Bronchiolitis – surviving the season

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VICTORIA State Government | Health and Human Services

Webinar Outline

1. **Introduction/Burden of Disease [TC]**
2. **Investigations [TC]**
3. **Use of pulse oximetry [TC]**
4. **Treatment [DA]**
5. **High Flow Nasal Cannula Therapy [DA]**
6. **Quality Improvement [DA]**
7. **Q & A [TC and DA]**

Clinical Practice Guideline: The Diagnosis, Management, and Prevention of Bronchiolitis

Bronchiolitis is caused by a viral LRTI in infants

Acute inflammation, oedema, and necrosis of epithelial cells lining small airways and increased mucus production

Illness typically begins with rhinitis and cough, which may progress to tachypnoea, wheezing, nasal flaring, decreased feeding

Most common cause is **RSV > rhinovirus> influenza> HMPV> parainfluenza**

Co-infection in up to 1/3 of infants

95% of children are infected with RSV in the **first 2 years of life**

Do not get immunity after infection

Question 1

Is bronchiolitis a common cause for admission in infants and children < 12 months of age?

Is bronchiolitis a common cause for admission in infants and months of age?

Bronchiolitis is the most common cause of hospitalisation among infants < 12 m

~100,000 admissions in the US each year

At RCH Melbourne ~ 1100 admissions every season (of total 7500 admissions to GM)

Estimated cost ~ $1.7 billion

Highest rate of admissions between 30 and 60 days of age (25/1000 children)

This means the variation in care is an important may impact significantly given the overall number of patients admitted.

Question 2

What investigations should we order in infants presenting with bronchiolitis?

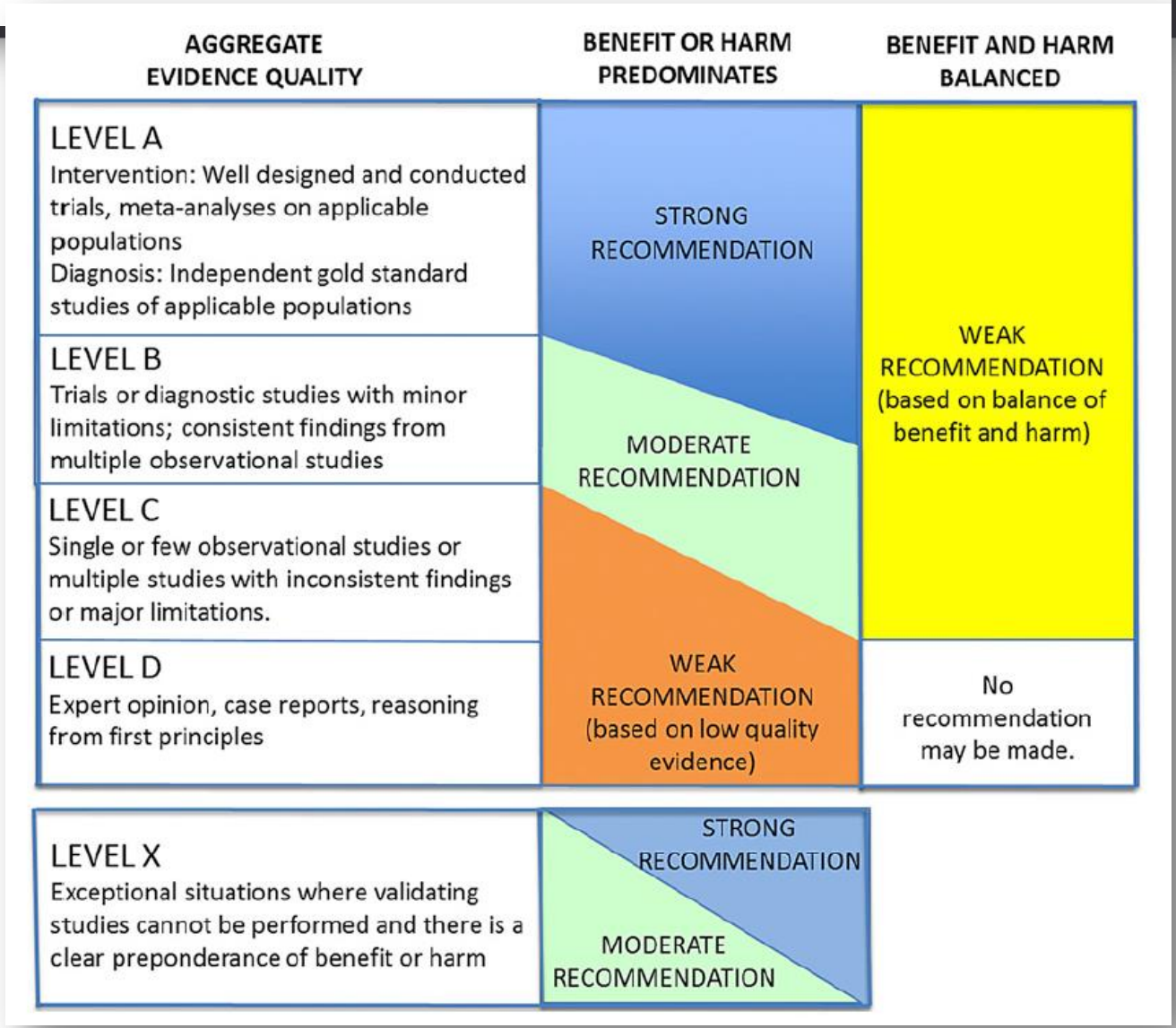
None?

