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Resuscitation Quality Improvement (RQI): a new training model

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Faculty Disclosure Information (Option A)

I have no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity.

I **do not** intend to discuss an unapproved/investigative use of a commercial product/device in my presentation.

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Additional Disclosure

I am a member of

Neonatal Resuscitation Program® Steering Committee (Co-chair)

International Liaison Committee on Resuscitation Neonatal Life Support Content Expert Group

American Heart Association/American Academy of Pediatrics- Neonatal Resuscitation Guideline Writing Group Member

The views expressed here are my own and they do not represent official policy statements by these bodies

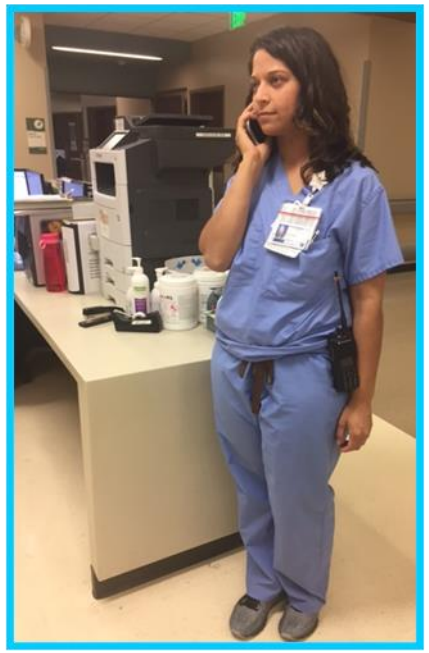
In past 12 months, I have had no relevant financial relationship with the manufacturer of any commercial product and/or provider of commercial service discussed in this presentation

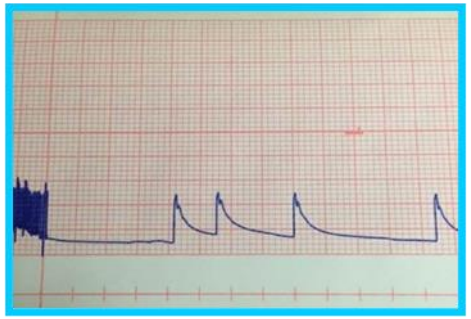
Learning Objectives

At the conclusion of the presentation, participants should be able to:

1. Recognize important role facemask ventilation plays in neonatal resuscitation at birth
2. Describe the pitfalls in the existing model for teaching positive pressure ventilation (PPV) skills in neonatal resuscitation program
3. Discuss the alternate education methodology for PPV skills: Resuscitation Quality Improvement (RQI) for NRP®

A case of Newborn Needing Resuscitation





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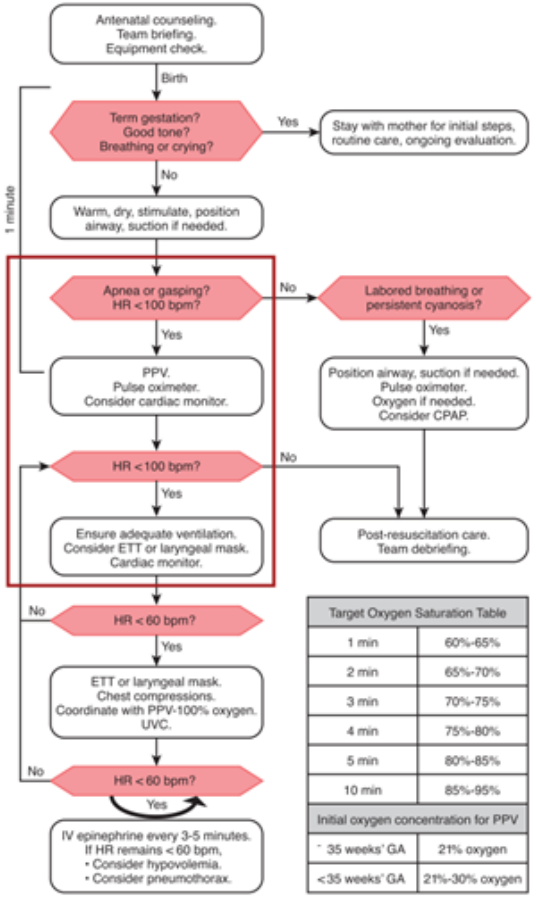


