Project Title

Reduce Incidences of Babies with BrONchopulmonary Dysplasia (RIBBON)

Project Lead and Members

Project leaders: Dr. Agnihotri Biswas, Dr. Khadijah Binti Abdul Kader, Ms. Wang Xia

Project members: Dr. Jeanette Lek, Dr. Pradip Dashraath, Dr. Kalaimathy Veerappan Ms. Allelieh Capistrano, Ms. Zhang Suhe, Ms. Illene Chen Yi Ling,Ms. Sarasvati A/p Rajoo, Ms. Melissa Madu Pal, Ms. Nicole Chan, Ms. Siti Ihdinaa

Organisation(s) Involved

National University Hospital (NUH)

Healthcare Family Group Involved in this Project

Nursing, Medical

Applicable Specialty or Discipline

Neonatology, Pulmonary, Nutrition & Dietetics

Project Period

Start date: Mar 2023
Completed date: December 2023

Aims

To reduce the incidence of Bronchopulmonary Dysplasia (BPD) in premature infants. The goal is to reduce the rate from 20.9% to 15% by the first quarter of 2024 and to 10% by the first quarter of 2025 in babies born between 28 and 32 weeks gestation.

Background

In NUH, Bronchopulmonary Dysplasia (BPD) has increased significantly over the last 11 years, especially since 2020. The project aims to examine current workflows and pathways to identify gaps and strengthen processes from antenatal to postnatal stages.

Methods

The project utilizes tools such as Value Stream Mapping (VSM), Root Cause Analysis (RCA), and various best practice methodologies to address identified gaps.

Results

The post-implementation Chronic Lung Disease (CLD) rate was reduced to 5% from a pre-sprint rate of 20.9%. Interventions included enhanced nutrition plans, new ventilation protocols, suction protocols, and changes in nursing care practices.

Lessons Learnt

Protected time for discussions, open and honest communication, and active participation were crucial for the project's success. Regular feedback and brainstorming sessions helped generate new ideas and maintain team motivation.

Conclusion

The project successfully reduced the incidence of BPD in premature infants. Continuous monitoring and refinement of care processes will be necessary to sustain these improvements.

Project Category

Care & Process Redesign

Quality Improvements, Workflow Redesign, Clinical Practice Improvement, Risk Management, Adverse Outcome Reduction

Keywords

Bronchopulmonary, Dysplasia (BPD), Chronic Lung, Disease (CLD), Preterm Infants, Antenatal Corticosteroids, Respiratory Support, Neonatal ICU, Less Invasive Surfactant Administration (LISA), Nutritional Management, Golden Hour Protocol, Neonatal Outcomes, Quality Improvement, Ventilation Protocols, Pre-eclampsia Management, Premature Birth Complications

Name and Email of Project Contact Person(s)

Name: Dr Agnihotri Biswas

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National University Hospital

Reduce Incidence of Babies with BrONchopulmonary Dysplasia (RIBBON)

A joint collaboration between Neonatology and Obstetrics Teams

14 to 17 Mar 2023 (3.5-day)

Project Title 1 : **R**educe **I**ncidence of **B**abies with **BrON**chopulmonary Dysplasia **(RIBBON)**

Department: Neonatology, O & G

Period: Mar '23 to Dec '23

Sponsors (HODs): A/Prof Zubair Amin, (Neonatology), A/Prof Mahesh A Choolani (O & G), ADON Sarah Ho-Lim

Facilitators, Team Leaders & Members: See next page

National University Hospital | INCREDIBLE care @NUH It starts with me

1. Reason for Action

In NUH, **Bronchopulmonary Dysplasia (BPD)** has increased over the last 11 years, markedly so since 2020. For all babies (23-31 weeks), BPD incidence increased from 30% to 67%; 23-27 weeks 50-60% to 85%; 28-31 weeks 10-15% to 60%. ANZNN 2017-2019 BPD rate in 23-27 weeks babies' was 63.6%.

BPD is Chronic Lung Disease (CLD) of prematurity, where babies still require supplemental oxygen or respiratory support at 36 weeks post menstrual age. BPD evolves with time, and babies who will have more severe BPD are usually identified during the course of the neonatal ICU stay based on duration of invasive ventilation, duration of non-invasive bi-level respiratory support and chest X-ray findings. These babies may already be at higher risk of BPD based on non-modifiable factors such as gestation and weight at birth, and severity of respiratory distress syndrome (RDS) at birth.

Therefore, the team would like to examine the current workflows and pathways to identify gaps and areas to strengthen the processes from antenatal to postnatal.

In-scope:

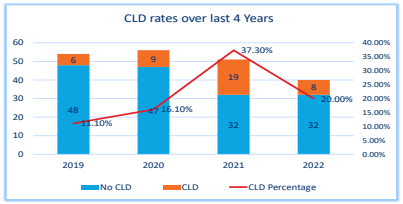
Antenatal→Delivery→Postnatal

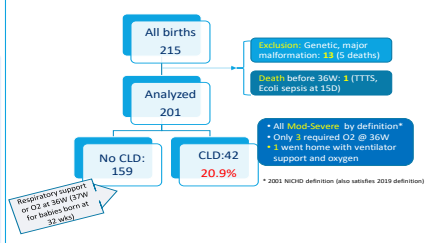
Start: Antenatal @ 23 weeks

End: Postnatal 36 weeks (post-menstrual age) for all babies and 37 weeks for 32 weeker

2. Initial State

Current State: Before Improvement Sprint
Baseline: CLD rate for the last 4 years was **20.9%**





3. Target State

Improve Patient Outcome

To reduce the incidence of CLD from 20.9% to 15% (↓28%) by 1st qtr of 2024 and to 10% (↓52%) by 1st qtr in 2025 in babies born between 28 and 32 weeks completed gestation.

4. Problem Analysis

Tools used as follows (refer to next few slides for details)

- ✓ Current VSM (Antenatal, Delivery & Post 1 week)
- ✓ 3 RCAs to analyze the following Gaps
  - ➢ Sub-optimal growth & nutrition
  - ➢ Sub-optimal respiratory care
  - ➢ Sub-optimal foetal state
- ✓ Paradigm Breaking Exercise

5. Solution Approach

Tools used as follows (refer to next few slides for details)

- ✓ Lean solutions
- ✓ Best practices
- ✓ Future VSM (Antenatal, Delivery & Post 1 week)

6. Rapid Experiment and Prototyping

The following standard works were derived during the improvement sprint.

1	Rational antenatal corticosteroid administration	
2	Nutrition proposal	
3	LISA	
4	Nursing Practice (BPD)	
5	Physiologic Assessment of BPD	
6	Ribbon Card, Daily Documentation Template, Golden Hour refinements	
7	Summary of Standard Work	

7. Completion Plan

7. Completion Plan (phase 1, 30 Apr)

SN	Item	Who	When
1	Enhanced Nutrition Plan	Dr Kalai, **Dr Jeanette**, dietician, Dr Lee LY	Phase 1 (30 April draft finalized implement 15 May)
2	Ribbon Card	Dr Khadijah, **Saraswati**	Phase 1
3	Ventilation protocol	Dr Agni, Prof Lee, **Alleileh**	Phase 1
4	Suction protocol	Sister Wang Xia, **Ilene Chen**	Phase 1
5	BPD template	Dr Jeanette, **Dr Khadijah, Santosi**	Phase 1
6	Finalise Lisa protocol	**Dr Agni**, Alleileh, Nicole	Phase 1
7	Nursing care	**Sister Wang Xia**, Melissa, Suhe	Phase 1
8	Golden hour	**Dr Khadijah**, Dr Kalai, Dr Amutha, Alleileh, Saraswati	Phase 1
9	Physiologic assessment	Dr Agni, **Suhe, Nicole**, Alleileh	Phase1

7. Completion Plan (phase 2, May to Jul)

SN	Item	Who	When
10	Antenatal Steroids - Rescue steroids	**Dr Pradip**, Dr Sarah	Phase 2 (30 June draft finalized-implement 15 July)
11	O&G – Neonate communication Deck	**Dr Pradip**, Dr Sarah Sister Sis, Dr Agni	30 June draft finalized implement 15 July
12	Apnoea chart	Saraswati, **Suhe**	30 April draft finalized implement 15 May
13	GWR nurse rep	Sister Wang Xia, **Melissa**, Suhe	30 April draft finalized implement 15 May
14	Adopt a baby concept	**Melissa**, Nicole, Ilene, **Dr Kalai**	30 April draft finalized implement 15 May
15	Postnatal Steroid protocol	Prof Zubair, **Dr Agni**, Dr Krish	30 June draft finalized implement 15 July
16	Lung Ultra sound @1 hour of life	**Dr Khadijah**, Dr Agni, Dr Mary, Dr Kalai, Dr Shegufta	30 June draft finalized implement 15 July

7. Completion Plan (Longer term)

SN	Item	Who	When
17	FORECAST (Pre-eclampsia, IUGR, Cervical length) Start Aspirin if indicated De-sensitising aspirin allergy	**Dr Pradip**, Dr Sarah, Prof Mahesh	To follow-up in 2024
18	Increase trained golden hour pool	Dr Khadijah, Dr Amutha, Sister **Wang Xia**, Alleileh	To follow-up in 2024
19	Doctor and nurses to be trained on ventilation support	**Alleileh**, Dr Khadijah, Saraswati, Dr Agni, **Ilene**	Phase 2 (July)
20	Early BPD prediction	**Dr Agni**, Dr Khadijah	To follow-up in 2024
21	Vitamin A supplementation	-	To follow-up in 2024
22	Urea plasma screening and treatment	-	To follow-up in 2024
23	1st Review Meeting (2 weeks post RIE)	**All full time members**	Physical meeting unless off/shift work - Friday, 31 March, 11.30-1pm (TD9-02) Zoom:
24	2nd Review Meeting (2 weeks post RIE)	**All full time members**	Friday, 14 April, 11-1pm hybrid

7. Results Tracking Plan

SN	What	How	Freq/Period	Who
1	**Antenatal corticosteroid** Proportion of babies delivered within therapeutic window of ANS	Manual	Quarterly	Dr Pradip Dr Sarah
2	**O&G-Neonatology communication** Compliance, high-risk delivery in office hours	Manual	Monthly	Dr Pradip Dr Sarah Sister SIS (Sister Zet)
3	**LISA: Less Invasive Surfactant Administration** Number of intubations prevented, BPD rates, safety and success (based on clinical parameters).	System (Red cap) and manual	Monthly	Nicole Melissa Alleileh Dr Kalai
4	**Physiologic assessment** Proportion of newborns correctly identified based on their physiology	System (Red cap) and manual	Monthly	Suhe Nicole Dr Agni
5	**BPD rate**	System (Red cap) and manual	Monthly	Dr Khadijah Dr Agni Sister Wang xia

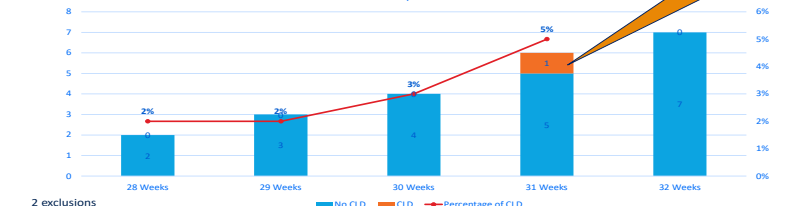
8. Confirmed State

Post Implementation from 1st April 2023 to 16 August 2023:
Total 24 babies between 28+0 – 32+6 weeks

- Severe IUGR
- Doppler abn
- Severe RDS
- Mild Pul Hypoplasia
- HFOV, iNO, Steroids
- Doing well now
- GRADE 2 BPD

Pre Sprint CLD rate = 20.9% **Post Sprint CLD rate = 4.5%**

Patient numbers; n=22



2 exclusions
- Moderately severe Pulmonary stenosis- one of triplets
- Severe congenital cerebral malformation-CBBA

9. Insights (Feedback from the team)

What went well?