NPA?

CXR?

Blood gas?

Clinical Practice Guideline: The Diagnosis, Management, and Prevention of Bronchiolitis



Question 2

What investigations should we order in infants presenting with bronchiolitis?

NPA – may detect prolonged viral shedding. Not recommended yet still done. No real value to patient (but parents and doctors?) - **good evidence**

CXR? – not routinely recommended and may lead to unnecessary antibiotic use – **good evidence**

Blood gas? – not recommended – no role outside of PICU

Pulse oximetry?

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Bronchiolitis

This guideline has been adapted for statewide use with the support of the Victorian Paediatric Clinical Network

Features on investigation

In most children with bronchiolitis **no investigations** are required

- Nasopharyngeal aspirate
  - **NOT routinely required** for children with typical bronchiolitis

Chest x-ray

- **NOT routinely required** unless diagnostic uncertainty eg localised signs on auscultation, cardiac murmur with signs of congestive cardiac failure.
- For children with typical clinical picture of bronchiolitis X-ray typically demonstrates hyperinflation, peribronchial thickening, and often patchy areas of consolidation and collapse.

Blood gas

- **NOT routinely required**

Results of a survey of adherence of CPGs for Bronchiolitis at RCH
Scholarly selective students
Data obtained:
Meredith Allen: Clinical lead for quality
Stephen Ratcliffe: Improvement lead strategy and improvement

100 medical records reviewed for bronchiolitis

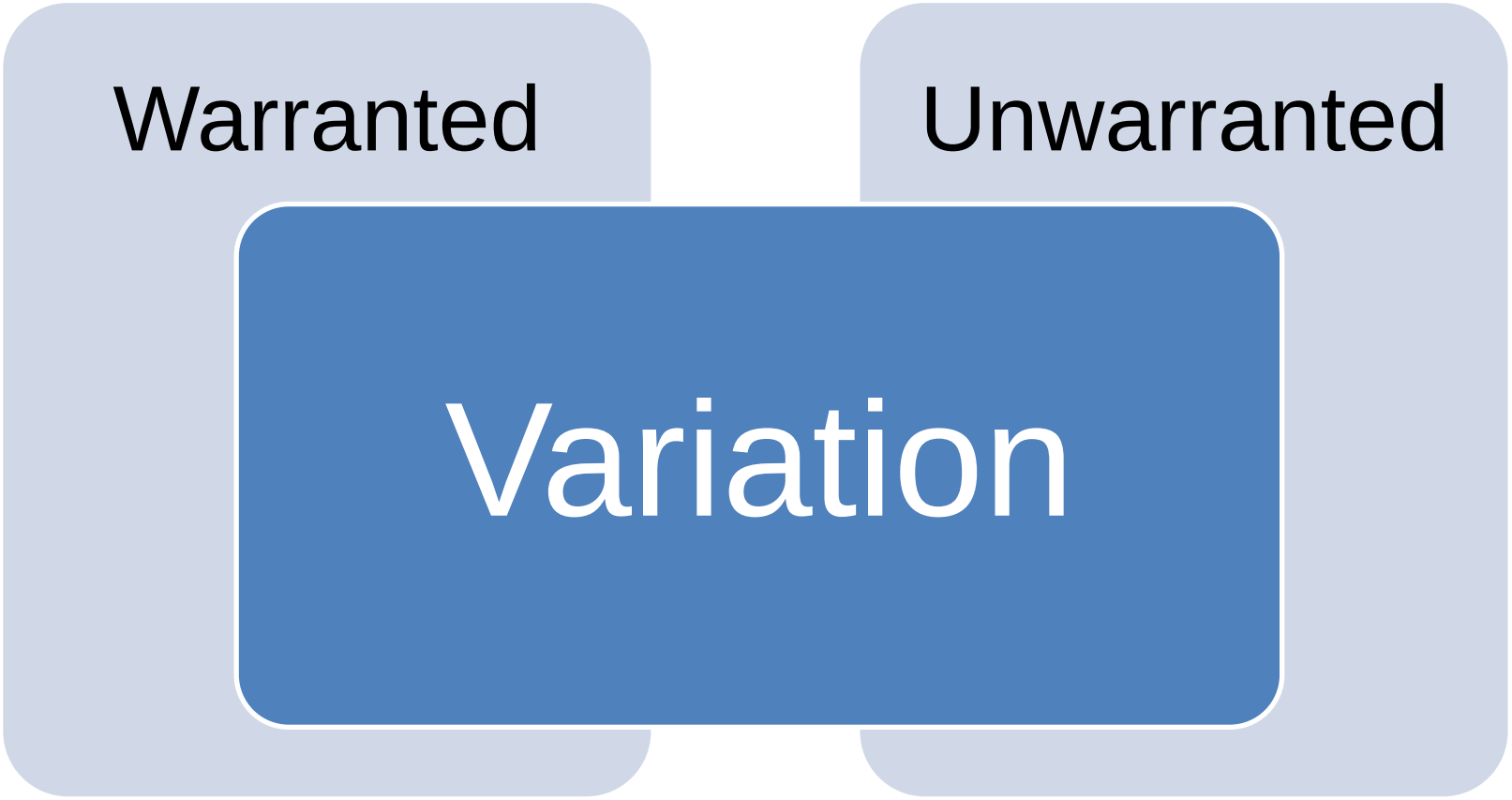
Investigations:

