

# **Non-invasive respiratory care of the preterm infant: Early management**

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# Acknowledgements

Thank you to the Conference Organisers and to Chiesi for arranging my attendance

The parents who gave written permission for use of photos and videos for teaching and publication (but please don't copy)

# Structure

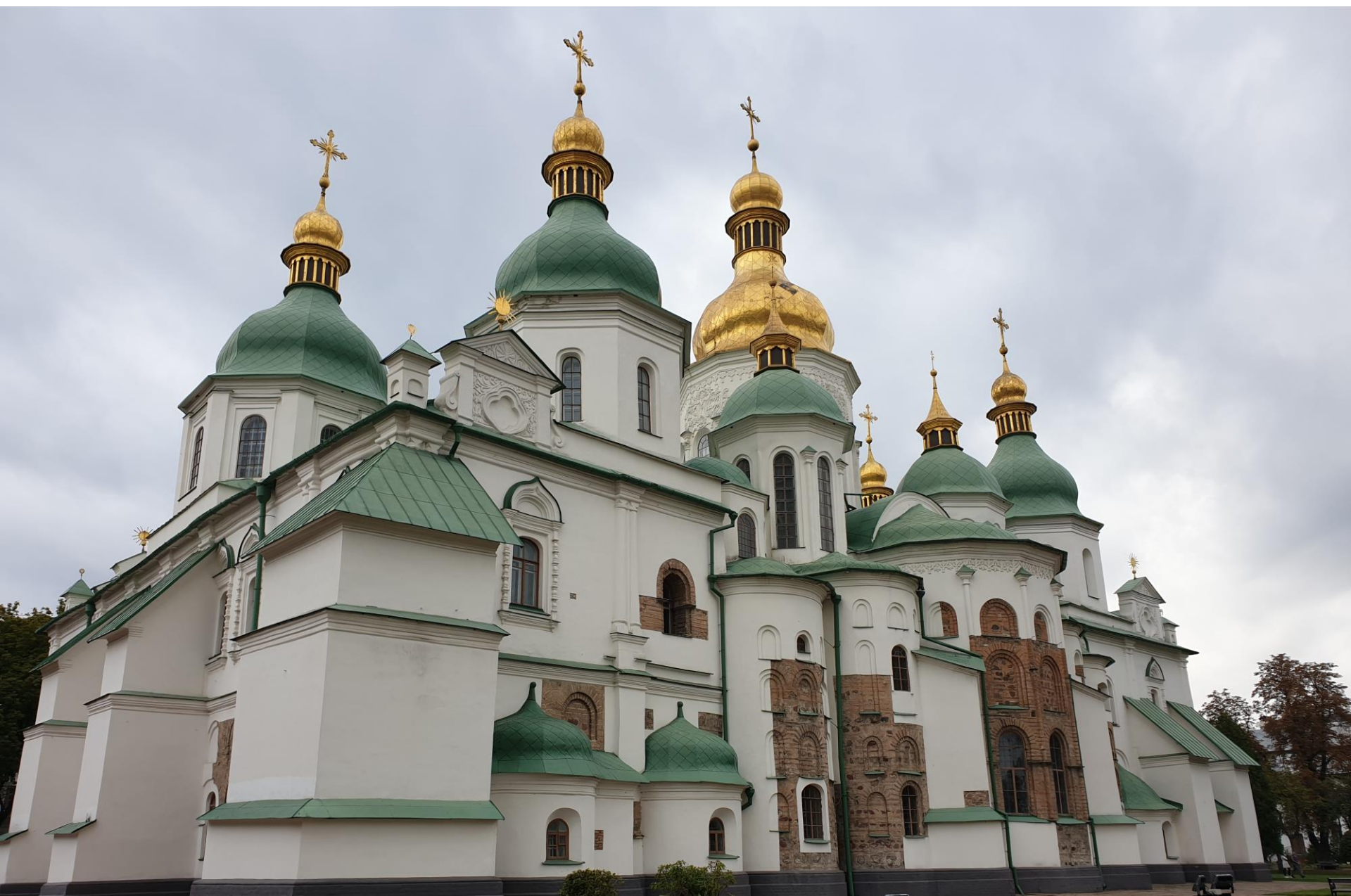
- Delivery room management of the preterm infant – “our evolution”
  - Nasal High Flow stabilisation
  - Delayed Cord Clamping
  - Birthday “Cuddle”
- Less invasive surfactant administration (LISA)
- Setting the direction for the preterm infant

# St Peter's Hospital, Surrey



# Royal Holloway University of London, Surrey





## TEENY WEENY BEANY Smallest ever Brit baby boy to survive weighed less than a tin of beans when he was born

Frankie Thompson was born at 24 weeks just before Christmas

**EXCLUSIVE**

By Nick McDermott

29th April 2018, 10:00 pm | Updated: 30th April 2018, 11:40 am



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COMMENTS

**TINY Frankie Thompson is the smallest baby boy to survive — weighing less than a tin of baked beans at birth.**

He was born at 24 weeks and a day at just 13oz, but suffered none of the complications common in premature babies.