- Brainstorming was superb with excellent ideas
- Learnt new concepts
- Well-fed with brain food
- Big charts with constant easy visibility & excellent facilitation
- Well organized
- Very high yield output
- Every points are taken seriously
- Very active participation by all members
- Active discussions
- Great conversations
- Great teamwork!
- Open & honest
- Team dynamics
- Cohesiveness
- Respect
- Open to change
- Cheerful and helpful facilitators (S & S)
- Very friendly team
- Nice food and very well fed!

What could be better?

- Protected time post RIE
- Talk one at a time
- Provide water
- Time management

Reduce **I**ncidences of **B**abies with **BrON**chopulmonary Dysplasia **(RIBBON)**

Sponsors:
1. A/Prof Zubair Amin, Chief (Neonatology)
2. A/Prof Mahesh A Choolani, Head Chief (O&G)
3. ADON Sarah Ho-Lim, Assistant Director of Nursing (Neonatalogy & O & G)

QI & MA Sponsors:
1. Roy Ngong,
   Assistant Chief Operating Officer (Plans & Strategy)
   Corporate Planning & Development & Quality Improvement
2. Dr Bhuvaneshwari Mohankumar, Head, Medical Affairs (Clinical Governance)

Facilitators:
1. Stacy Leong, Manager (Quality Improvement),
2. Sangeetha Guruvayurappan, Assistant Manager, Medical Affairs (Clinical Governance)

Invitees:
1. Dr. Poon Woei Bing, Head of Neonatology (SGH)
2. Dr. Priyantha Edison, Staff Physician (SGH)
3. Dr. Lee Jiun, Senior Consultant (Neonatology)
4. Dr. Chinnadurai Amutha, Senior Consultant (Neonatology)
5. Dr. Krishnamoorthy Niduvaje, Senior Consultant (Neonatology)
6. Dr. Anita Sugam Kale, Senior Consultant (O&G)
7. Dr. Diana Santos, Assistant Director (MACG)
8. Ms. Lee Soke Yee, Senior Nurse Clinician (Ward 24)
9. Ms. Charlotte Lin, Principal Dietician (Dietetics)
10. Ms. Wong Chui Ying, Senior Dietician (Dietetics)
11. Mr. David Leong, Manager (QI)

Team Leader:
1. Dr. Agnihotri Biswas, Senior Consultant (Neonatology)
2. Dr. Khadijah Binti Abdul Kader, Associate Consultant (Neonatology)
3. Ms. Wang Xia, Nurse Clinician (Ward 24)

Members:
4. Dr. Jeanette Lek, Clinical Associate (Neonatology)
5. Dr. Pradip Dashraath, Associate Consultant (O&G)
6. Dr. Kalaimathy Veerappan (Senior Resident Physician)
7. Ms. Allelieh Capistrano, Respiratory Therapist (Neonatology)
8. Ms. Zhang Suhe, Senior Nurse Clinician, Advanced Nurse Practitioner (Neonatology)
9. Ms. Illene Chen Yi Ling, Senior Staff Nurse (Ward 29)
10. Ms. Sarasvati A/p Rajoo, Senior Staff Nurse (Ward 24)
11. Ms. Melissa Madu Pal, Senior Staff Nurse (Ward 24)
12. Ms. Nicole Chan, Staff Nurse (Ward 24)
13. Ms. Siti Ihdinaa, Nurse Clinician (Ward 22)

1. Reason for Action

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Therefore, the team would like to examine the current workflows and pathways to identify gaps and areas to strengthen the processes from antenatal to postnatal.

In-scope:

Antenatal→Delivery→Postnatal

Start: Antenatal @ 23 weeks

End: Postnatal 36 weeks (post-menstrual age) for all babies and 37 weeks for 32 weeker