28% had a CXR
50% had a nasopharyngeal aspirate

What is driving this use?
Important questions and lots of room for improvement

Costs:
1000 admissions last year to RCH with bronchiolitis
28% had a CXR ($16,800)
50% had a nasopharyngeal aspirate ($30000)
Conservative - ~$45,000 on testing

Variation in itself does not infer good or bad



Slide courtesy of Harriet Hiscock

Variation: not all bad

Warranted (expected) variation

Reflects population health need or burden of disease

Individual preferences and values of patients

On a small scale may reflect practice innovation

Unwarranted variation

Not explained by need, preferences and values

May signal inappropriate care – safety and quality issues

May signal resource misallocation – questions around equity/access, efficiency ($) and value

Slide courtesy of Harriet Hiscock

Question 3

Do pulse oximetry values influence decisions to admit in bronchiolitis?

What is a safe 0_2 saturation?

When should we administer 0_2?

Oxygen saturation

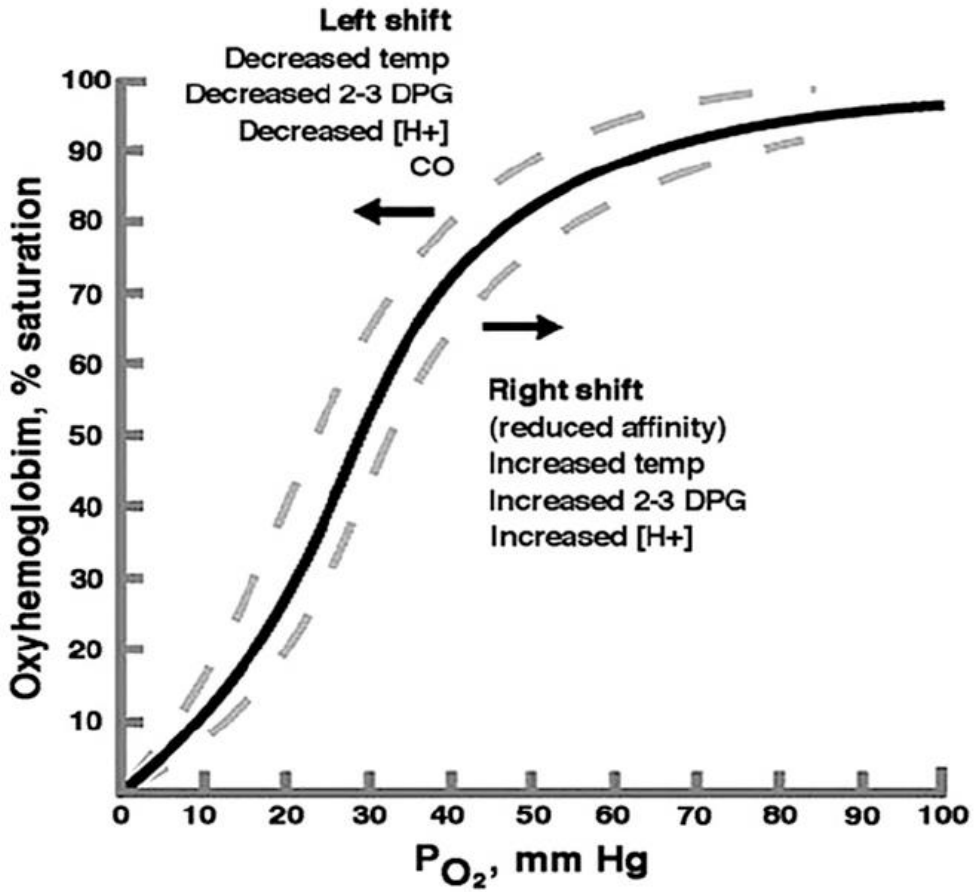
Pulse oximetry is associa

Data from the **Oxyhaem** in
arterial partial pressure (lse
oxygen saturation when

No real data to increase

No studies (until v recen
occurs in bronchiolitis

Transient hypoxaemia is



Accuracy of pulse oximetry is poor between 76 and 90% saturations

Co2 level in blood is a much stronger influence on respiratory drive

Oxygen saturation

Pulse oximetry is associated **with a perceived need for hospitalisation**

Since introducing pulse oximetry admissions for bronchiolitis have increased 150% without any increase in virulence

Data from the **Oxyhaemoglobin dissociation curve** show that small increases in arterial partial pressure of 02 are associated with marked improvement in pulse oxygen saturation when it is **<90%**

No real data to increase **to above 90%** in terms of patient benefit

No studies (until v recently) on the effect of brief periods of hypoxaemia as occurs in bronchiolitis

Transient hypoxaemia is common in normal children

Accuracy of pulse oximetry is poor between 76 and 90% saturations

Co2 level in blood is a much stronger influence on respiratory drive

Original Investigation

Effect of Oximetry on Hospitalization in Bronchiolitis

A Randomized Clinical Trial

JAMA. 2014;312(7):712-718. doi:10.1001/jama.2014.8637

Suzanne Schuh, MD, FRCPC; Stephen Freedman, MD, FRCPC; Allan Coates, MD; Upton Allen, MD, FRCPC; Patricia C. Parkin, MD, FRCPC; Derek Stephens, MSc; Wendy Ungar, PhD; Zelia DaSilva, RT; Andrew R. Willan, PhD