# Who Cares Wins 2018



# Delivery Room Stabilisation

Evolution of our non-invasive pathway







# Stabilisation of premature infants in the delivery room with nasal high flow

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## ABSTRACT

**Objective** This was a pilot study to determine the feasibility of using nasal high flow (nHF) (also known as heated humidified high-flow nasal cannula) for stabilisation of babies born at <30 weeks gestation in the delivery room (DR) and transfer to the neonatal intensive care unit (NICU).

**Design** Observational study.

**Setting** Single-centre NICU.

**Patients** Infants born at <30 weeks gestation.

**Interventions** Stabilisation and transfer to NICU using nHF.

**Main outcome measures** Feasibility of stabilisation as defined by successful transfer and clinical measures of stability at admission to NICU including oxygen requirement, temperature, requirement for surfactant and intubation within 72 h of delivery.

## What is already known on this topic?

- Delivery room stabilisation of preterm infants using nasal continuous positive airway pressure (NCPAP) improves outcomes.
- Nasal high flow (nHF) is not inferior to NCPAP for postextubation management of neonates.
- nHF has gained popularity due to ease of use, effectiveness and patient comfort.

## What this study adds?

- It is feasible to stabilise premature babies in

# New (unpublished) data

- 4 years retrospective
- 221 babies < 32 weeks stabilised on HF (56%)
- Median 28+0 weeks, 988g
- 96% at least 1 dose A/N steroids, 59%  $\text{MgSO}_4$
- Admission temperature 36.9°C (median)
- Admission  $\text{FiO}_2$  28% (median)
- 43% required surfactant
- At 72 hrs 78% did not require invasive ventilation
- 6% died

# Evolution of Pathway

- Previously used cord milking
- Evidence for DCC
- Straightforward to integrate into pathway



# Stabilisation with DCC

- Baby active?
- Placed into plastic bag on LifeStart<sup>®</sup>
- Breathing? - no drying, no suction, minimal handling
- Immediate application of High Flow 7 L/min 0.21
- Masimo Rad-5V applied to right hand (pre-ductal)
- DCC for 3 minutes whilst stabilising
- Aim HR > 100bpm
- Aim initial SaO<sub>2</sub> >40% with steady increase about 10% per minute
- Saturations targeted to 90-95%

# Birthday Cuddle

“because everyone deserves a cuddle on their birthday”



# The “normal” pathway

- Higher acuity babies get “imprisoned” in incubators, “shackled” with leads and it may be weeks before they can be held by their parents
- Babies who die may never have been previously held by their parents

**This can be changed.**

# Teamwork and Communication

- Guideline!
- Prepare parents beforehand
- Prepare/remind obs/midwifery staff beforehand
- Senior neonatal support (reg, nurse, cons)
- Effective stabilisation
- Temperature management
- SpO<sub>2</sub> monitoring



Stabilised on nasal High Flow

# Prospective Audit in progress

## **Staff**

Mainly 5 mins achieved

Did not hinder management 75/75

Baby was safe 75/75

Normal admission temperature 65/75 (36.8°C)

Blood glucose:

46( $\geq 2.0$ mmol/L)

14 ( $\geq 1.0 < 2.0$  mmol/L)

2 ( $< 1.0$ mmol/L) - IUGR preterm

13 not recorded

# Safety – Prospective Audit

## **Parents**

Very positive 100%

## **COMMENTS**

“I was really happy to be able to cuddle him”

“This was the most amazing experience of our lives” (other Twin had undergone feticide)

“I got to hold my baby”

**“Amazing” is the most used word in feedback...**

“The team throughout our care has been amazing they have made us feel very reassured and we know our baby is in the best care”

“Just amazing. Brilliant!!”

“An amazing and wonderful experience”

“Neonatal team have been and are amazing at explaining and comforting us. I am so grateful he is here - thank you”

“Neonatal support amazing, really happy with support I have been given”