What does BPD/CLD look like

Neonate with chronic respiratory distress

Chronic respiratory / O2 support which tends to improve

Hemodynamic disturbance – pulmonary hypertension

Growth failure

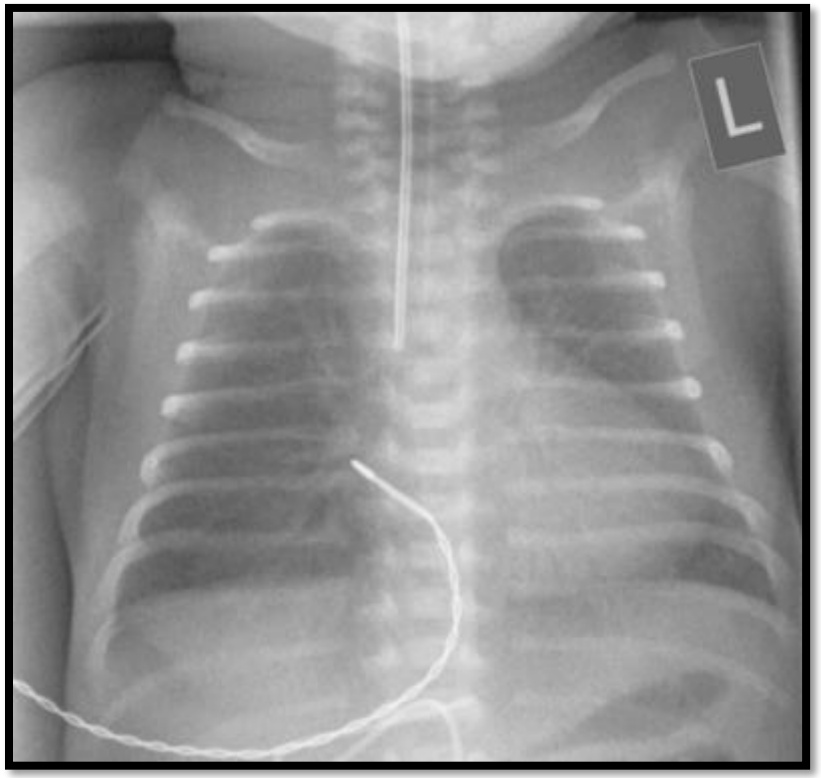
Maturational delay

Strong association with later neurodevelopmental issues

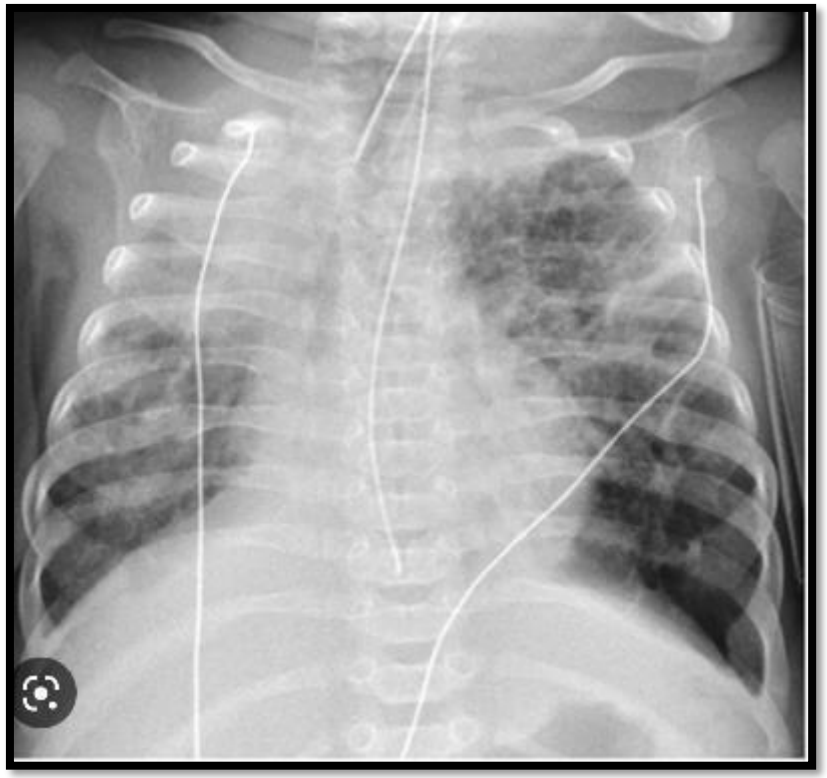
Long term chronic pulmonary issues

Sometimes death

BPD/CLD – Xrays – it's a spectrum



Mild



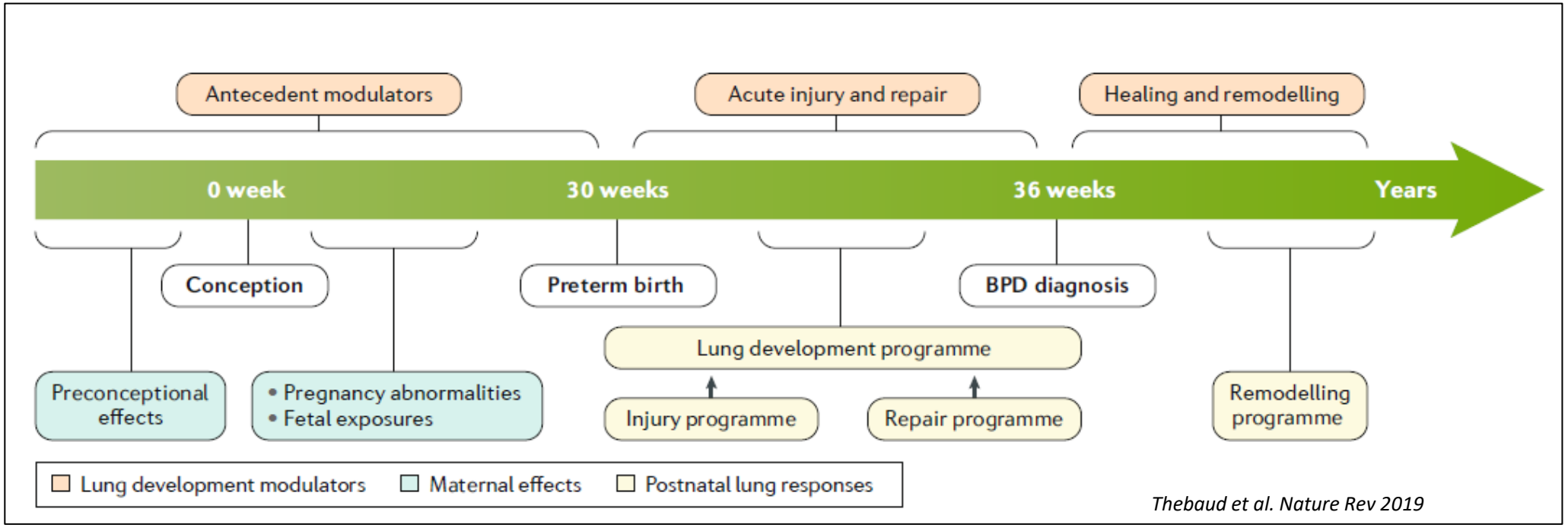
Severe

Definition of BPD

Author and Year	Definition
Shennan et al, 1988[146]	Use of supplemental oxygen at 36 weeks PMA
NIH consensus, 2001[147]	Oxygen use for 28 days (not consecutive), with severity based on amount of supplemental oxygen and mode of respiratory support at 36 weeks PMA; mild (room air), moderate (<30% supplemental oxygen), severe (≥30% supplemental oxygen and/or positive pressure)
Walsh et al, 2004[148]	Receipt of positive pressure or supplemental oxygen at 36 weeks PMA. In infants receiving ≤ 30% oxygen via hood or nasal cannula, a stepwise room air challenge test is performed. Failure of the room air challenge, or need for mechanical ventilation and/or positive pressure are classified as BPD
Isayama et al, 2017[149]	Use of oxygen and/or respiratory support (including invasive and non-invasive support) at 40 weeks PMA
NICHD workshop, 2018	Supplemental oxygen or positive pressure at 36 weeks PMA along with radiographic evidence of parenchymal lung disease, irrespective of prior duration of oxygen supplementation. Incorporates 3 grades of severity depending on levels of supplemental oxygen and mode of support[150]
Jensen et al, 2019[151]	Any respiratory support at 36 weeks PMA, irrespective of prior duration or current level of oxygen therapy. Further categorized according to disease severity: grade 1, nasal cannula at flow rates ≤2L/min; grade 2, nasal cannula at flow rates >2L/min or non-invasive positive airway pressure; and grade 3, invasive mechanical ventilation

BPD: Bronchopulmonary Dysplasia aka CLD: Chronic Lung disease

It is a clinical expression of the process, in which injured premature lungs repair and remodel over years

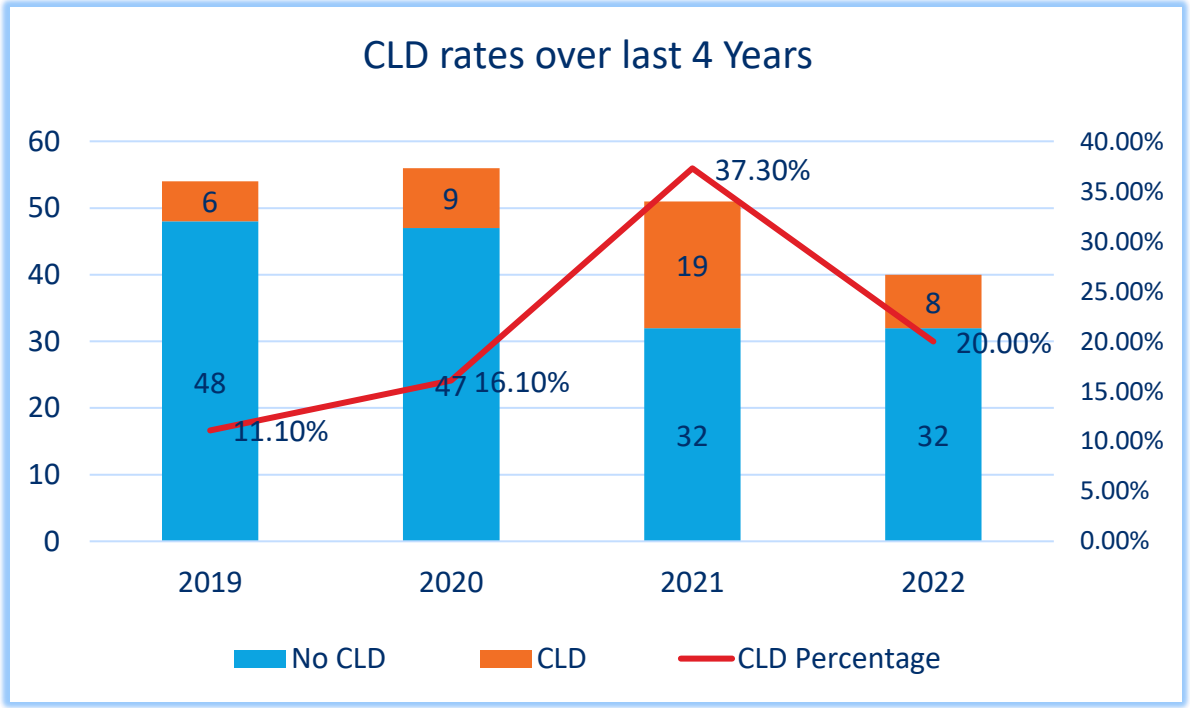


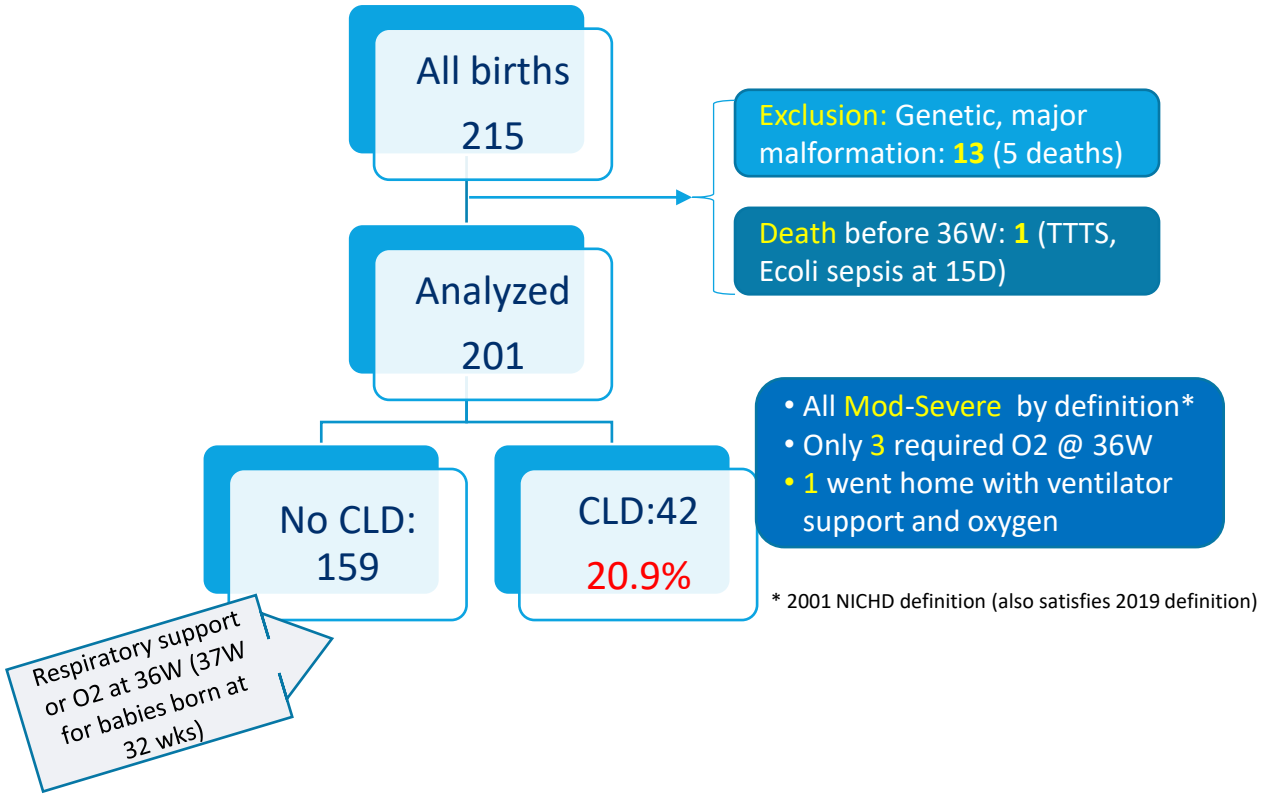
Thebaud et al. Nature Rev 2019

2. Initial State

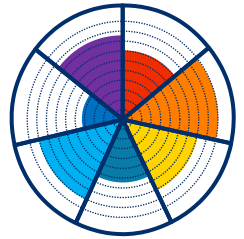
Current State: Before Improvement Sprint

Baseline: CLD rate for the last 4 years was **20.9%**





3. Target State



Improve Patient Outcome

To reduce the incidence of CLD from 20.9% to 15% (↓28%) by 1st qtr of 2024

and to 10% (↓52%) by 1st qtr in 2025

in babies born between 28 and 32 weeks completed gestation.

4a. Problem Analysis (PLAN) Value Stream Map

Current Value Stream Map – Antenatal (1)

Mom visited Clinic
- History (65%)
- Forecast (Predictor of PIH, IUGR)
- Ultrasound scan (11-12W)
- PAPP-A, PLGF
- Aspirin by 16 W
- Vitamin D
- Calcium

- Screening for pre-eclampsia/IUGR (FTQ-80%)
- Aspirin allergy
- Non compliance
- Late bookers
- Missed early growth scan for high risk (27-28W)

Admitted to DS

Reviewed by nurses & doctors
- Check vitals & CTG
- Blood & urine tests
- Order medications

- Update Neonate of imminent delivery
- Verbal counsel of parents
- Neonate – O&G communication
- Timing of steroids- 1st dose 23w, 2nd dose 12 hours later
- Timing of MgSo4 for neuro protection

- Decline admission/AOR
- Decision to give steroids – Time to first dose.
- Objective assessment (Primi/Multipara)
- ROM
- OS open/closed
- APH
- Actim Partus
- Subjective assessment

Admitted to antenatal ward when stablised
- Monitor in hospital
- Home with OPD management

Daily reviews
- Fetal monitoring (CTG/Daptone)
- Review regarding delivery timing

At least weekly blood tests

Not reviewed by Neonate team

Next slide

Current Value Stream Map – Antenatal (2)

Diagnosed with Oligohydramnios, IUGR
- Scan frequency
- Fetal Monitoring

- Timing of delivery for IUGR/OLIGO
- (longer wait worse lung)

Preterm premature rupture of membranes
- Chorioaminonitis
- Treat with antibiotics (EES)

- Diagnosis of Chorioaminonitis
- Antibiotic choice
- PPROM and no Chorio deliver at 37w
- Tocolysis – decisions, duration. Reviewed daily.