Effective and Timely PPV Can Improve Neonatal Outcomes

Spontaneous breathing
Lung fluid clearance
Lung aeration
Decreased pulmonary vascular resistance
Increased Pulmonary blood flow

Normal Transition

+

Crying
Spontaneous respirations
HR > 100 BPM

Abnormal Transition

Gasping or no spontaneous breaths
HR < 100 BPM

Positive Pressure Ventilation

Timely and Effective PPV may reduce
Duration of bradycardia
Incidence of unnecessary intubation or CPR,
Improve newborn outcomes

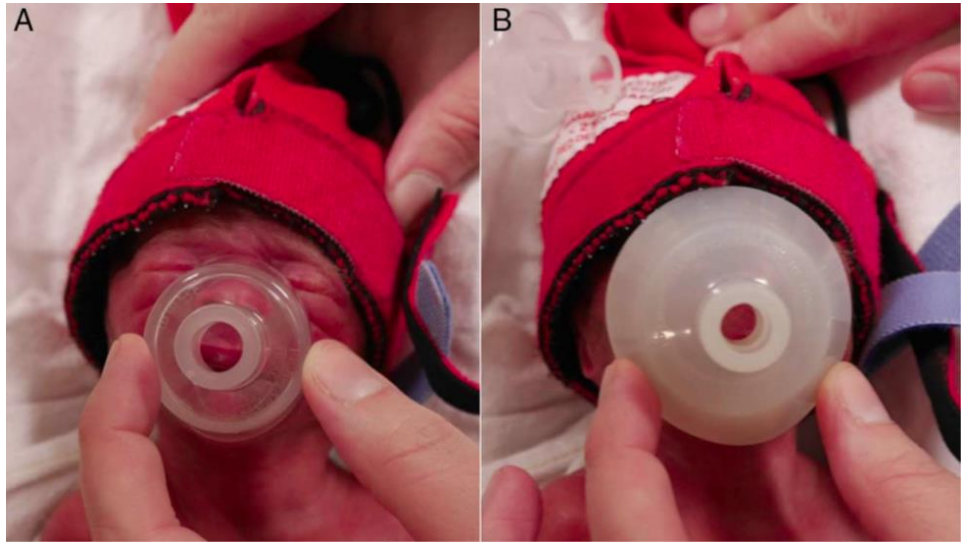
Underventilation
Intubation→ Lung injury (VILI)
Prolonged bradycardia, Mortality, CPR,
Brain injury
Hypoxia, Pulmonary hypertension

Overventilation
Volutrauma/ barotrauma→ Lung injury (VILI)
Hypocapnea→ Cerebral blood flow decrease
Pneumothorax/ PIE

PPV: Most Important Skill in NRP

- About 3 to 6% of newborns receive PPV at birth. That is about 200,000 to 230,000 newborns a year in the United States.
- Underventilation or overventilation at birth can result in significant adverse health outcomes
- Effective and Timely PPV can improve neonatal outcomes
- What is Effective PPV?
  - One that results in chest-rise?
  - One that increases heart rate in bradycardic newborns?
  - One that delivers adequate tidal volume? What is adequate tidal volume?

What Does High Quality PPV Mean? PPV Metrics



The Stem Hold The Two Point Top Hold The C Hold

O'Shea et al, ADC F&N 2016

Wood F. ADC FN 2008
Chua C. Resuscitation 2012
Arai YC. Anesth Analg 2005
Tracy MB. ADC FN 2011

High Quality PPV: What is recommended

	Initial setting
PIP	20-25 cm H_2O
PEEP	5 cm H_2O
Rate	40-60 breaths per minute
Mask Leak	Minimum (?<20%)
Gas Flow	10 L/min

What about tidal volume? Avoid < 4 ml/kg and >8 ml/kg???