# There are so many reasons...

No negative impact on immediate medical care

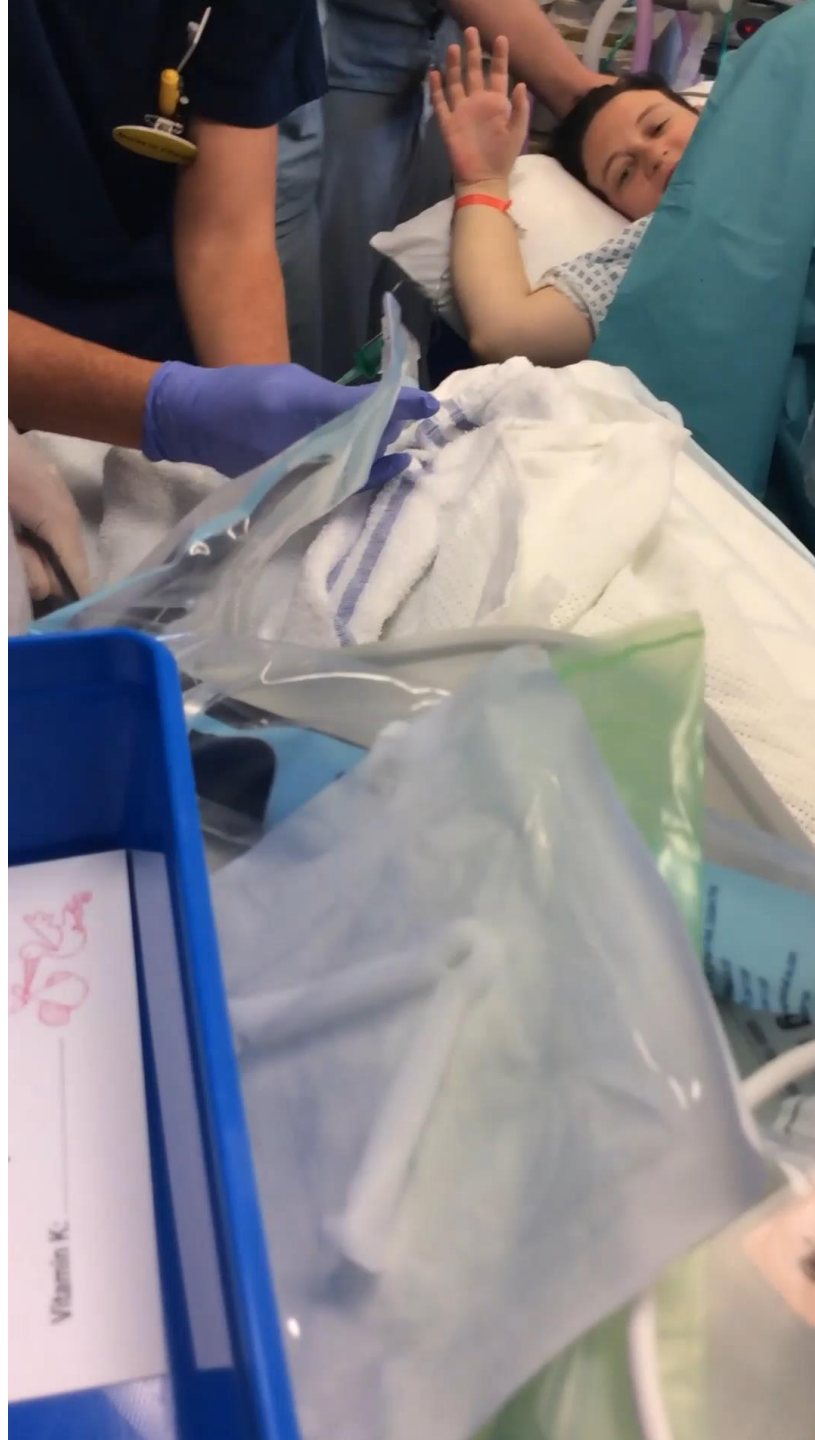
Positive impact on

- Bonding with baby (both parents)
- Relationship (between parents)
- Breast feeding
- Coping with sickness and death
- Staff – positive emotions

“First time events between parents and preterm infants are affected by the designs and routines of neonatal intensive care units”

Baylis 2014

24 week  
intubated  
Birthday  
Cuddle



**Delivery of premature infant  $\leq 32$  weeks gestation likely to require respiratory support?**

**Get mobile HF, set up circuit prior to delivery**

**3 mins Delayed Cord Clamping on LifeStart<sup>®</sup>**

**Active, breathing?**

**Plastic bag, apply HF 7l/min,  
Pulse oximetry**

**Stabilising?  
Continue**

**If stable => Birthday Cuddle  
then transfer to NICU**

**Not breathing?**

**Plastic bag, suction if needed,  
inflation breaths, pulse oximetry**

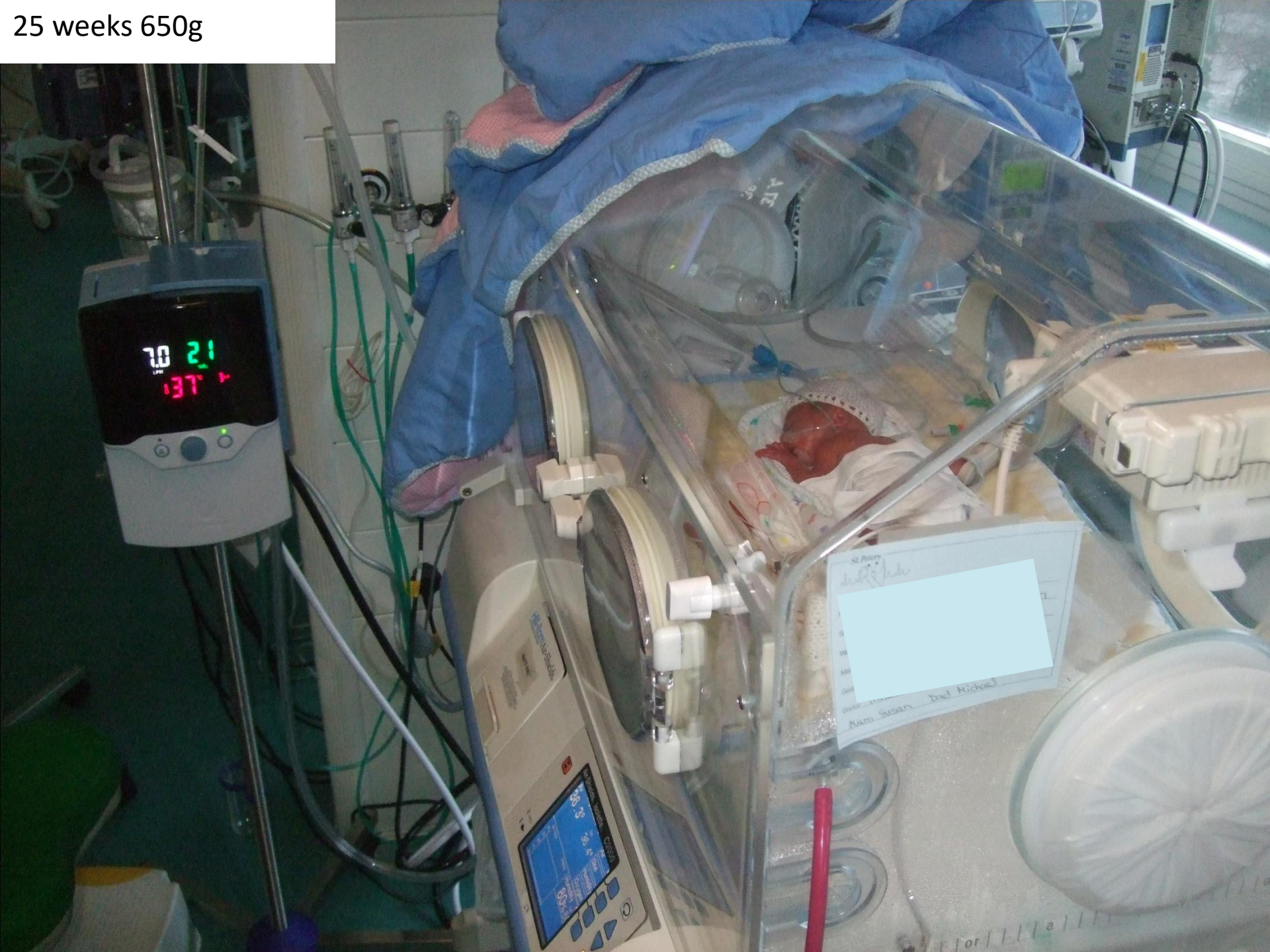
**Prompt response?  
Consider HF 7l/min**