Background: In US rates of admission with bronchiolitis have doubled from 1980 -2000 (12.9 to 31.2/ 1000) – Sp02

Threshold for supplemental 02 ranges from 90 -95%
Small differences in Sp02 saturations may impact on hospital admissions

Aim: to determine if increasing (artificially altered) the Sp02 to 3% above true values would result in a reduced rate of hospitalisation within 72 hours

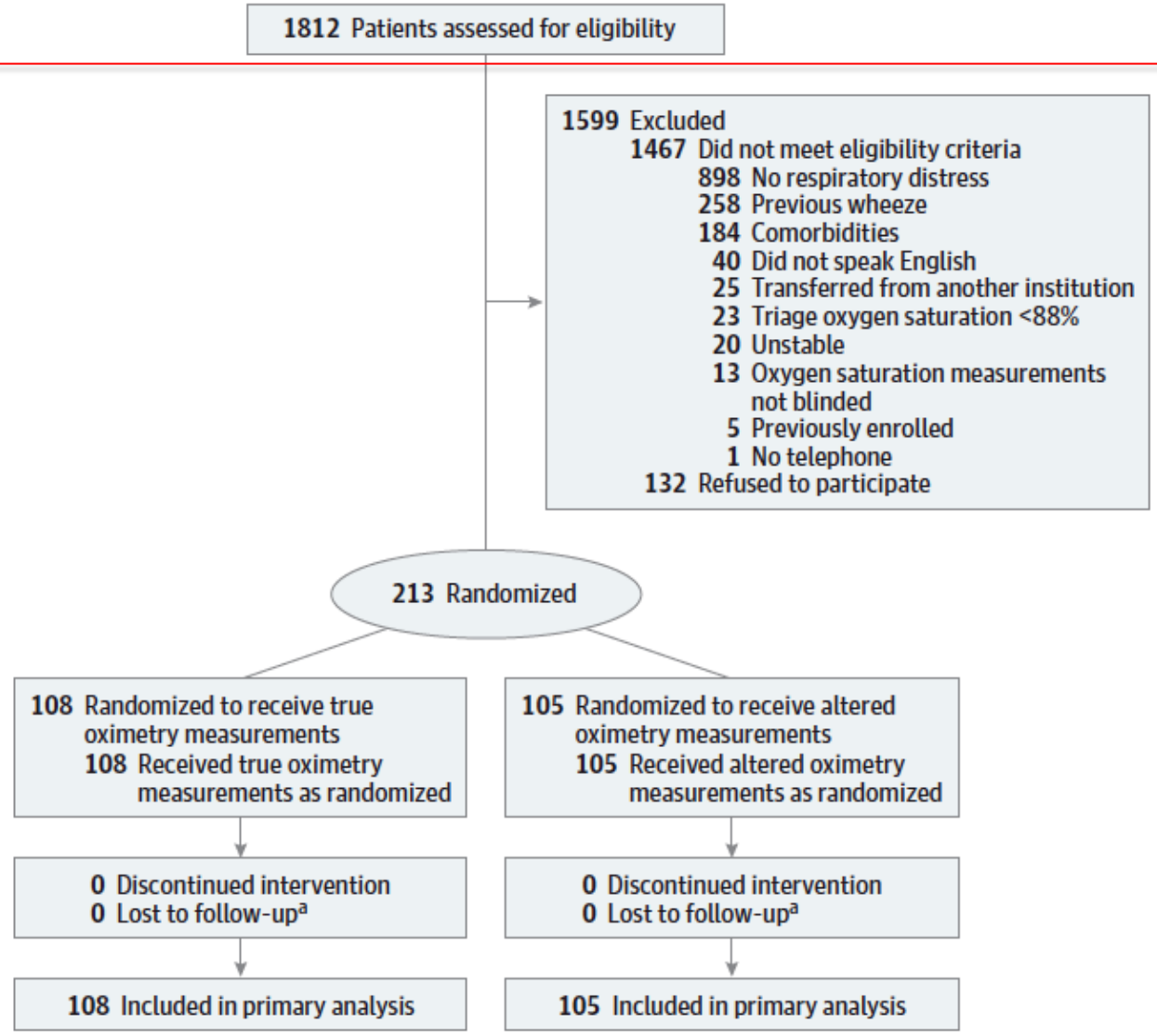
Study design: Double blind, over 5 years
Children: Age 4 -12 months
Excluded: children with Sp02< 88%, RDAI > 8 (max 17)

Randomised (Block size 6): **True** saturation or **altered** saturation

ED physicians informed that 50% probability that there may be a variation in Sp02.