Recognize Ineffective PPV and Perform Ventilation Corrective Steps

Corrective Steps – MR.SO.P.A

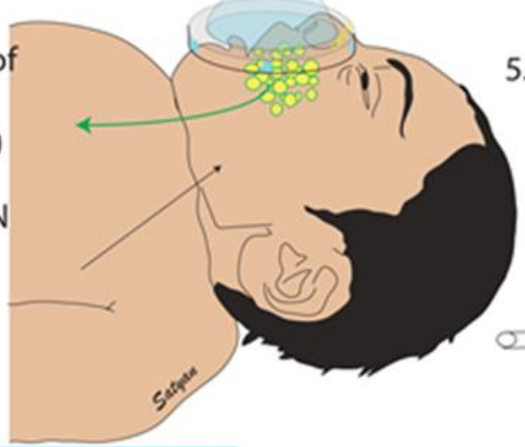
1. M - Adjust MASK to assure good seal on the face

2. R - REPOSITION airway by adjusting head to sniffing position

Try PPV and reassesschest movement

3. S - SUCTION mouth and nose of secretions (if present)

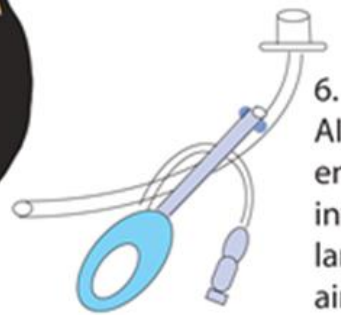
4. O - OPEN mouth slightly and move jaw forward