**Not stabilising?  
Intubate**

**No response?  
Intubate, resuscitate**

**Consider surfactant, Birthday  
Cuddle, transfer to NICU**

25 weeks 650g



What about using HF on NICU as  
primary support?

# **Nasal High-Flow Therapy as Primary Respiratory Support for Preterm Infants without the Need for Rescue with Nasal Continuous Positive Airway Pressure**

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# Population

| Infant characteristics                | JRH<br>( <i>n</i> = 191) | SPH<br>( <i>n</i> = 190) | <i>p</i> value |   |
|---------------------------------------|--------------------------|--------------------------|----------------|---|
| Mean GA, weeks                        | 32.9±2.2                 | 32.3±2.4                 | 0.01           |   |
| GA, weeks                             | 33 (31–34.6)             | 32.4 (30.3–34.3)         | <0.001         | ← |
| GA <32 weeks                          | 69/191 (36.1%)           | 83/190 (43.7%)           | 0.13           |   |
| Mean birth weight, g                  | 2,018.6±663              | 1,770.4±576              | <0.001         | ← |
| Male sex                              | 113/191 (59.2%)          | 111/190 (58.4%)          | 0.88           |   |
| Multiple births                       | 70/191 (36.6%)           | 80/190 (42.1%)           | 0.28           |   |
| Median 1-min Apgar score              | 8 (6–9)                  | 8 (6–9)                  | 0.167          |   |
| Median 5-min Apgar score              | 10 (9–10)                | 9 (8–10)                 | <0.001         | ← |
| Mean starting cord pH                 | 7.29±0.1                 | 7.21±0.13                | <0.001         | ← |
| Median FiO <sub>2</sub> prior to nHFT | 0.25 (0.21–0.35)         | 0.3 (0.21–0.35)          | 0.16           |   |
| Caffeine in first 24 h                | 95/191 (49.7%)           | 71/190 (37.4%)           | 0.02           |   |
| Primigravida                          | 68/191 (35.6%)           | 79/190 (41.6%)           | 0.007          | ← |
| Antenatal steroids                    | 125/191 (65.4%)          | 133/190 (70%)            | 0.34           |   |
| Caesarean section                     | 128/191 (67.0%)          | 122/190 (64%)            | 0.36           |   |
| PROM >24 h                            | 26/191 (13.6%)           | 25/190 (13.2%)           | 0.89           |   |

# Main Outcomes

| Intubation within 72 h | JRH<br>( <i>n</i> = 191) | SPH<br>( <i>n</i> = 190) | Both centres combined | <i>p</i> value |
|------------------------|--------------------------|--------------------------|-----------------------|----------------|
| All infants            | 28/191 (14.7%)           | 21/190 (11.1%)           | 49/381 (12.8%)        | 0.29           |
| GA <32 weeks           | 18/69 (26%)              | 14/83 (16.9%)            | 32/152 (21%)          | <0.001         |
| GA >32 weeks           | 10/122 (8.2%)            | 7/107 (6.5%)             | 17/229 (7.4%)         | <0.001         |



Data are presented as *n* (%). GA, gestational age; JRH, John Radcliffe Hospital; SPH, St Peter's Hospital.

| Reasons for intubation           | JRH ( <i>n</i> = 191) | SPH ( <i>n</i> = 190) | <i>p</i> value |
|----------------------------------|-----------------------|-----------------------|----------------|
| Apnoea                           | 1/191 (0.5%)          | 4/190 (2.1%)          | 0.18           |
| FiO <sub>2</sub> >0.4            | 16/191 (8.4%)         | 18/190 (9.5%)         | 0.56           |
| Respiratory acidosis             | 7/191 (3.7%)          | 3/190 (1.6%)          | 0.2            |
| Urgent need for intubation       | 3/191 (1.6%)          | 0                     | 0.08           |
| Clinician's decision to intubate | 8/191 (4.2%)          | 9/190 (4.7%)          | 0.79           |

Data are presented as *n* (%). FiO<sub>2</sub>, fraction of inspired oxygen; JRH, John Radcliffe Hospital; SPH, St Peter's Hospital.