Safety: concealed oximetry set to alarm at 92% so reassessment would occur

Figure. Enrollment, Randomization, and Follow-up of Pulse Oximetry in Infant Bronchiolitis Trial



Characteristic	Oximetry	
	True (n = 108)	Altered (n = 105)
Age, mean (SD), mo	4.8 (3.0)	5.4 (3.0)
Male sex, No. (%)	63 (58)	62 (62)
Fever ≥38°C within 48 h, No. (%)	53 (49)	57 (54)
History of atopy, No. (%)	31 (29)	20 (19)
Family history of atopy, No. (%)	46 (4	48 (47)
Duration of respiratory distress, median (range), h		48 (7-360)
Therapy within 48 h of arrival, No. (%)		
Inhaled albuterol		31 (30)
Oral corticosteroids	5)	11 (10)
Inhaled corticosteroids	8 (8)	2 (2)
Triage oxygen saturation, mean (SD)	97.3 (2.1)	96.8 (2.2)
Triage saturation <94%, No. (%)	11 (10)	17 (16)
Experimental oxygen satu		
Mean (SD)[a,b]	96.0 (2.8)	97.6 (2.4)
Median (IQR) [	96 (95-98) [86-100]	98 (96-100) [90-100]
Initial respiratory ra mean (SD)	53.0 (11.6)	50.0 (15.0)
Initial heart rate per mi mean (SD)	152 (18)	151 (22)
Initial RDAI, mean (SD)[c]	8.0 (2.9)	8.3 (2.9)
Participating emergency department physicians, No.	13	12
No. of patients per same physician, median (IQR)	8 (6-10)	8 (7-9)

No difference in groups at baseline

Table 2. Outcomes of Patients in the True vs Altered Oximetry Groups

Outcome	Oximetry		Difference, % (95% CI)	*P* Value
	True (n = 108)	Altered (n = 105)		
Primary				
Hospitalized within 72 h, No. (%)	44 (41)	26 (25)	16 (0.04 to 0.28)	.005
Secondary				
Length of emergency department stay, h				
Mean (SD)	5.2 (5.6)	5.0 (2.4)	0.2 (-0.13 to 0.12)	.82
Median (IQR)	4.0 (3.0-5.6)	4.1 (2.9-5.5)		.76
Supplemental oxygen in emergency department, No. (%)	4 (3.7)	4 (3.8)	-0.1 (-0.05 to 0.05)	.97
Agree/strongly agree with discharge home, No. (%)				
At initial assessment	29 (27)	28 (27)	0 (-0.16 to 0.15)	.94
At 60 min	46 (43)	58 (55)	8 (-0.25 to 0.02)	.08
At 120 min	39/71 (55)	29/64 (45)	10 (-0.26 to 0.07)	.26
Unscheduled visits within 72 h, No. (%)	23 (21)	15 (14)	7 (-0.3 to 0.17)	.18
Exploratory, No. (%)				
Delayed hospitalizations within 72 h	8 (7)	7 (7)	0 (-0.06 to 0.08)	.99
Treatment in hospital >6 h	37 (34)	20 (19)	15 (0.04 to 0.27)	.01
Hospitalization at index visit	26 (24)	16 (15)	9 (-0.01 to 0.2)	.10

Original Investigation

Effect of Oximetry on Hospitalization in Bronchiolitis
A Randomized Clinical Trial

Suzanne Schuh, MD, FRCPC; Stephen Freedman, MD, FRCPC; Allan Coates, MD; Upton Allen, MD, FRCPC; Patricia C. Parkin, MD, FRCPC; Derek Stephens, MSc; Wendy Ungar, PhD; Zelia DaSilva, RT; Andrew R. Willan, PhD

Conclusions:

Artificially increasing Sp02 reduced admission rates
3% considered safe given within normal variation

Previous studies have shown 2% difference in Sp02 doubled admissions rates

Single centre study – relatively small numbers

Most infants had Sp02 well above 88%

How best to use Sp02?

Good example of over reliance on information from a medical device

Original Investigation

Use of Intermittent vs Continuous Pulse Oximetry for Nonhypoxemic Infants and Young Children Hospitalized for Bronchiolitis

A Randomized Clinical Trial

JAMA Pediatr. 2015;169(10):898-904.

Russell McCulloh, MD; Michael Koster, MD; Shawn Ralston, MD; Matthew Johnson, MD; Vanessa Hill, MD; Kristin Koehn, MD; Gina Weddle, DNP; Brian Alverson, MD

Background: Major determinant in LOS
AAP – continuous monitoring not required if there is improvement – intermittent in those not requiring 02

Hypothesis: intermittent monitoring will reduce length of stay
Primary outcome: LOS and range of secondary outcomes
Powered to detect difference in LOS of **18 hours**

Methods: RCT – parallel, superiority trial of continuous vs intermittent pulse oximetry
161 infants (80 continuous/81 intermittent)
4 children's hospitals, Monday to Friday recruitment
02 saturations of **90%** as criteria for admission
Adequate inclusion criteria
Randomisation relatively well described
Intermittent arm - saturations 90% or greater
Groups well matched at baseline

Table 1. Characteristics of 161 Enrolled Patients by Pulse Oximetry Monitoring Strategy

Characteristic	Patients, No. (%)	
	Continuous (n = 80)	Intermittent (n = 81)
Demographics		
Age, median (IQR), y	0.22 (0.13-0.44)	
Female sex	41 (51.3)	
Referred from ED	69 (86.3)	
Admitted to hospitalist service	61 (76.3)	
History of tobacco exposure	17 (21.3)	
Day-care exposure[a]	8 (10.0)	
Family history of asthma/RAD	30 (37.5)	
Therapies given prior to admission		
Oral corticosteroids	4 (5.0)	
Antibiotics	10 (12.5)	
Bronchodilators	58 (72.5)	
Symptoms at presentation		
Rhinorrhea/congestion	77 (96.3)	
Decreased oral intake	51 (63.8)	
Vomiting	32 (40.0)	
Diarrhea	14 (17.5)	
Rash	6 (7.5)	
Irritability	29 (36.3)	
Lethargy	12 (15.0)	11 (13.6)
Seizure	0 (0.0)	0 (0.0)

