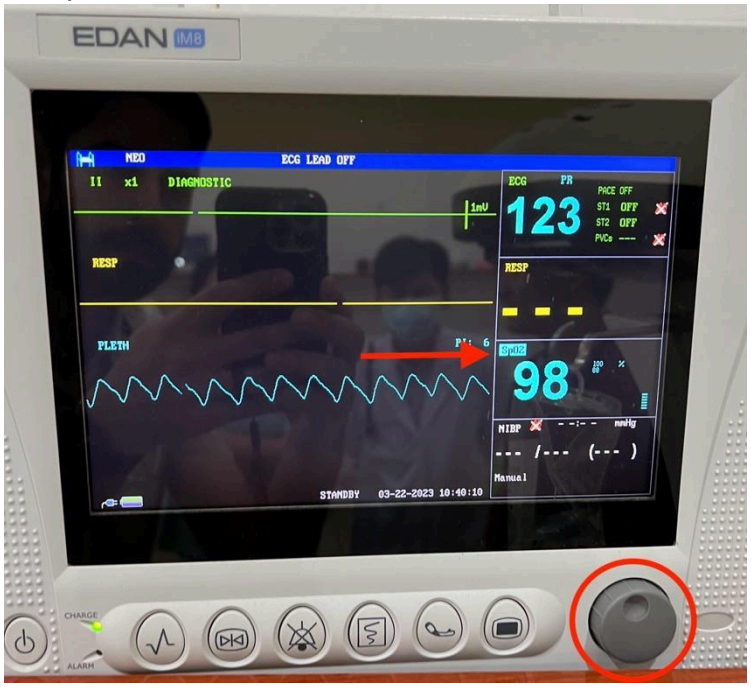
2. Premature babies that have died would likely have benefitted from surfactant therapy, especially if administered earlier in their RDS process (i.e. FiO2 >40% is a trigger to consider surfactant).
    a. Most premature infants who died were hypothermic on admission. I didn't have the chance to review too many charts of surviving babies to see if there was a pattern to this, but hypothermia is associated with increased mortality.
    b. In cases of shock, there is inconsistency with use of steroids; neonates, especially preterm neonates, are at moderate to high risk of adrenal insufficiency in times of critical illness, and hydrocortisone should be considered in any cases of refractory shock, or with clinical/laboratory signs of adrenal insufficiency.

3. There have been at least a couple of cases of cardiovascular collapse at day 3-5 after birth suspicious for a critical congenital heart lesion with a closing/closed PDA. Prostaglandin therapy may be life-saving in these cases, but only if there is an operative pathway for the patient.
    a. A way to consider implementing this is start the PGE on a patient, and continue until echocardiogram is completed and prognosis determined.

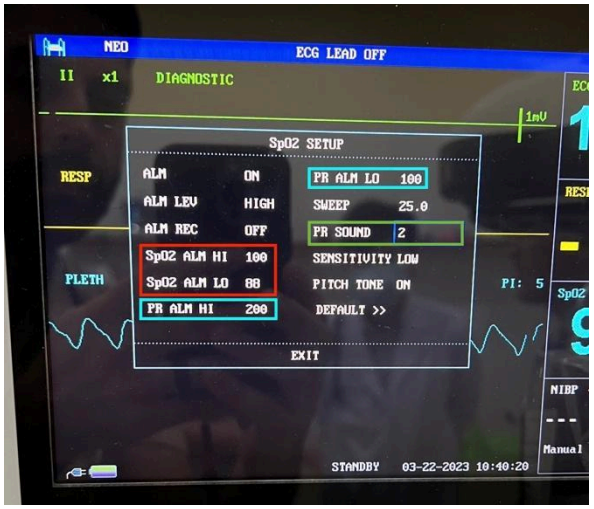
4. In at least one case, an exchange transfusion performed on admission could have potentially reversed symptoms of bilirubin encephalopathy, and staff either feel that these cases are hopeless or that they are uncomfortable with exchange transfusion, or both, but this is an important skill.

Appendix 1: Setting alarm parameters at Mondulkiri, and silencing audible HR.

1. Rotate knob (circled red) until SpO2 is highlighted (red arrow), then press knob to bring up menu



2. To silence the pulse rate sound, select PR sound (green box) with the selection knob, and decrease to zero. Accept this setting by pressing the selection knob
3. To set SpO2 limits, select SpO2 Alm Hi and Alm Lo (red box) to set appropriate parameters based on respiratory support needs (SpO2 High should be 100% if only in 21% FiO2, or 95% if requiring supplemental O2)
4. To Set HR limits, select PR Alm Hi and Alm Lo (light blue boxes) to set appropriate parameters based on patient age.



Appendix 2: Neonatal Resuscitation/Airway Box supplies

- ETTs 2 of each size 2.5 (do you have these?), 3.0, 3.5
- ETT stylets appropriate for ETT sizes (not clear if we have stylets for small ETT, if we don't, we should)
- Laryngoscope handle (2x if possible) with full batteries and bright bulbs
- 1 each miller blades 00,0,1
- 1 portable pulse oximeter with 2 sticky wrap probes
- Fabric armband cover for pulse ox probe
- 2 pedi caps
- 1 each gel LMA size 0/1 (brand dependent)
- Ambu bag (might not be able to fit into a reasonable sized box, but could work if you used a file-box sized container)
- 1 size large mask
- 1 size medium mask
- 1 size small/micro ambu mask
- 1 roll ett tape
- 1 sterile scissors
- saline wipes
- 3ml luer lock syringes
- 1ml luer lock syringes
- Supplies for needle thoracentesis: Iodine or chlorhex, Butterfly needle, 3-way stopcock and 10-30ml syringe

If surfactant available:
- blunt tip needles for drawing up surfactant
- Surfactant catheter (too expensive to maintain abroad)
    - Alternative: Substitute surfactant 5fr feeding tube with luer lock adapter

If space available, could consider including IV catheters, tubing, medication administration supplies, UVC or sterile feeding tubes that could be used as emergent umbilical venous catheters and resuscitation drugs (epinephrine, normal saline).

If doing so would also need to include sterile gloves, betadine, umbilical tie, curved forceps and scalpel for placement of UVC

This would effectively make a neonatal code box