# Adverse Events

| Adverse events                                              | JRH ( <i>n</i> = 191) | SPH ( <i>n</i> = 190) | <i>p</i> value |
|-------------------------------------------------------------|-----------------------|-----------------------|----------------|
| Death before discharge                                      | 0                     | 1/190 (0.5%)          | 0.32           |
| FiO <sub>2</sub> , respiratory support, or both at 36 weeks | 5/191 (2.6%)          | 12/190 (6.3%)         | 0.16           |
| Air leak                                                    | 8/191 (5.8%)          | 5/190 (2.6%)          | 0.4            |
| Postnatal steroids                                          | 0                     | 1/190 (0.5%)          | 0.32           |
| Nasal trauma                                                | 0                     | 0                     |                |
| PDA requiring treatment                                     | 2/191 (1%)            | 1/190 (0.5%)          | 0.57           |
| Confirmed sepsis                                            | 15/191 (7.9%)         | 14/190 (7.4%)         | 0.9            |
| Necrotising enterocolitis                                   | 4/191 (2.1%)          | 1/190 (0.5%)          | 0.25           |
| Intestinal perforation                                      | 0                     | 0                     |                |
| Retinopathy of prematurity grade >2                         | 0                     | 0                     |                |
| Intraventricular haemorrhage 3–4                            | 1/191 (0.5%)          | 2/190 (1.1%)          | 0.22           |
| Periventricular leukomalacia                                | 1                     | 0                     | 0.32           |

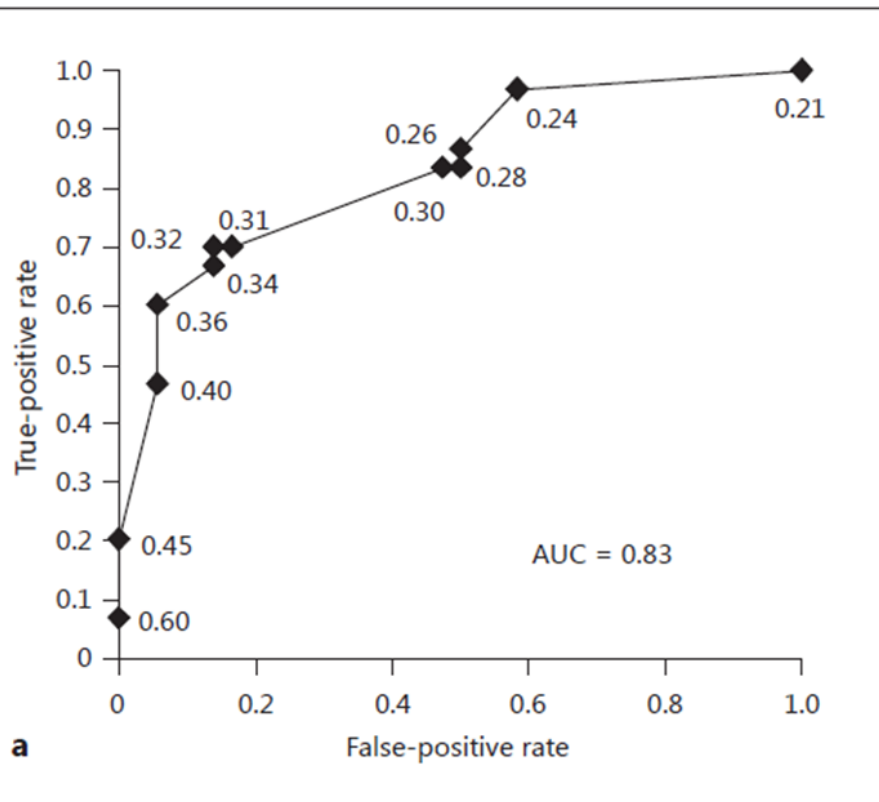
Data are presented as *n* (%). FiO<sub>2</sub>, fraction of inspired oxygen; JRH, John Radcliffe Hospital; PDA, patent ductus arteriosus; SPH, St Peter's Hospital.