Figure 2. Kaplan-Meier Curve of Time to Hospital Discharge Based on Oximetry Monitoring Strategy

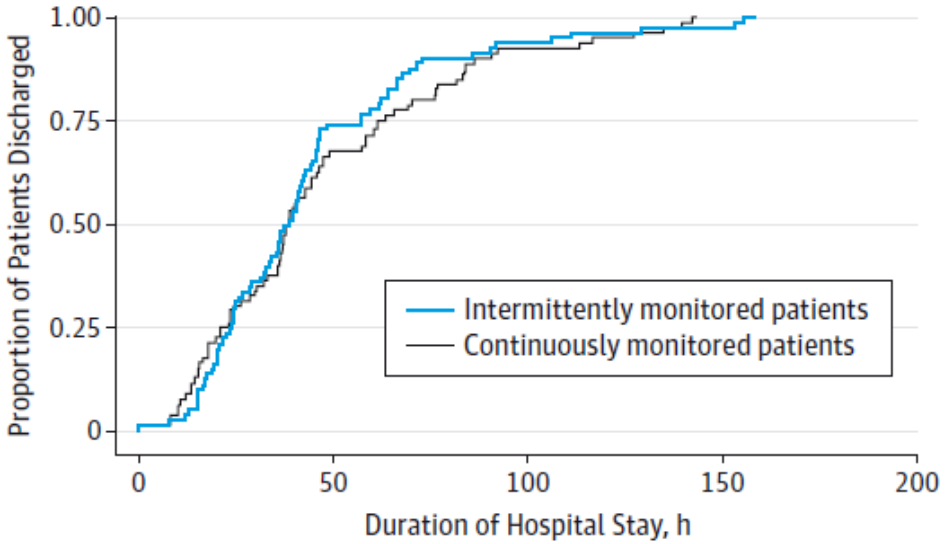


Table 2. Clinical Management of Patients by Pulse Oximetry Monitoring Strategy

Testing/Treatment	Patients, No. (%) Continuous (n = 80)	Intermittent (n = 81)	*P* Value
Testing performed			
Complete blood cell count	16 (20.0)	27 (33.3)	.06
Serum chemistries	16 (20.0)	21 (25.9)	.37
Urinalysis	20 (25.0)	16 (19.8)	.42
Urine culture	16 (20.0)	15 (18.5)	.81
Blood culture	14 (17.5)	19 (23.5)	.35
CSF analysis/culture	0 (0.0)	2 (2.5)	.16
Influenza virus testing	6 (7.5)	6 (7.4)	.98
RSV viral antigen testing	31 (38.8)	29 (35.8)	.70
Respiratory PCR testing[a]	29 (36.3)	22 (27.2)	.22
Chest radiography	32 (40.0)	35 (43.2)	.68
Treatments/interventions during hospital stay			
Received supplemental oxygen	34 (42.5)	36 (44.4)	.80
Duration, median (IQR), h	23.0 (9.0-38.0)	17.0 (7.5-36.5)	.23
Corticosteroid use	2 (2.5)	3 (3.7)	.66
Antibiotic use	11 (13.8)	13 (16.0)	.68
Received intravenous fluids	48 (60.0)	45 (55.6)	.57
Received albuterol	18 (22.5)	18 (22.2)	.97
Received racemic epinephrine	0 (0.0)	1 (1.2)	.32
Received high-flow nasal cannula	9 (11.3)	7 (8.6)	.58
Nasopharyngeal suctioned	62 (77.5)	55 (67.9)	.17
No. of times suctioned, median (IQR)	4.5 (3.0-8.0)	4.0 (2.0-7.0)	.93
Transferred to PICU	4 (5.0)	4 (4.9)	.99

Study not powered correctly for a condition with a median length of stay of 40 hours

Would have needed > 2000 to show the difference they showed

02 cut-off of 90% may have influenced results

Need to extend to infants and children on 02

Original Investigation

Effect of Oxygen Desaturations on Subsequent Medical Visits in Infants Discharged From the Emergency Department With Bronchiolitis

JAMA Pediatrics June 2016 Volume 170, Number 6

Tania Principi, MD, FRCPC, MSc; Allan L. Coates, MD; Patricia C. Parkin, MD, FRCPC; Derek Stephens, MSc; Zelia DaSilva, RT; Suzanne Schuh, MD, FRCPC

Background: Major determinant in LOS
AAP – continuous monitoring not required if there is improvement – intermittent in those not requiring 02
No study has investigated oxygen saturations in home?