Try PPV and reassesschest movement

5. P - PRESSURE - increase pressure to achieve chest rise

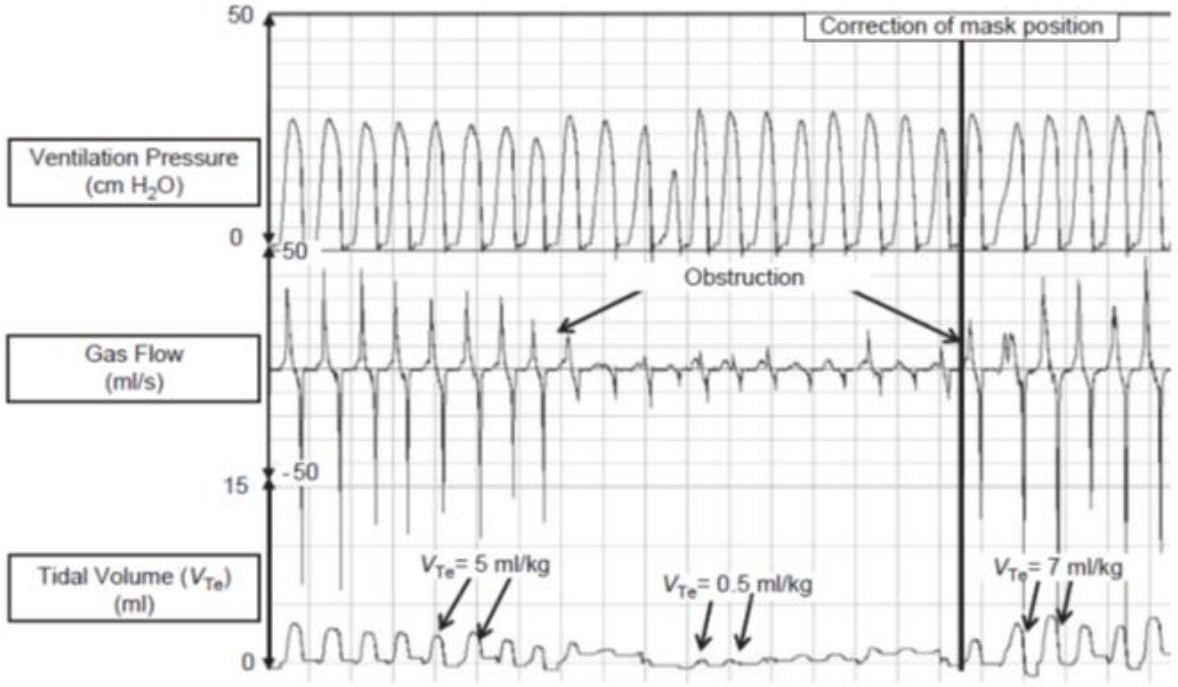
Try PPV and reassess chest movement



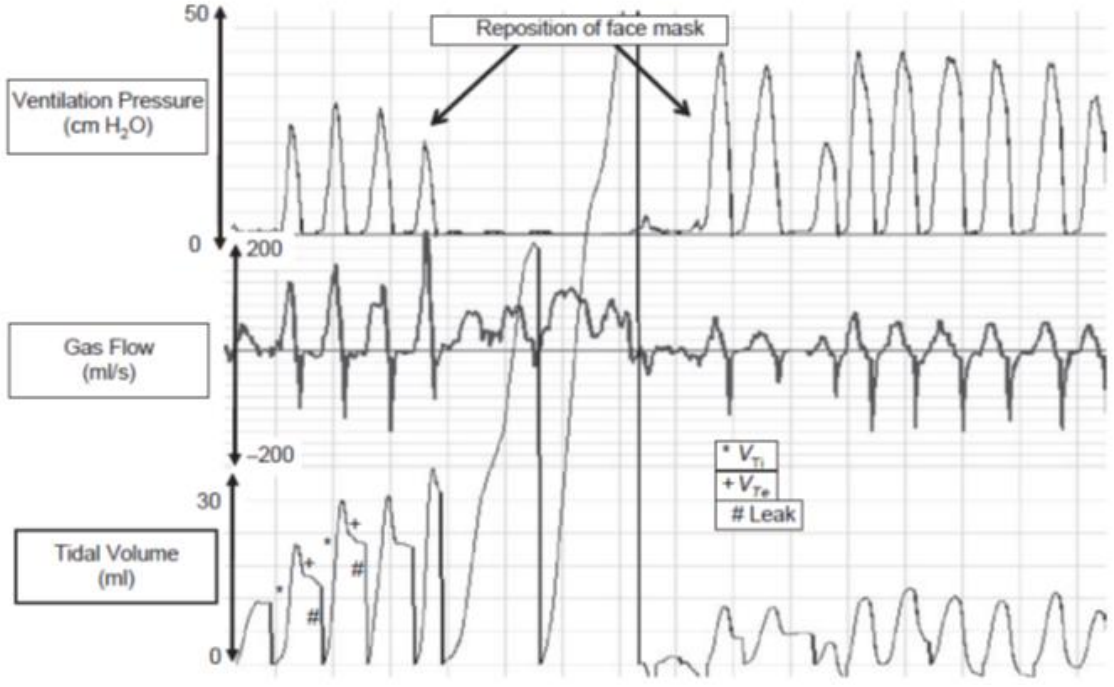
6. A - Consider AIRWAY alternative endotracheal intubation or laryngeal mask airway

How good are we at performing facemask ventilation at birth?