# Less Invasive Surfactant Administration

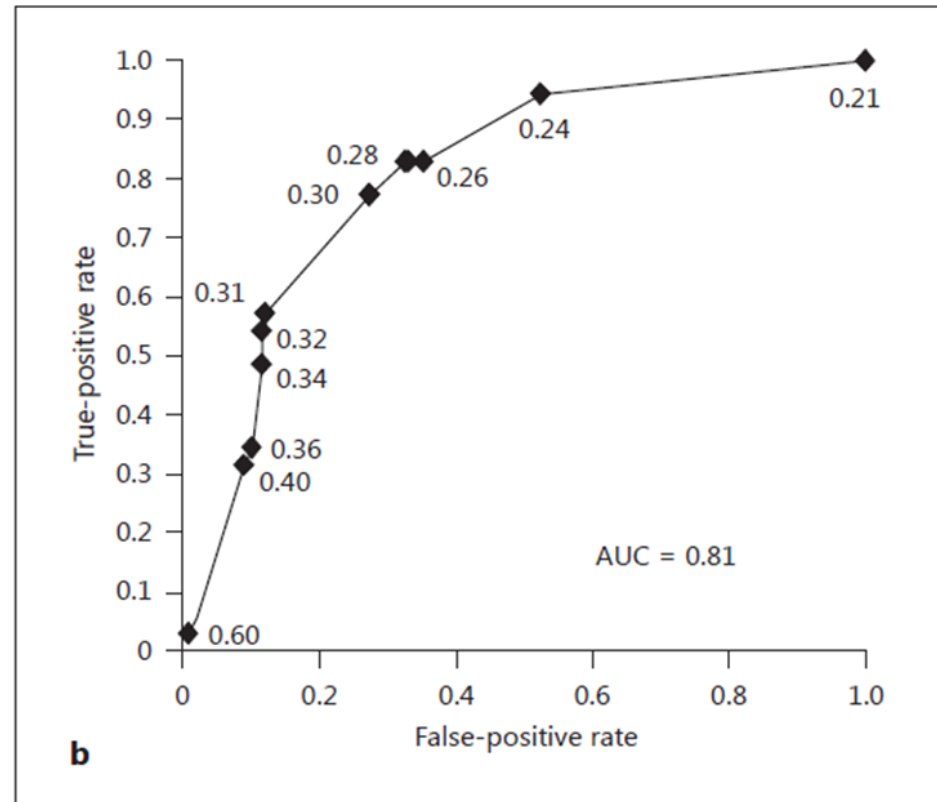
An evolution of our practice

# Prediction of NIV failure at all gestations

25-28 weeks (2 hours)



29-32 weeks (6 hours)



# LISA Guideline 2019

- Any gestation with RDS requiring surfactant
- Normally in NICU but can be on Delivery Suite
- On NIV (Vapotherm High Flow)
- Aim to give if  $\text{FiO}_2 \geq 30\%$  or increased work of breathing, recession, grunting, rapid onset
- Routine caffeine
- Sedation/atropine optional (0.7 ug/kg fentanyl)
- Video-laryngoscope encouraged
- Use of LISACath™
- Aim 200mg/kg Curosurf, slow - 0.5ml/minute
- Repeat dosing on same criteria



# LISA Advisory Board

- Preparing UK Expert Guideline for LISA
- Aim to provide expert guidelines for the 82% of neonatal units in the UK still not using LISA
- Will include guidance for use of Laryngeal Mask Airways as well as catheters for LISA

# Routine Caffeine

- Routine use of caffeine citrate <30 weeks
- Normal practice to administer IV Caffeine Citrate (Peyona) then switch to oral when on full feeds
- Loading dose 20mg/kg
- Maintenance dose 10mg/kg



# Day 1

At delivery

≤ 30 mins

≤ 60 mins

≤ 2 hrs

≤ 4 hrs

≤ 6 hrs

Non-invasive ventilation, DCC, cuddle

IV access and fluids, IM Vitamin K, TcCO<sub>2</sub>

Antibiotics (if indicated), IV Caffeine load

Umbilical Lines (if indicated, can defer)

Cranial US

PN commenced (vamin/lipid/vitamins)

Breast milk (Harvested/MEBM/DEBM)  
and feeding pathway determined

Curosurf (surfactant)

Labinic (probiotic)

Budesonide (neb)

Parents

FiO<sub>2</sub> ≥ 0.3 (or significant WOB)

Start when feed volume ≥ 1ml

Routine use unless sepsis present

Consultation senior doctor/ANNP <24hrs

# Day 2

Feeding

Pathway reviewed

NIV

Continue, wean flow only if in air

cUS

Repeat (if indicated), IV Caffeine

Caffeine

Maintenance dose

Skin-to-skin

Family centred care

# And finally...

Of emerging interest....

1. No contraindications to feeding on High Flow
2. Automated oxygen control
3. Lung ultrasound
4. Inhaled steroids to reduce BPD







# Randomised cross-over study of automated oxygen control for preterm infants receiving nasal high flow

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► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/archdischild-2018-315342>).

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## ABSTRACT

**Objective** To evaluate a prototype automated controller (Intello<sub>2</sub>) of the inspired fraction of oxygen (FiO<sub>2</sub>) in maintaining a target range of oxygen saturation (SpO<sub>2</sub>) in preterm babies receiving nasal high flow (HF) via the Vapotherm Precision Flow.

**Design** Prospective two-centre order-randomised cross-over study.

**Setting** Neonatal intensive care units.

**Patients** Preterm infants receiving HF with FiO<sub>2</sub> ≥25%.

**Intervention** Automated versus manual control of FiO<sub>2</sub> to maintain a target SpO<sub>2</sub> range of 90%–95% (or 90%–100% if FiO<sub>2</sub>=21%).