Aim: to determine if there is a difference in proportion of unscheduled medical attendances within 72 hours of discharge in infants with desats < 90% for at least 1 minute with home oximetry monitoring versus those with no desats

Primary outcome: unscheduled medical visits

Methods:
Prospective study over 5 years in infants 6 weeks to 12 months
Patients not needing any 02 were discharged with a pulse oximeter (displays all turned off)

Desaturation: at least one episode of desaturation < 90% for at least 1 minute
Major desaturation: 3 x events as above or > 10% of time on monitor with sats <90% or < 905 for 3 minutes continuously

Unscheduled medical visits recorded

Figure. Enrollment of Patients Into the Study

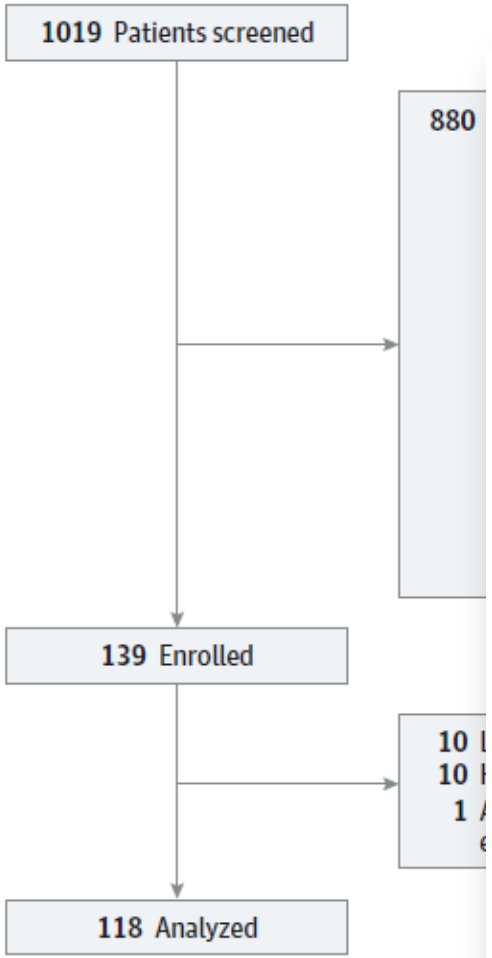


Table 1. Demographic and Clinical Characteristics of the Participating Infants[a]

Characteristic	Desaturation (n = 75)	No Desaturation (n = 43)	Difference (95% CI)
Age, mean (SD), mo	4.6 (2.3)	4.4 (2.1)	0.2 (−0.66 to 1.02)
Male, No. (%)	41 (55)	28 (65)	−10 (−0.29 to 0.08)
Temperature ≥38°C within 48 h, No. (%)	44 (59)	28 (65)	−6 (−0.25 to 0.12)
History of atopy, No. (%)	57 (77)	33 (77)	0 (−0.16 to 0.16)
Family history of atopy, No. (%)	36 (48)	26 (60)	−12 (−0.31 to 0.06)
Duration of respiratory distress, mean (SD), h	49 (33)	49 (77)	0 (−20.5 to 20.3)
Previous medical visit, No. (%)	52 (70)	21 (49)	21 (0.02 to 0.39)
Feeding <50% of usual amount, No. (%)	34 (46)	13 (30)	16 (−0.34 to 0.02)
Therapy within 48 h of arrival, No. (%)			
Inhaled albuterol	22 (29)	8 (19)	10 (−0.26 to 0.05)
Oral corticosteroids	9 (12)	5 (12)	0 (−0.12 to 0.12)
Inhaled corticosteroids	8 (11)	4 (9)	2 (−0.13 to 0.09)
Any ED treatments, No. (%)	41 (55)	19 (45)	10 (−0.28 to 0.09)
Inhaled albuterol	32 (43)	16 (38)	5 (−0.23 to 0.14)
Oral corticosteroids	16 (21)	10 (24)	−3 (−0.13 to 0.18)
Inhaled epinephrine	9 (12)	2 (5)	7 (−0.17 to 0.03)
At discharge, mean (SD)			
Respiratory rate, breaths/min	42 (10)	44 (10)	−2 (−5.1 to 2.5)
Heart rate, beats/min	146 (17)	144 (14)	2 (−3.4 to 8.7)
Oxygen saturation, %	97.9 (1.9)	98.2 (1.4)	−0.3 (−0.99 to 0.32)
RDAI score at ED discharge, mean (SD)	3.8 (2.3)	3.8 (2.8)	0 (−0.99 to 0.92)
Discharged with albuterol, No. (%)	23 (31)	14 (33)	−2 (−0.16 to 0.19)
Duration of ED visit, mean (SD), h	3.6 (1.9)	3.5 (2)	0.1 (−0.60 to 0.85)
Mean home oxygen saturation, mean (SD), %	95.9 (2.1)	97.9 (1.3)	2.0 (−2.81 to −0.98)

Table 2. Outcomes of Infants With and Without Desaturation

Outcome	Desaturation (n = 75)	No Desaturation (n = 43)	Difference (95% CI)[a]
Primary			
Unscheduled medical visits, No. (%)	18 (24)	11 (26)	−1.6 (−0.15 to ∞)
Secondary			
All-cause medical visits, No. (%)	24 (32)	16 (37)	−5.2 (−0.13 to 0.23)
Hospitalizations, No. (%)	1 (1)	2 (5)	−3.3 (−0.04 to 0.10)
Exploratory			
Cumulative hypoxemic score, median (IQR)	10.7 (2.7 to 22.6)	0.5 (0.25 to 0.75)	10.2 (6.6 to 13.8)

75/118 (64%) had at least 1 desaturation event

Of the 75, 50 (79%) spent more than 1 minute with sats < 80% and 29 (39%) has sats < 70% for than 1 minute

Unscheduled visits among infants with major desaturations were similar to those without major desaturations

Majority of children experience significant desaturations at home and the data suggests that pulse oximetry may not be good tool to identify sicker children

Questions whether we should act on transient desaturations in hospital setting

Treatment for Bronchiolitis

Respiratory support

- oxygen, HFNC therapy [mechanical ventilation]

Fluid support

- nasogastric vs IV fluids

Medications

- antibiotics, bronchodilators, corticosteroids … etc

Respiratory Support

Low flow oxygen – benefits NOT studied [!]