- Diagnosis of Chorioaminonitis
- When to intervene

Decision to deliver
- OG Reg will communicate Neonate Reg

- Type of delivery (O&G)
- Time of birth (office vs out of office birth)

- After office hours delivery- no GH team

Decision made -Planned delivery or unplanned
- Deliver NVD

Activated LSCS
- OG doctor to inform Neonate team

Activated Golden Hour (GH) team
- Attend without GH team

Performed equipment checks, schedule staff to assist

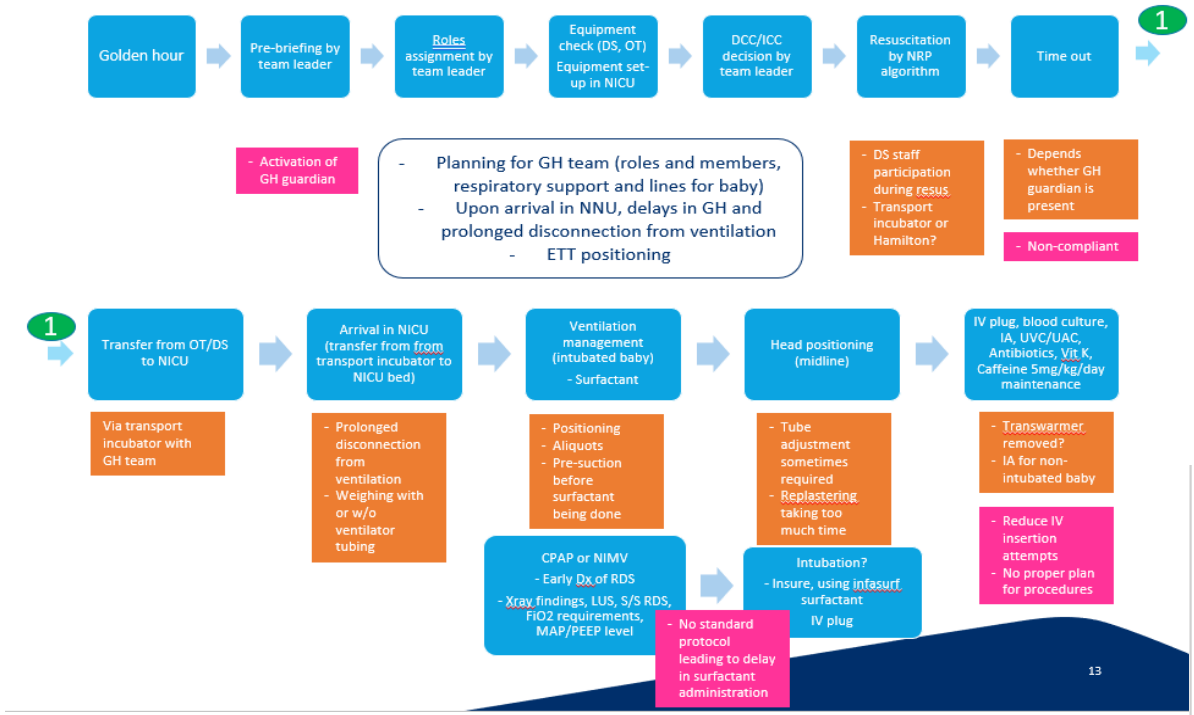
Baby delivered!!!

Legend
- Process Steps
- Variations in practices
- Potential failure

Scope of the workshop
- Start: Antenatal @ 23 weeks
- End: Postnatal 36 weeks (post-menstrual age) for all babies and 37 weeks for 32 weeker

4b. Problem Analysis (PLAN) Value Stream Map

Current Value Stream Map – Birth to 1 HOL

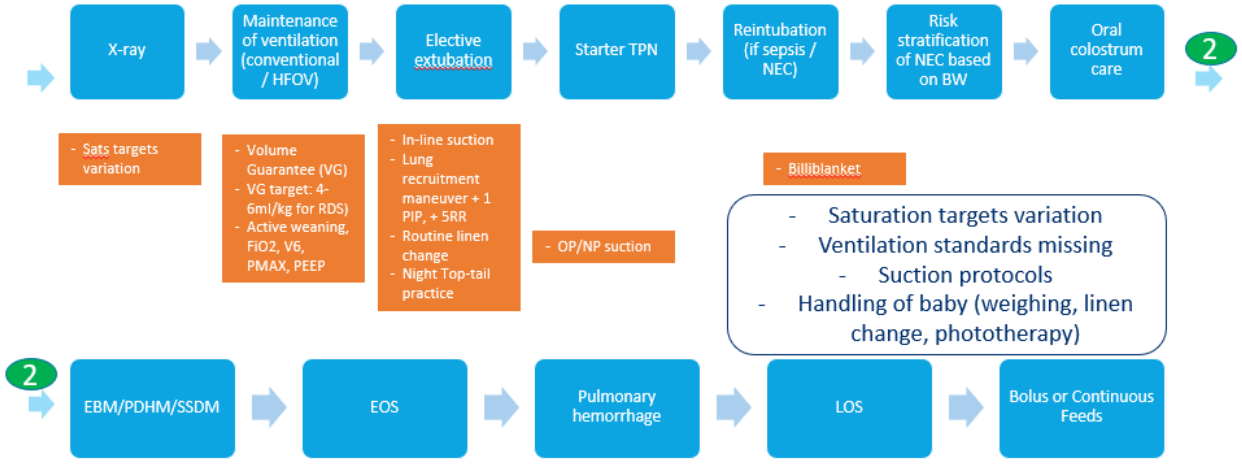


Legend

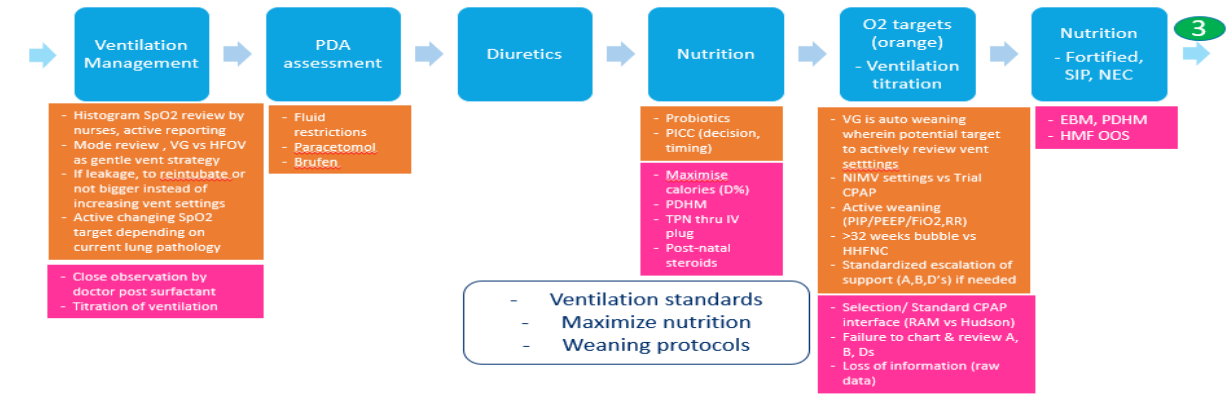
- Process Steps
- Variations in practices
- Potential failure

Scope of the workshop
- Start: Antenatal @ 23 weeks
- End: Postnatal 36 weeks (post-menstrual age) for all babies and 37 weeks for 32 weeker

Current Value Stream Map – 1st Hour onwards (2)



Current Value Stream Map – Week 1 onwards (3)



4C. Problem Analysis (PLAN) Gap Analysis

3 RCAs were done to analyze the following Gaps,

1. Sub-optimal growth & nutrition
2. Sub-optimal respiratory care
3. Sub-optimal foetal state

Gap Analysis: Sub-optimal Growth & Nutrition

S/n	Issues	Root Causes	Solutions / Interventions
1	Prolong PDHM use	Low EBM supply	--
		PDHM easily available	Chargeable PDHM
		Lack of support (husbands /LCs)	Improve parental counselling Drs & LCs
2	Prolong bottle feeding (duration/feed)	Concern of aspiration?	Evidence required
		No NNS guideline	Create NNS guideline
3	Nutritional loss	Feeding intolerance /reflux	Timely review of feeding method
		Slower feeding increment as fear of NEC	
4	Parental nutrition not optimize	Concern of hyperglycaemia	Review of HGT /micro nutrients threshold
		Can't optimize macro nutrients in TPN	Early PICC /central lines
5	Delay in recognising poor growth	No routine review of growth data	Nutritional intake as daily vital signs
		Priortization of other issue	Drs to calculate Kcal/kg/day + protein
			Excel spreadsheet to auto calculate
		High nursing workload	Revise weighing protocol
		Compromise respiratory status	
6	Delay in milk supplement	Lack of guideline for liquid protein and how to achieve nutritional optimisation	once /week dietician review
		Lack of nutritional round. No dieticians support.	Dietician education for nurses and Drs

Gap Analysis: Sub-optimal Respiratory Care

s/n	Issues	Root Causes	Solutions / Interventions
1	No early diagnosis	Lack of skills & training among doctors & nurses	Lung ultrasound at 1 HOL (NN core & RT)
2	No standard ventilation strategy in NNU	No regular meeting between nurses and doctors	Time set aside for clinical issues dissemination during department meetings
		No VG protocol (limitations & troubleshooting)	VG protocol – team to ensure compliance
3	Lung decruitment because of vent. disconnected		
4	No Lisa	No available curosurf	Upload Lisa protocol
			Awaiting curosurf from pharmacy
			Conduct training of Lisa for nurses & Drs
5	No standard weaning strategy	No milestone	Gold card
			BPD prediction @ D7
			Focus on baby at high risk
			Visuals in multi-disp corner 24 for checklist
6	Delay in depronging	Inadequate objective insight on baby's readiness	Objective radiological assessment at 2 weeks before CLD diagnosis
			Objective physiological assessment 2 weeks before 36/37 week
		"No A & B means adequate caffeine"	Reuse & optimise caffeine dose every week
7	No extubation readiness assessment	No milestone	Identify nurse for GWR
			Golden card
			Extubation checklist
			Chronic lung review template
8	Sub optimal PDA management	Protocol for PDA tx not enforced	--
9	No consistent care provider	Consultant changing every week	Longer duration of rotation for Drs
		Nursing shift discontinuity	Continuity for same baby (Primary nurse); Adopt a baby concept
10	No full first responder team present	Out of office hour delivery	More standardized training for team leader
			Give more training opportunity for nurses
			Nurses to be included in mock care
			Pre-briefing & team allocation to allow GH consultants
			Every nurses must be equipped to be PR by training them