Mask Leak and Obstruction are Very Common



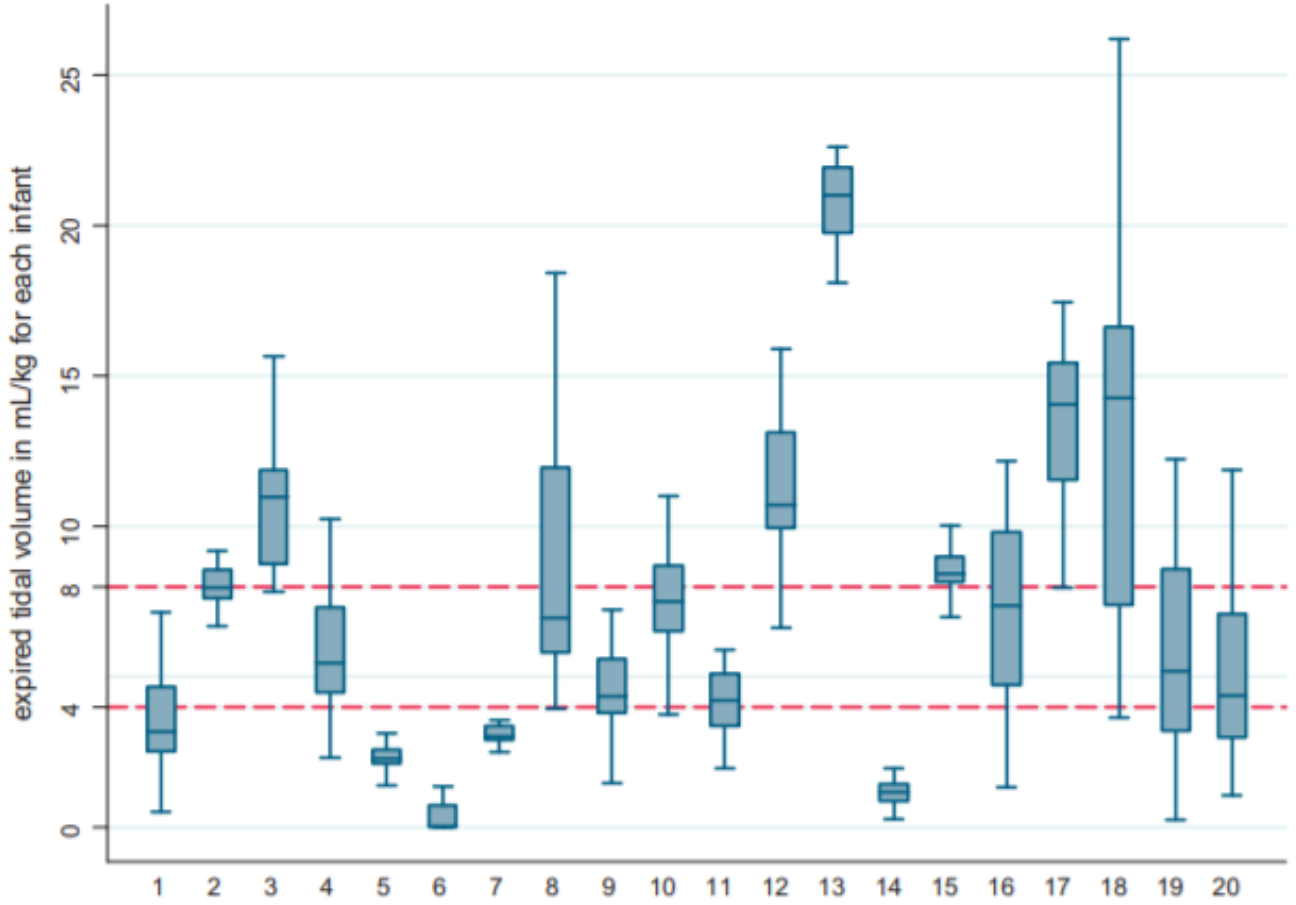
Obstruction occurred in 26% of the recordings



Large leak occurred in 51% of the recordings

Schmolzer et al. *Arch Dis Child Fetal Neonatal Ed*. 2011

Delivered Tidal Volumes Vary on a Large Scale



Poulton et al. Resuscitation. 2011

Large leak and variability in delivered tidal volumes even in clinical trial setting

(51352 inflations)	RFM visible N = 138 (25432 inflations)	RFM non-visible N = 150 (25920 inflations)
RFM measurements		
PPV inflations per infant analysed, median (IQR)	137 (78–261)	136 (59–240)
Ventilation rate, median (IQR)	54 (45–65)	55 (46–65)
Duration of PPV (sec), median (IQR)	184 (101–331)	170 (82–292)
Duration of Vte > 8 ml/kg (sec) , median (IQR)	34 (10–75)	38 (10–78)
PEEP cm H_2O, median (IQR)	6 (5–7)	6 (5–7)
Peak inflating pressure cm H_2O, median (IQR)	25 (23–27)	25 (23–26)
Mean Vte ml/kg per infant, median (IQR)	5.1 (4.0–7.1)	5.9 (4.2–8.4)
% Vte < 4 ml/kg, median (IQR)	40.7 (20.5–62.4)	34.1 (18.5–52.6)
% Vte 4–8 ml/kg, median (IQR)	30.2 (18.0–41.6)	30.7 (15.8–43.4)
% Vte > 8 ml/kg, median (IQR)	20.0 (7.2–41.1)	25.6 (9.6–47.8)
% of time leak > 60% during PPV per infant, median (IQR)	17.4 (7.2–33.3)	13.6 (3.7–32.1)
% leak per infant, median (IQR)	24.9 (13.6–39.2)	20.7 (12.3–39.6)