**Main outcome measures** The primary outcome measure was per cent of time spent within target SpO<sub>2</sub> range. Secondary outcomes included the overall proportion and durations of SpO<sub>2</sub> within specified hyperoxic and hypoxic ranges and the number of in-range episodes per hour.

**Results** Data were analysed from 30 preterm infants with median (IQR) gestation at birth of 26 (24–27) weeks, study age of 29 (18–53) days and study weight 1080 (959–1443) g. The target SpO<sub>2</sub> range was achieved 80% of the time on automated (Intello<sub>2</sub>)

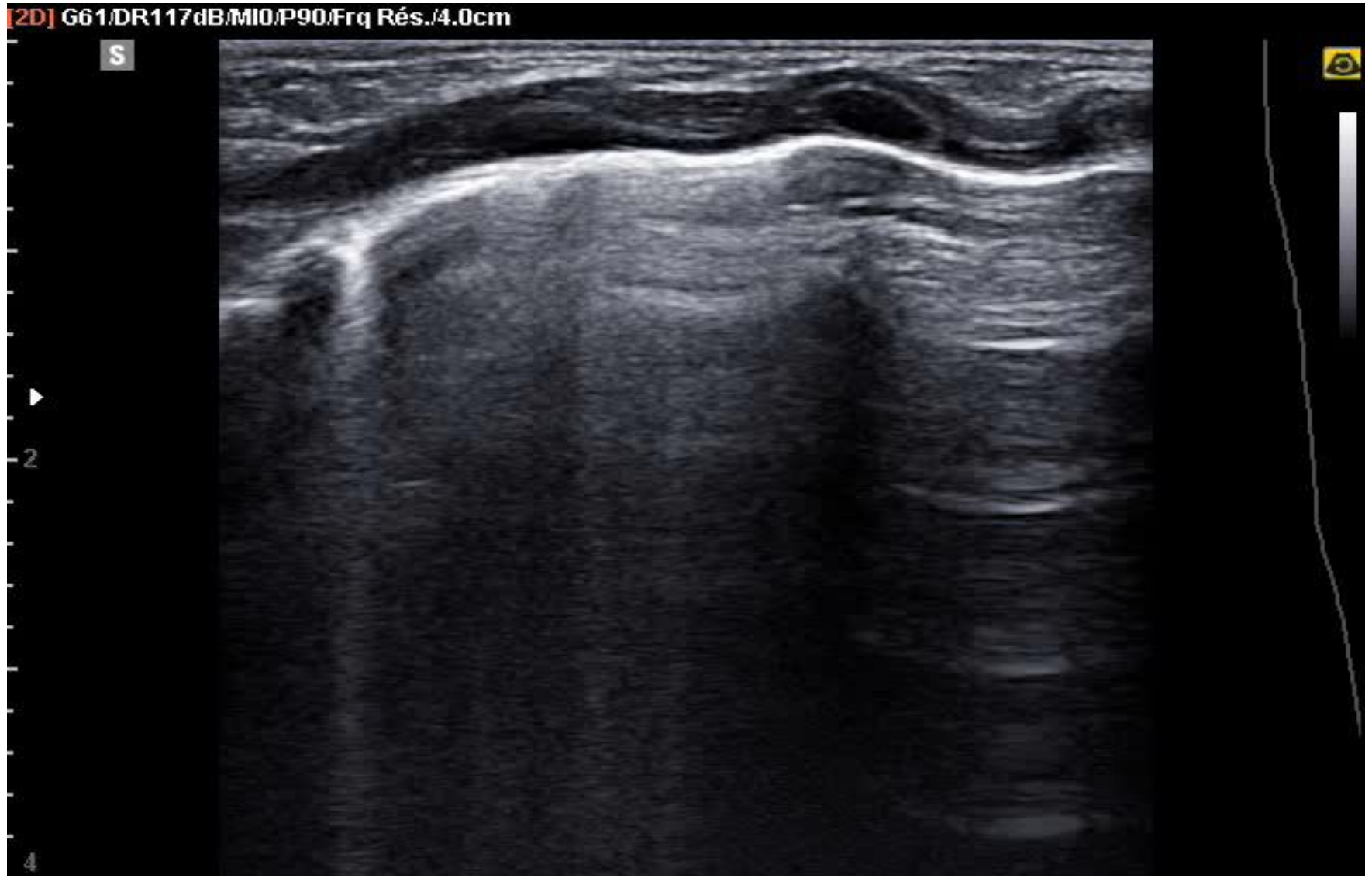
## What is already known on this topic?

- Many neonatal units target higher SpO<sub>2</sub> ranges (eg, 90%–95%) for preterm babies.
- Automated control devices have been shown to improve SpO<sub>2</sub> targeting.
- Hypoxic episodes with SpO<sub>2</sub> <80% for ≥60 s are associated with poorer outcomes in preterm infants.

## What this study adds?

- The Intello<sub>2</sub> device significantly improved the time spent in SpO<sub>2</sub> target range from 49% under manual control to 80% under automated control.
- Under automated control there were fewer and shorter episodes of SpO<sub>2</sub> <80% for ≥60 s.
- There were overall reductions in the proportion of time in hypoxic and hyperoxic SpO<sub>2</sub> under automated control, with more time spent in air.

# Lung Ultrasound



# Use of routine inhaled steroids

Baby <32 weeks requiring oxygen

Sepsis confirmed / strongly suspected?