4d. Problem Analysis (PLAN) Gap Analysis

Gap Analysis: Sub-optimal Foetal State

SN	Issues	Root cause	Solution/Intervention
1	Poor identification of patients with Pre-eclampsia/IUGR	FORECAST is not part of SOP	Create SOP Preterm foetal group (NUWOC) – work in progress
2	Poor identification of patients with Pre-Term Labour	Lack of resources to do cervical length monitoring – Ultrasound, trained personnel, cost	Create SOP Preterm group – work in progress
3	Suboptimal timing of Antenatal Steroids (ANS)	Current SOP is too general Guidelines to give ANS not clear	Revise SOP and disseminate information Timing of ANS Actim partus
4	Rescue steroids not given	Evidence conflicting	-
5	Patient's non compliance to admission/ medications	Not enough support- MSW, WEHS, O&G and Neonates	Ensure patients are referred to MSW, WEHS for support and constant communications. Inpatient workflow
6	Suboptimal recognition of subclinical chorioaminonitis	No established parameters for clinical infection	-
7	Aspirin not given when indicated	Option to desensitize patients to aspirin not disseminated.	Actively refer patients to desensitization clinic.

Restricted, Non-Sensitive

Gap Analysis: Sub-optimal Foetal State

SN	Issues	Root cause	Solution/Intervention
8	Decision on when to deliver not optimised	No formal arrangement for regular updates between O&G and Neonate in both inpatient and out patient settings.	Create inpatient workflow (Weekly inpatient communication between Neonate and O&G) Regular referral to neonate – selective patients (need neonate buy-in)
9	Baby not delivered in optimum conditions	Inadequate joint planning for delivery No formal joint Neonate and O&G morning and exit rounds	High risk deliveries during office hours Daily rounds in DS (9.30am, 6.30pm)

4e. Problem Analysis (PLAN) Paradigm Breaking Exercise

S/n	Why Can't We……?	Are you able to shift out of this Paradigm?	
		Y	N
1	Screen 100% for risk of PIH / PE	w/ EBD, screen for risk of PIH / PE	
2	Diagnose chorioamniontis		No established EBD
3	More selective of when to start Dexa (ANS)	w/ EBD start DEXA	
4	Rescue Dexa dose	w/ EBD rescure DEXA dose	
5	OG & Neonates meet weekly	w/ EBD OG & NN meet	
6	Prevent PPROM		Biologically impossible yet
7	High risk cases be discussed between OG & NM Seniors	Morning & evening OG / NN meet in DS	
8	High risk deliveries in office hour	Possible, but not promise	
9	How might we preserve intranterine growth		No EBD
10	Use Actim Partus results for Management	Actim Partus possible w/ EBD	
11	Predict Preterm Delivery	Cervical length screen	
12	Mom's nutrition affects fetus		No EBD
13	Desensitise mom's with Aspirin Allergy	Refer to allergy	
14	Stop giving moms intrapartum O2	EBD / Knowledge	
14A	Delay delivery >24hr post 2nd dose	Possible, no reason why can't delay delivery > 24hrs post 2nd dose	
15	Make GH more effective	Provide training w/ core neonates	
16	Train everyone to be GH member	Core neonates + neonate nurses + consultants	
17	Baby own incubator be place in D/S or OT		Not for now but maybe with new DS
18	Time out for each critical step	Will tighten the t/o process (before treatment)	
19	Standardize transport ventilator use	Use new transport vent machine when arrive in April	
20	Not change linen daily	Talk w/ infection control KIV change every DD	
21	Photo lights in incubator		Not available now
22	Monitor TV during resus	Hamilton; neopuff over ambubag transport use Hamilton to monitor TV	
23	We have regular RT session with Nurses	Will do it once /mth; doctors teaching one /mth	
24	Reduce disconnection	Will tighten lung decruitment awareness	
25	Doctor observe baby more closely when weaning	Possible since doctor is doing it before	
26	Fix ETT for the 1st time	Return demo midline plastering among nurses; Print out GA ETT level. Review NTL bt tut + 6 level	
27	Diagnose RDS early → Give surfactant early	Timepoint of early surfactant rescue; Lung USS in RDS diagnosis	

S/n	Why Can't We……?	Are you able to shift out of this Paradigm?	
		Y	N
28	Give Lisa instead of insure	w/ EBD give Lisa	
29	Use curosurf instead of infra surf	w/ EPD use curosuft	
30	Predict early BPD	w/ EBD Predict early BPD	
31	Lung u/s for RDS diagnosis	Training for doctors; lung u/s for RDS diag	
32	Standard DAART protocol timing	To be discussed	
33	Histogram renew practice for FiO2	For FiO2 titration	
34	Standardise VG	Protocol existing will review & tighten up; Consider Histogram Epic graph vital signs	
35	Improve nutrition	Yes	
36	Standard weaning & extubation criteria	No standard /EBM for weaning but can give broad guideline	
37	Standard consultant consensus to all practices	Grand ward rounds nurses, dietitian to be involved; Better communication among consultants	
38	Start early NMV rather than CPAP		Conflict NIMV can marked the need for surfactant
39	Have VG titration standard	Review existing V6 + PTV guidelines	
40	Treat all PDA early	Details TBD	
41	Deprong at 34 weeks	Assessment of baby readiness to deprong > 34 weeks onwards	
42	Review A/Bs chart	Possibility of manual chart for (A, B, D)	
43	Vitamin A	To be discussed	
44	Maximise nutrition	Yes	
45	Non-invasive instead of intubation	w/ Lisa Protocol	
46	BPD Bundle protocol	For further discussion	
47	Optimization of caffeine	w/ EBD	
48	Treat ureoplasma infection	Details TBD	
49	Nurses intubate / RT	Doctor to tighten the skills of intubation. RT to be involved. Layers of conflict to be discussed	

5. Interventions & Action Plan (DO) – Best Practices

Expert Invitees from SGH

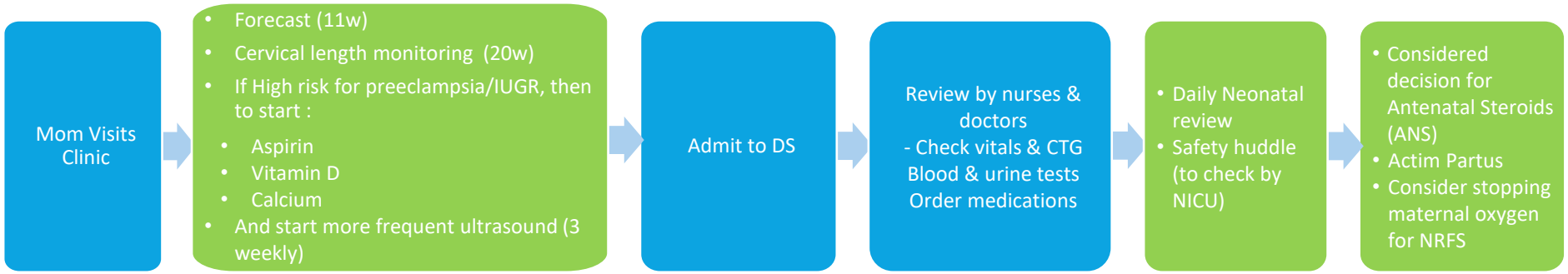
Best Practices Cross Sharing between SGH & NUH

Dr. Poon Woei Bing, Head of Neonatology (SGH)

Dr. Priyantha Edison, Staff Physician (SGH)

All inputs from invitees have been carefully considered and incorporated into the plans

5a. Future Value Stream Maps – Antenatal (1)



- History (65%)
- ~~Forecast (Predictor of PIH, IUGR)~~
- Ultrasound scan (11-12W)
- PAPP-A
- ~~Aspirin by 16 W~~
- ~~Vitamin D~~
- ~~Calcium~~

- ~~Screening for pre-eclampsia/IUGR (FTQ-80%)~~
- Aspirin allergy
- Non compliance
- Late bookers
- ~~Missed early growth scan for high risk (27-28W)~~

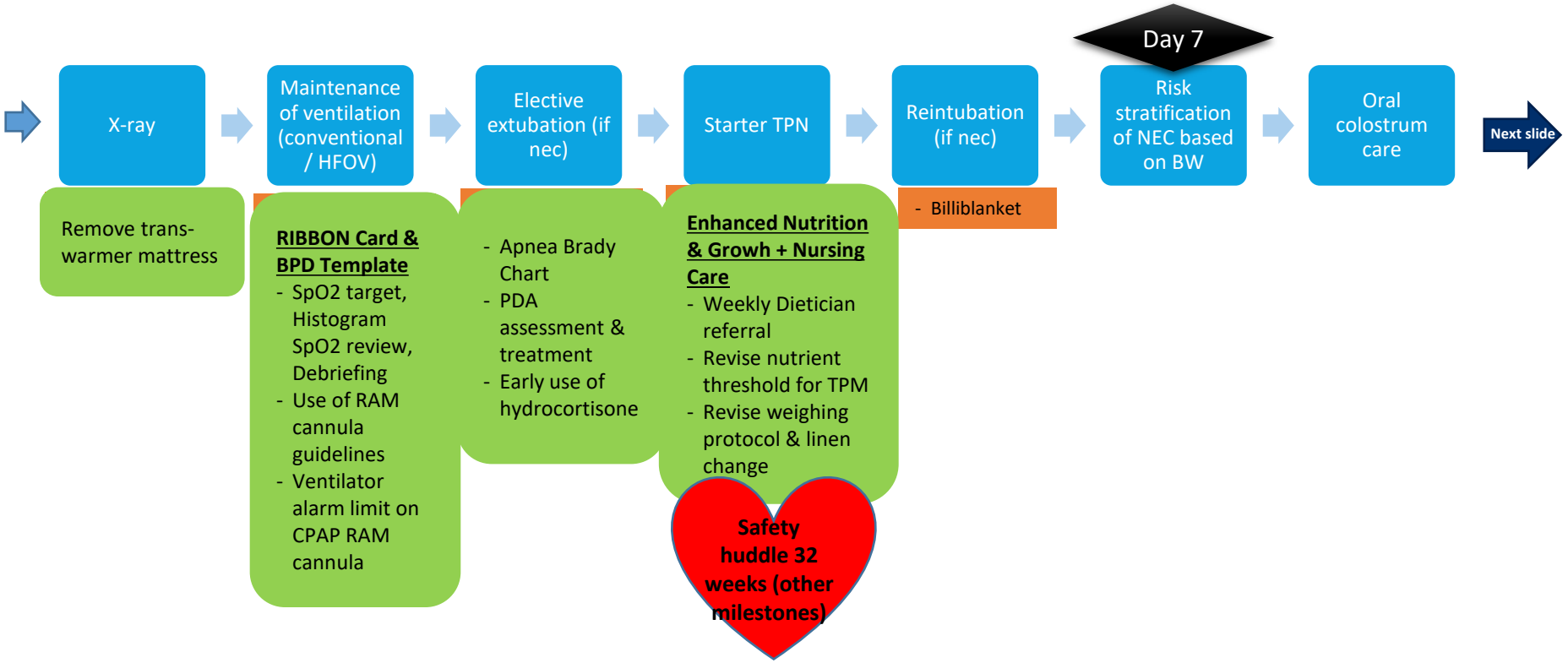
- Update Neonate of imminent delivery
- Verbal counsel of parents
- ~~**Neonate – O&G communication**~~
- ~~**Timing of steroids- 1st dose 23w, 2nd dose 12 hours later**~~
- Timing of MgSo4 for neuro protection