- Start if SaO_2 < 92%, cease when ≥ 92%
- Decision to admit + LOS

HFNC therapy

- $Sa0_2$ < 92% and increased WOB
- Reduces WOB, LOS and transfer to ICU [low level]

Nasal Cannula Therapy

NC therapy for O_2 delivery at low flow [0.5l/m]

Easy to administer for care-givers

Well tolerated

Higher flow [1-2 l/min] can deliver CDP, dependent on NC size, gas flow, anatomy, leak, body weight

Potential problems of HFNC

Mucosal dryness and thick nasal secretions due to inadequate humidification when neonates treated with flows > 1-2 l/min

What is HFNC Therapy?

Delivery of “high flow” [i.e. > 1-2/min] heated and humidified air and oxygen via nasal cannulae

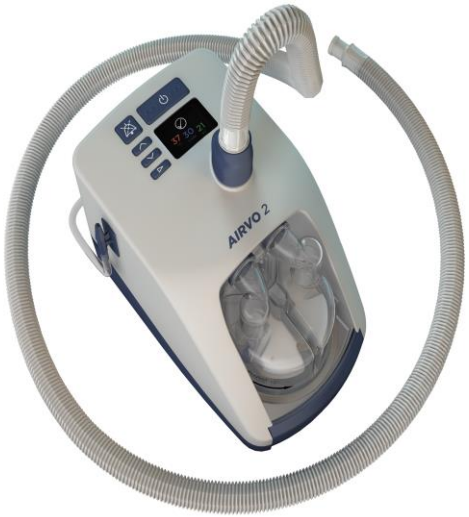
Prevents cooling and water loss from airway

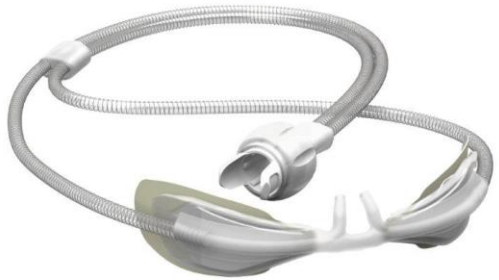
Prevents impairment of muco-ciliary transport and increased viscosity of airway secretions

Flows up to 40 l/min

95-100% relative humidity

Warmed to 34-43° C





How does it work?

Washout of NP dead space

Attenuates UA resistance, decreasing work of breathing

Warmed humidified air improves lower airway conductance and compliance

Provision of warmed humidified gas reduces metabolic work associated with gas conditioning

HF through naso-pharynx can be titrated to provide positive distending pressure for lung recruitment

Summary of Efficacy Studies of HFNC Therapy in pre-term infants

HFNC delivers CDP only if mouth closed

CDP delivered by HFNC is unpredictable

Effect of HFNC on lung mechanics and major infant outcomes are unclear

HFNC is effective in minimising nasal mucosal injury

Effectiveness of HFNC vs NPCPAP for apnoea of prematurity, RDS and prevention of extubation failure are insufficient and contradictory

HFNC in ICU

Improves respiratory distress and oxygen saturation in children with respiratory illness

COMFORT scale improves

Mechanism of action

Generates mild positive airway pressure

Lung volume recruitment

Fluid Therapy

Both NG and IV routes are acceptable

Mean LOS no different, but NG more likely to be inserted successfully 1st time

Insufficient evidence to recommend a specific proportion of maintenance fluid

No evidence, wide variation [restricted to liberal]

If IV route chosen, use ISOTONIC fluid

To reduce risk of hyponatraemia

Medications and other therapies

Do not use antibiotics [including azithromycin]

Do not use SABA [ineffective, significant side effects]

Do not use systemic or local glucocorticoids

Do not use adrenaline [with or without steroids]

Consider use of hypertonic saline

Some evidence of reduced admission rate and LOS

Chest physiotherapy and nasal suction not recommended

PARIS Study will provide high quality evidence for HFNC

PCN Bronchiolitis Improvement Project 2105

Based upon EB state-wide CPG for bronchiolitis

RCH + 5 smaller paediatric health services

Use of Plan-Do-Study-Act methodology

Pre-audit, intervention, post-audit

	Pre	Post
Was a CXR avoided?	55%	97%
Was a NPS avoided?	39%	97%
NPS only if clinically indicated?	13%	94%
Discharged within 6h of oxygen being ceased	0	27%

Summary

Avoid routine investigations and treatments

- PDSA methodology works to improve practice!!!

Don’t use hypotonic IV fluids

Little evidence to support use of continuous oximetry monitoring

The place of HFNC vs low flow is uncertain

- Paediatric Acute Intervention Study

Questions?