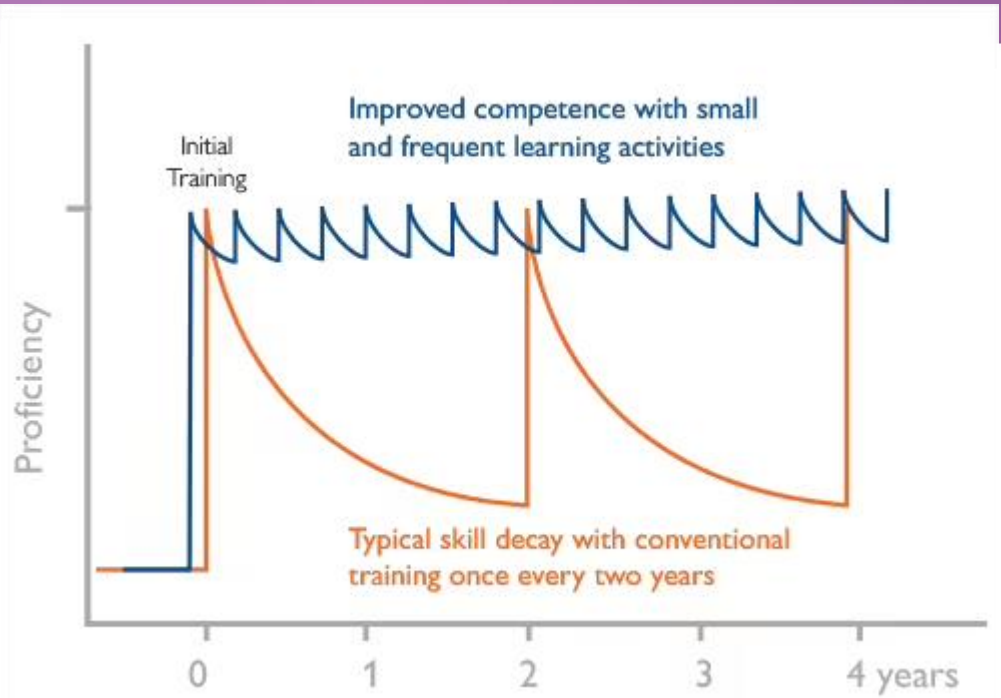
Van Zanten resus 2021

Why are PPV skills poor? Are we not teaching them properly?
Are the skills decaying/declining after teaching?

NRP PPV Skills Teaching in Current Model: Too little time, too variable teaching and not frequent enough