- Decline admission/AOR
- Decision to give steroids – Time to first dose.
- Objective assessment (Primi/Multipara)
- ROM
- OS open/closed
- APH
- ~~Actim Partus~~
- Subjective assessment

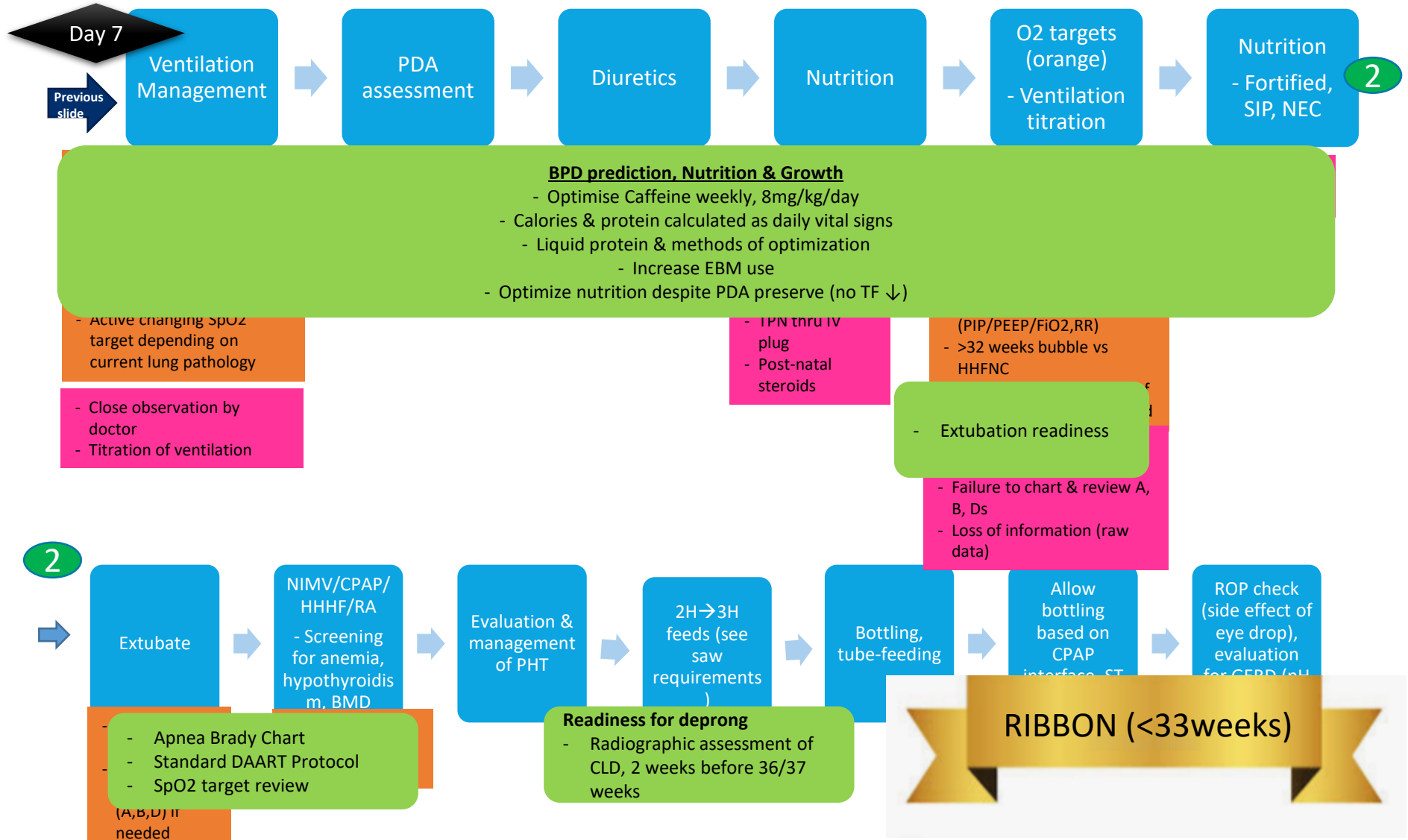
5b. Future Value Stream Maps – Antenatal (2)

5c. Future Value Stream Map – Birth to 1 Hour of Life (1)

5d. Future Value Stream Map – 1st Hour onwards (2)



5e. Future Value Stream Maps – Week 1 onwards (3)



6. Rapid Experiment and Prototyping

The following standard works were derived during the improvement sprint.

1	Rational antenatal corticosteroid administration	 OG-Antenatal
2	Nutrition proposal	 Nutrition Proposal
3	LISA	 LISA (MIST)
4	Nursing Practice (BPD)	 Nursing Practice - BPD
5	Physiologic Assessment towards cessation of Respiratory Therapy (PART)	 Physiologic Assessment
6	Ribbon Card, Daily Documentation Template, Golden Hour refinements	 Card_Temp_GH 
7	Summary of Standard Work	Summary of andard Work - Ag

7. Completion Plan

7. Completion Plan (phase 1, 30 Apr)

SN	Item	Who	When
1	Enhanced Nutrition Plan	Dr Kalai, **Dr Jeanette**, dietician, Dr Lee LY	Phase 1 (30 April draft finalized Implement 15 May)
2	Ribbon Card	Dr Khadijah, **Sarasvati**	Phase 1
3	Ventilation protocol	Dr Agni, Prof Lee, **Allelieh**	Phase 1
4	Suction protocol	Sister Wang Xia, **Illene Chen**	Phase 1
5	BPD template	Dr Jeanette, **Dr Khadijah, Santosi**	Phase 1
6	Finalise Lisa protocol	**Dr Agni,** Allelieh, Nicole	Phase 1
7	Nursing care	**Sister Wang Xia,** Melissa, Suhe	Phase 1
8	Golden hour	**Dr Khadijah,** Dr Kalai, Dr Amutha, Allelieh, Sarasvati	Phase 1
9	Physiologic assessment	Dr Agni, **Suhe, Nicole**, Allelieh	Phase1

7. Completion Plan (phase 2, May to Jul)

SN	Item	Who	When
10	Antenatal Steroids - Rescue steroids	**Dr Pradip**, Dr Sarah	Phase 2 (30 June draft finalized- Implement 15 July)
11	O&G – Neonate communication Deck	**Dr Pradip**, Dr Sarah Sister Siti, Dr Agni	30 June draft finalized Implement 15 July
12	Apnoea chart	Sarasvati**, Suhe**	30 April draft finalized Implement 15 May
13	GWR nurse rep	Sister Wang Xia, **Melissa,** Suhe	30 April draft finalized Implement 15 May
14	Adopt a baby concept	**Melissa,** Nicole, Illene, **Dr Kalai**	30 April draft finalized Implement 15 May
15	Postnatal Steroid protocol	Prof Zubair, **Dr Agni,** Dr Krish	30 June draft finalized Implement 15 July
16	Lung Ultra sound @1 hour of life	**Dr Khadijah,** Dr Agni, Dr Mary, Dr Kalai, Dr Shegufta	30 June draft finalized Implement 15 July

7. Completion Plan (Longer term)

SN	Item	Who	When
17	FORECAST (Pre-eclampsia, IUGR, Cervical length) Start Aspirin if indicated De-sensitising aspirin allergy	**Dr Pradip**, Dr Sarah, Prof Mahesh	To follow-up in 2024
18	Increase trained golden hour pool	Dr Khadijah, Dr Amutha, Sister **Wang Xia**, Allelieh	To follow-up in 2024
19	Doctor and nurses to be trained on ventilation support	**Allelieh**, Dr Khadijah**,** Sarasvati, Dr Agni, Illene	Phase 2 (july)
20	Early BPD prediction	**Dr Agni,** Dr Khadijah	To follow-up in 2024
21	Vitamin A supplementation	-	To follow-up in 2024
22	Urea plasma screening and treatment	**-**	To follow-up in 2024
23	1st Review Meeting (2 weeks post RIE)	**All full time members**	Physical meeting unless off/shift work - Friday, 31 March, 11.30-1pm (T09-02) Zoom: https://ihis.zoom.us/j/93964749015?pwd=L05TeE9BOWpYczlxcXBDRzYwWUltZz09
24	2nd Review Meeting (2 weeks post RIE)	**All full time members**	Friday, 14 April, 11-1pm hybrid

7. Results Tracking Plan

SN	What	How	Freq/Period	Who
1	**Antenatal corticosteroid** Proportion of babies delivered within therapeutic window of ANS	Manual	Quarterly	Dr Pradip Dr Sarah
2	**O&G-Neonatology communication** Compliance, high-risk delivery in office hours	Manual	Monthly	Dr Pradip Dr Sarah Sister Siti (Sister Zel)
3	**LISA: Less Invasive Surfactant Administration** Number of intubations prevented, BPD rates, safety and success (based on clinical parameters).	System (Red cap) and manual	Monthly	Nicole Melissa Allelieh Dr Kalai
4	**Physiologic assessment** Proportion of newborns correctly identified based on their physiology	System (Red cap) and manual	Monthly	Suhe Nicole Dr Agni
5	BPD rate	System (Red cap) and manual	Monthly	Dr Khadijah Dr Agni Sister Wang xia