No

Start inhaled budesonide 500 mcg BD via Aerogen ultrasonic nebuliser.

Episode of sepsis?

Continue until either

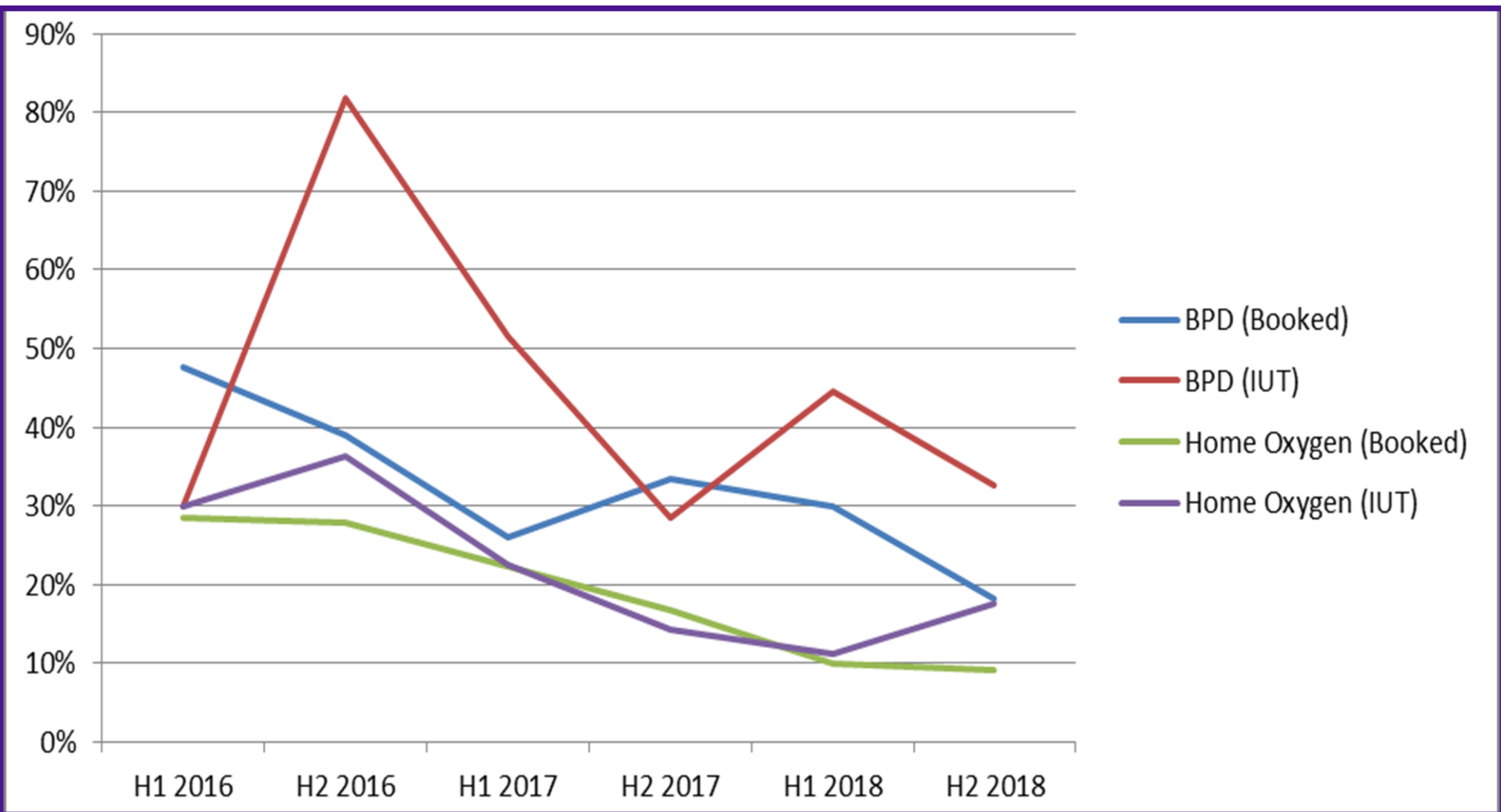
FiO<sub>2</sub> = 0.21 consistently for 1-2 weeks OR

Baby no longer receiving high flow / ventilation

Yes

Do not use inhaled budesonide until sepsis episode is controlled (clinical stability, CRP and WCC normalising)

# Early results are promising



# St. Peter's Non-invasive Strategy

- Antenatal steroids and magnesium
- Delayed cord clamping
- Avoid suction, ventilation breaths if possible
- Use of nasal High Flow in delivery room
- Birthday Cuddle
- Transcutaneous monitoring  $pCO_2$
- Early, prophylactic caffeine
- Minimal handling
- Curosurf – full dose,  $FiO_2$  0.3 by LISA
- Nebulised Budesonide
- Minimise use of umbilical / long lines (e.g. peripheral PN >800g)
- Early nutrition (10ml/kg milk <6hrs after birth then risk-based)
- Probiotics (Labinic) once milk volume  $\geq 1$ ml
- Add hydrolysed BMF when tolerating 150ml/kg/day
- Minimise feed osmolality (split additive doses)



The majority of preterm babies are well, can be stabilised early and “set” on the right pathway with careful and gentle management





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