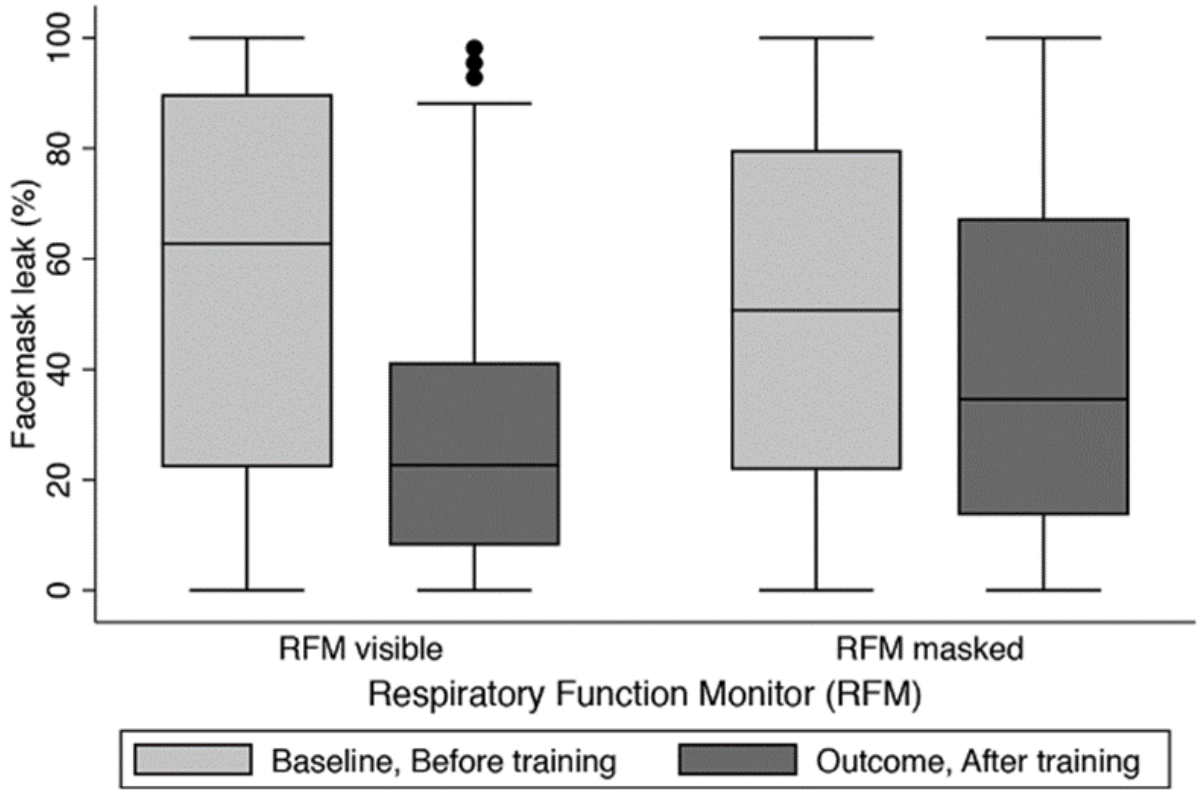
PPV skill acquisition: Problems with current model

- Time spent teaching PPV is a fraction of the course
- Skill of instructor and availability is variable



- Current standard for teaching PPV relies on an NRP instructor led skill station every 2 years
- There is a significant decay in PPV skills as early as 3 to 5 months post-training and this results in ineffective PPV in the DR.
- Those who frequently practice PPV in the DR are not protected.
- Current ILCOR recommendation is that more frequent refreshers are needed than every 2 year but it has not been mandated

Training with Respiratory Function Monitoring Improves PPV skills



Currain et al. *Arch Dis Child Fetal Neonatal Ed.* 2019

Ideal tool for NRP PPV booster training

What if we had a tool that allowed

- High frequency (quarterly), low dose (5-20 minute) booster training for PPV skills
- Used RFM but display was simple audio-visual display which would not need any interpretation
- Gave automatic objective feedback on pressures, head position, mask leak, rate and suggested corrective action
- No instructor presence required so it became feasible without adding burden, self-directed learning
- Focused on mastery learning, deliberate practice and spaced practice
- Gives competence but also confidence

RQI® for NRP®: Designed to Innovate NRP Training Using General Learning Theory Principles

- Alternate delivery method for NRP education
- Quarterly training 10 to 15 minutes long to practice NRP essential skills with emphasis on PPV and MRSOPA (HFLD)
- Quarterly cognitive and skills sessions assess learners' recall, application and practice of the NRP algorithm as well.
- Currently being used in > 95 organizations
- Used by 18.6K neonatal providers so far with databank of > 5 million individual ventilation using T-piece and >9 million ventilations using self inflating bag.

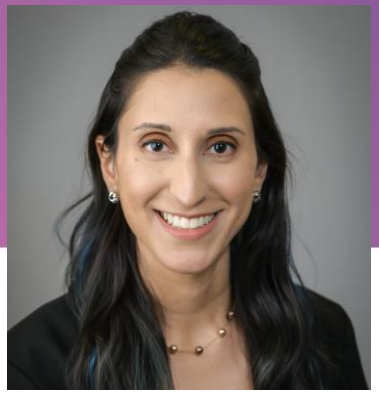
RQI for NRP: Skill Assessment and PPV Score

Overall Score incorporates the following submetrics:

- Peak inspiratory pressure (PIP) Score
- Ventilation Rate Score
- Head Position Score
- Mask Seal Score

$$\text{Submetric Score} = \frac{\text{\# of ventilations within guidelines}}{\text{50 ventilations}} \text{ x } 100$$