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9	Physiologic assessment	Dr Agni, **Suhe, Nicole**, Allelieh	Phase1

7. Completion Plan (phase 2, May to Jul)

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7. Consolidated Solutions (refer to following slides)

REDUCE INCIDENCE OF BABIES WITH BRONCHOPULMONARY DYSPLASIA (RIBBON)

The premature baby's journey in NUH

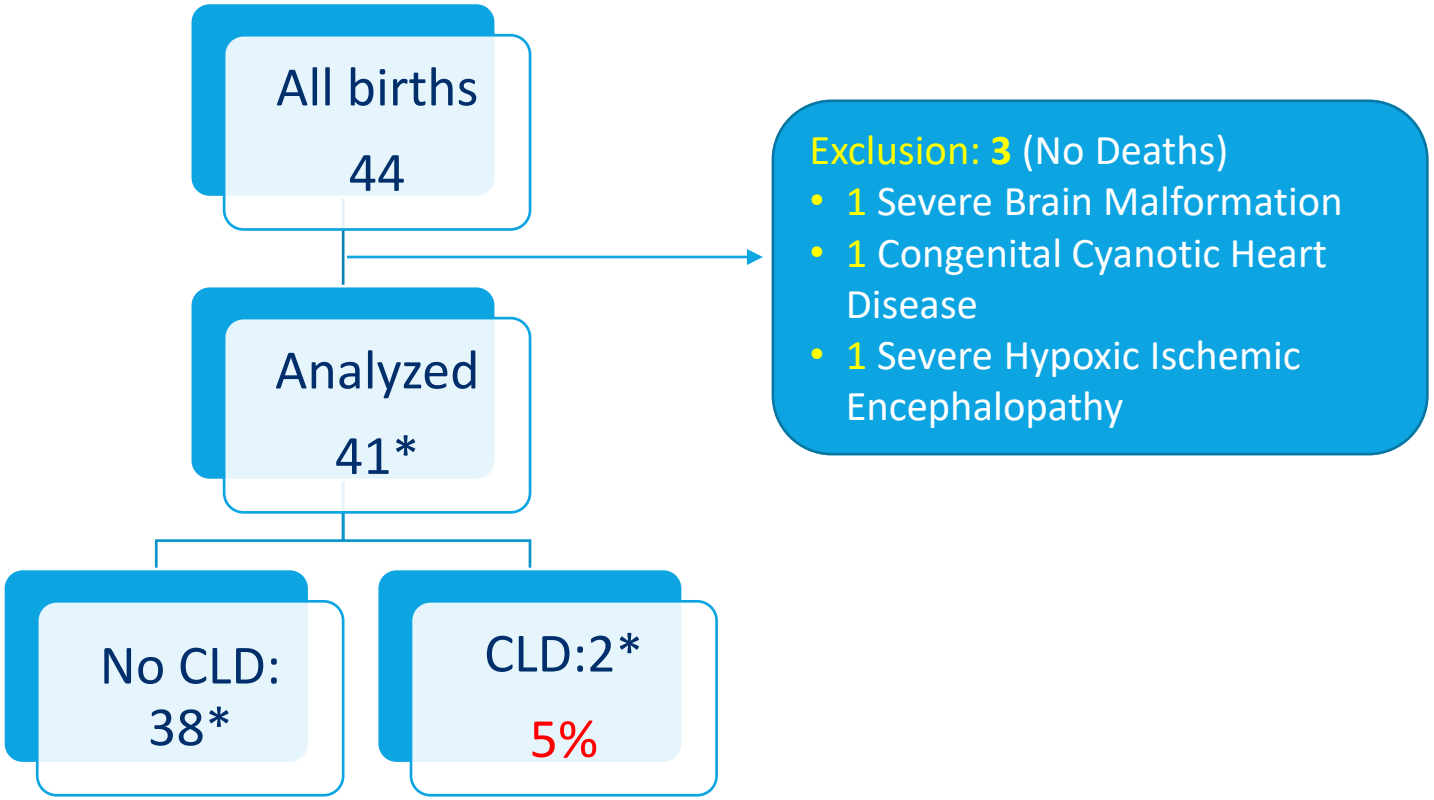
Jointly by O & G and Neonatal

Work Plans / Interventions

Refer to the following slides for details of the interventions

POST RIE Cohort of Preterms (28^{+0}- 32^{+6} wks)

1st April 2023 - 31st Dec 2023 (Q2,3 &4)



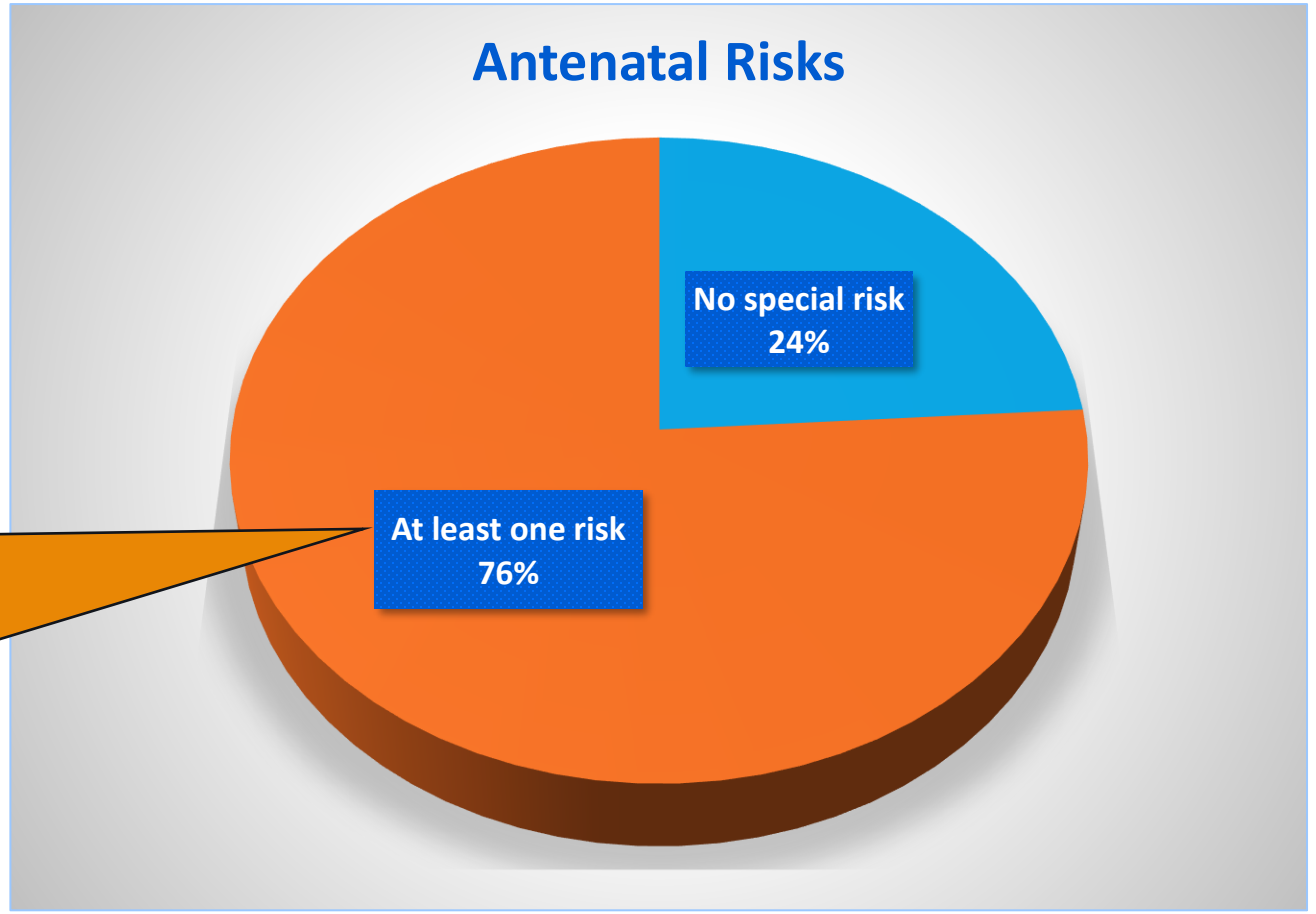
* Analyzed 40 patients for primary outcome: Last patient of the year not yet reached milestone for primary outcome

Antenatal & Perinatal RISKS of the Post Sprint Cohort

(N = 41)

- **Conceived as Multifetal pregnancy: 24.4%**

- PIH – 22%
- Diabetes – 24%
- Oligohydramnios -10%
- Doppler abnormalities -20%
- PPROM >7 Days – 2%
- Chorioamnionitis – 29%



Obstetric Management of the Antenatal & Perinatal Risks

Aspirin: 100% of eligible mothers received timely Aspirin

Targeted Antenatal Steroids (CBBA excluded):

-100% coverage with at least 1 dose of ANS
- On target ANS: 74% (post) vs 67% (pre RIE)
- 1 late delivery beyond ANS action

Perinatal antibiotics for Chorioamnionitis:

- 29% of babies born to mums with suspected chorioamnionitis
- 100% coverage with perinatal IV antibiotics in target pop
- None of the babies had early onset sepsis or pneumonia

Neonatal Management of Antenatal & Perinatal Risks

- All non-precipitous deliveries attended by Golden hour team

Delayed cord clamping (> 30 seconds)

- 63% - almost all 60 seconds, one-few minutes
- Reasons for not doing DCC (n=15)
  - Primary apnoea despite stimulation – 40%
  - Abruption – 20%
  - Nonpulsatile cord – 6%
  - Chorioamnionitis-6%
  - Others: CBBA, Encaul delivery

Temperature management

- Use of multiple resources to preserve thermoneutral environment
- Mean Rectal temp at admission 36.9^{o}C (Median 36.9^{o}C)
  - Adm Temp < 36.0^{o}C : 2.4%
  - Adm Temp < 36.5^{o}C : 17%
  - Adm Temp >37.5^{o}C : 17% (all below 38^{o}C)

Neonatal Management of Antenatal & Perinatal Risks

Day 1

Delivery room respiratory management

- 93% of babies attempted early CPAP/NIMV by prongs
- 7% needed ETT in DR
- Active oxygen management and documentation for all cases
- None of babies on CPAP hypoxic during transfer

Surfactant

- 66% did not require intubation or surfactant
- 34% required at least 1 dose; 15% required 2 or more doses
- All surfactants given within 1 hour of intubation
- Average age of receiving 1st surfactant: 2.5 hrs (Intubation), 2.5hrs (LISA)
- 50% of babies receiving surfactant through ETT extubated by 24 hours
- 92% of babies receiving surfactant through ETT extubated by 72hours

Neonatal Management of Antenatal & Perinatal Risks

Day 1

LISA (Service started 24 Sep 2023)

- 11/14 (79 %) of babies receiving surfactant eligible for LISA
  - LISA successfully performed: 2 babies (both escaped mechanical ventilation)
  - LISA not performed:9 babies
    - No equipment – 6/9 cases (prior to Sep 2023)
    - Declined consent – 1/9 cases (Religious)
    - Meets Exclusion criteria- 2/9 cases

Caffeine

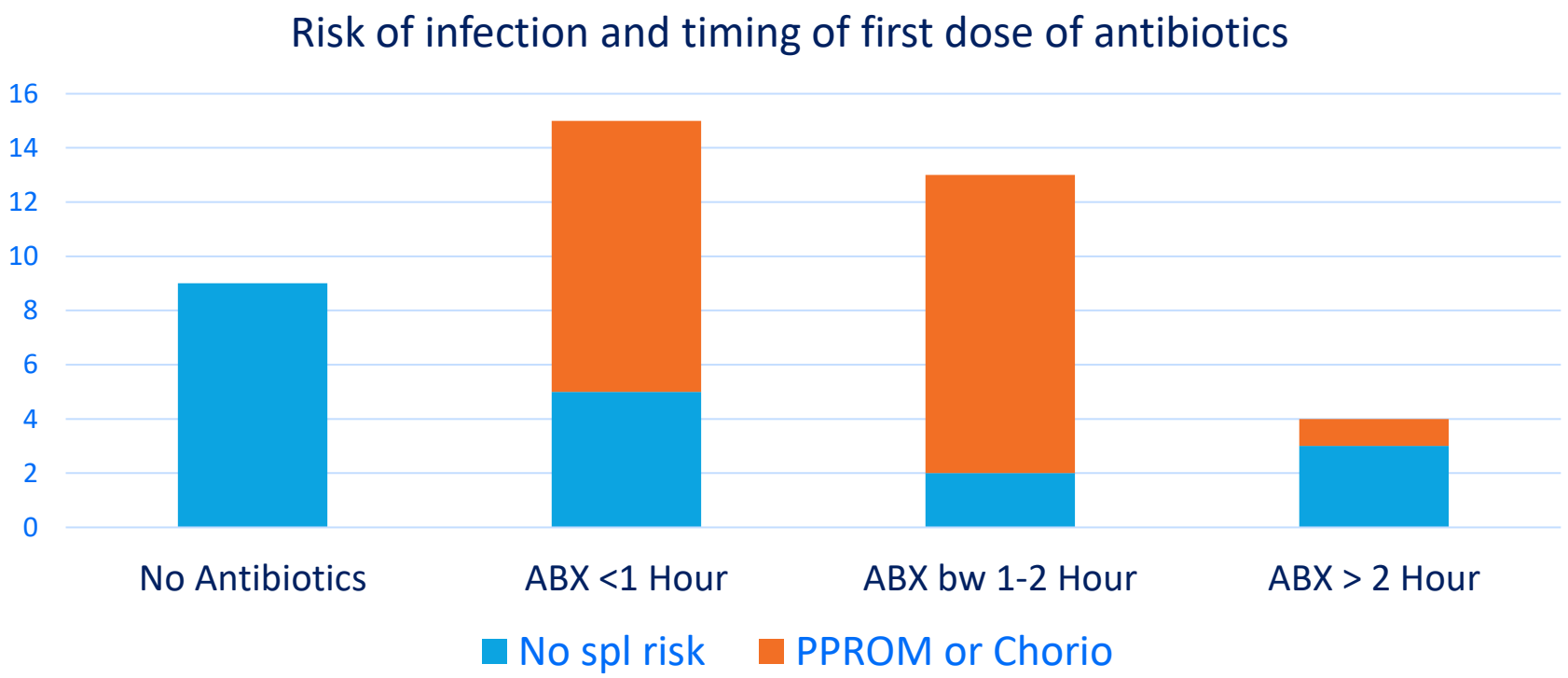
- 98% loaded on Caffeine on D1 – most in first few hours of life

Early parenteral nutrition

- 23 (56%) Did not receive Starter TPN / Early TPN by D1
  - 12 never started (bigger, relatively mature)
  - 11 started in next 48-72 hours

Neonatal Management of Antenatal & Perinatal Risks

Results



70% of babies born to Mum with PPROM or Chorio, had ABX > 1Hour

Antibiotics for babies at risk of early onset infection

- 5/12 (42%) of babies born to a mother with Chorioamnionitis received Antibiotics within 1 hour
- Scope to improve on achieving target of ABX within 1 hour in at-risk babies
- None had culture proven sepsis/ pneumonia

Respiratory Management & Outcome (Pre & Post Sprint)

	Characteristics	4yr Pre RIE data (2018-2022); n= 201	April-Dec 2023 (=9 mo); n=41
	MANAGEMENT		
	Invasive ventilation days, Mean (Med)	2.6 (0)	1.2 (0)
	Non Invasive ventilation days, Mean (Med)	23.5 (13)	20.3 (16); n=40*
	Oxygen use at 36 weeks	3 (1.5%)	1 (2.4%)
	Mean PMA when off Respi support, Mean (Med)	34+4 (33+4)	34+2 (33+3); n=40*
	PART utilization for eligible babies	NA	7/7 (100%)
	Successfully depronged after PART	NA	5 (71%)
	OUTCOMES		
	Death before 36 wks	0	0
	Death or BPD	42 (20.9%)	2 (5%); n=40*
	Grade 3 BPD (Jensen)	1 (0.5%)	0
	Grade 2 BPD (Jensen)	41 (20.4%)	2 (5%); n=40*
	Grade 1 BPD (Jensen)	0	0

PART: Physiologic assessment towards cessation of respiratory therapy

- 10 babies comsidered
- 7 eligible
- 5/7 successfully depronged
- Early failure 2 babies (apnoea)

*** One patient not reached outcome as yet**

How do Babies Who Do Not Receive TPM Fare?

		Received TPN (29)	Did not receive TPN (12)
	Mean Gestational age	30+4	32+2
	Mean Birth weight, g (z score)	1332 (-0.44)	1872 (0.24)
	Mean birth weight percentile	37	53
	Time to reach 100 ml/Kg feeds (days)	11.1	6.4
	Time to initiate fortification (days)	14.9	8.7
	Delta weight Z score (Birth to 35 weeks)	-1.101	-1.336
	PMA at discharge	38+4 (n=27)	36+3
	Weight Z score at discharge	-1.84 (n=11)	-1.14
	Time to regain Birth weight (days)	12.3	17.4

Dietary intervention after weaning TPN

TPN intervention in early days

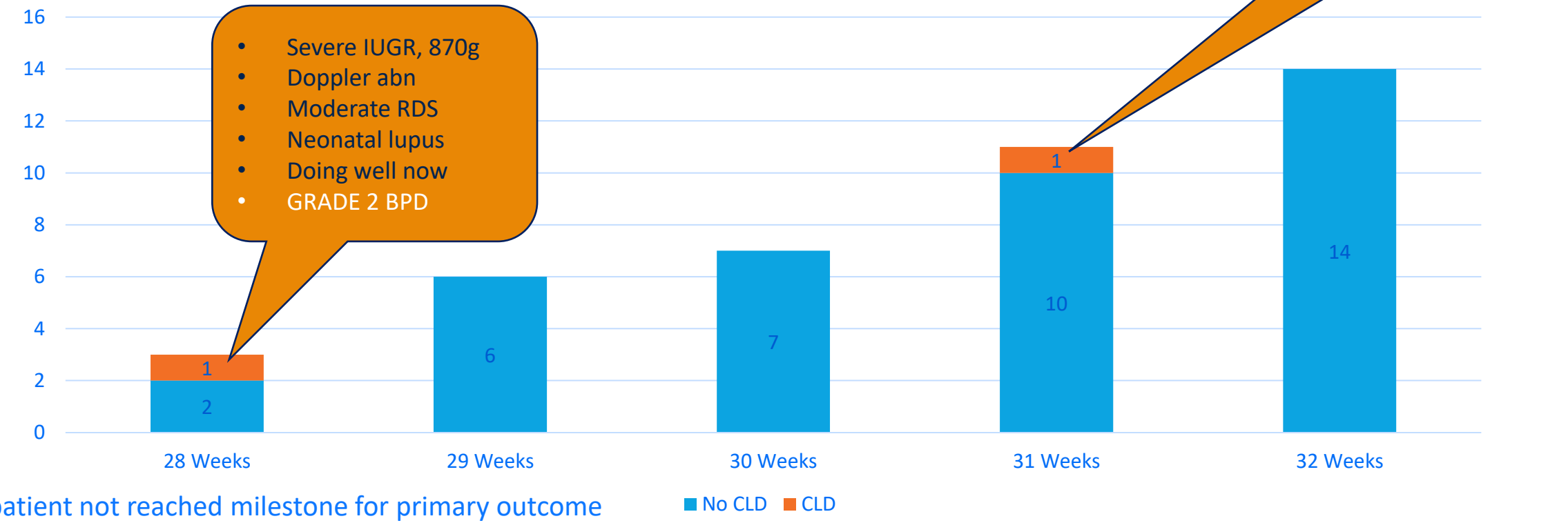
8. Confirmed State

Post Implementation from 1st April 2023 to 31 December 2023:
Total 41 babies between 28^{+0} – 32^{+6} weeks

Pre Sprint CLD rate = 20.9%

Post Sprint CLD rate = 5%

Patient numbers; n=40*



*1 patient not reached milestone for primary outcome

9. Insights (Feedback from the team)

What went well?

- **Brainstorming was superb with excellent ideas**
- Learnt new concepts
- Well-fed with brain food
- Big charts with constant easy visibility & excellent facilitation
- Well organized
- Very high yield output
- Every points are taken seriously
- Very active participation by all members
- Active discussions
- Great conversations
- Great teamwork!
- Open & honest
- Team dynamics
- Cohesiveness
- Respect
- Open to change
- Cheerful and helpful facilitators (S & S)
- Very friendly team
- Nice food and very well fed!

What could be better?

- **Protected time post RIE**
- Talk one at a time
- Provide water
- Time management

Kudos to RIBBON RIE Team

A joint collaboration between Neonatology and Obstetrics Teams

Thank you.

NUHS
National University Health System

National University Hospital
Ng Teng Fong General Hospital
Alexandra Hospital
Jurong Community Hospital
National University Polyclinics
Jurong Medical Centre
National University Cancer Institute Singapore
National University Heart Centre Singapore
National University Centre for Oral Health Singapore

NUS National University of Singapore | Yong Loo Lin School of Medicine
NUS National University of Singapore | Faculty of Dentistry
NUS National University of Singapore | Saw Swee Hock School of Public Health