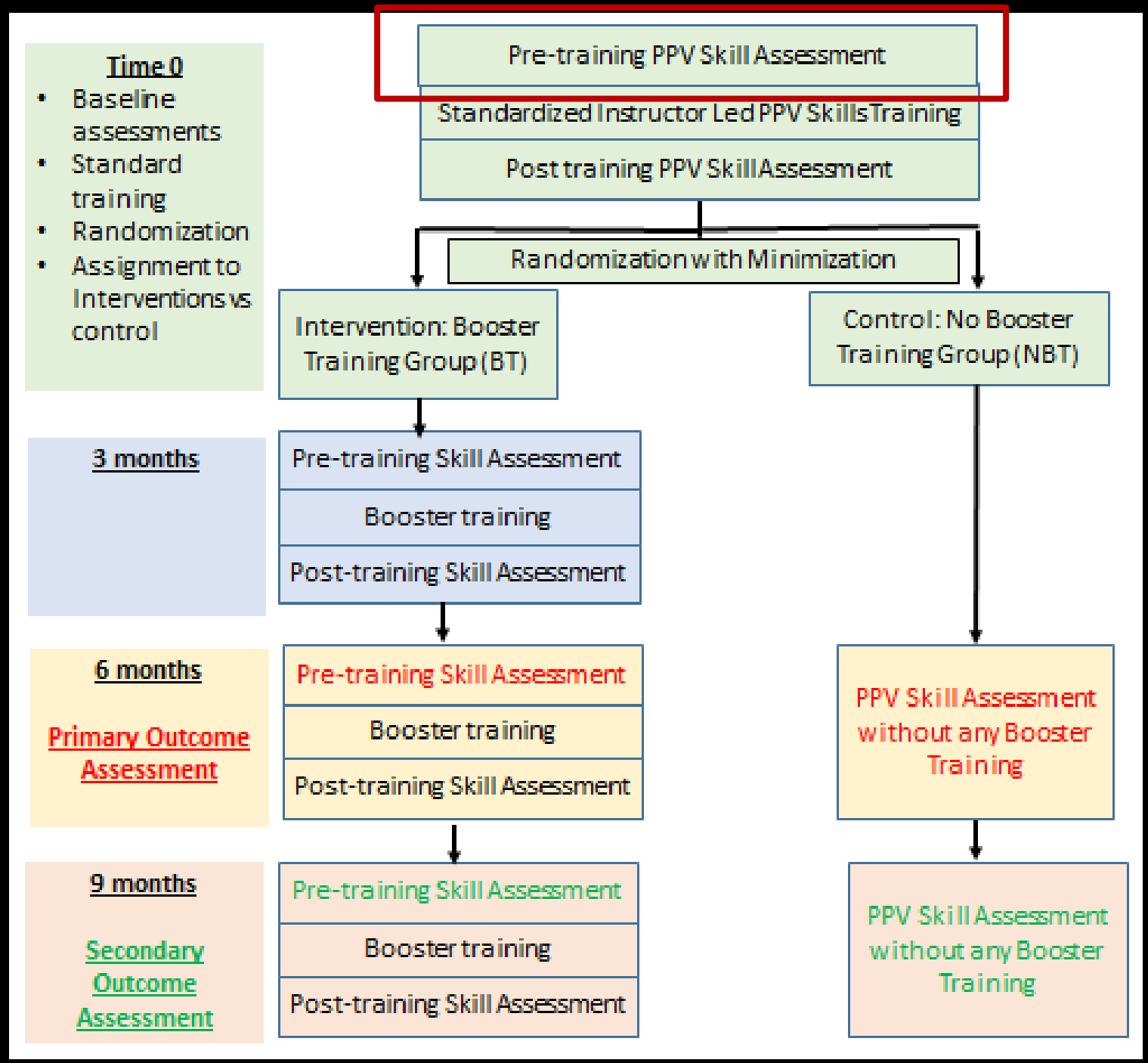
Does the RQI for NRP teaching model work? Will this 3 month booster using RQI for NRP result in better PPV skills?

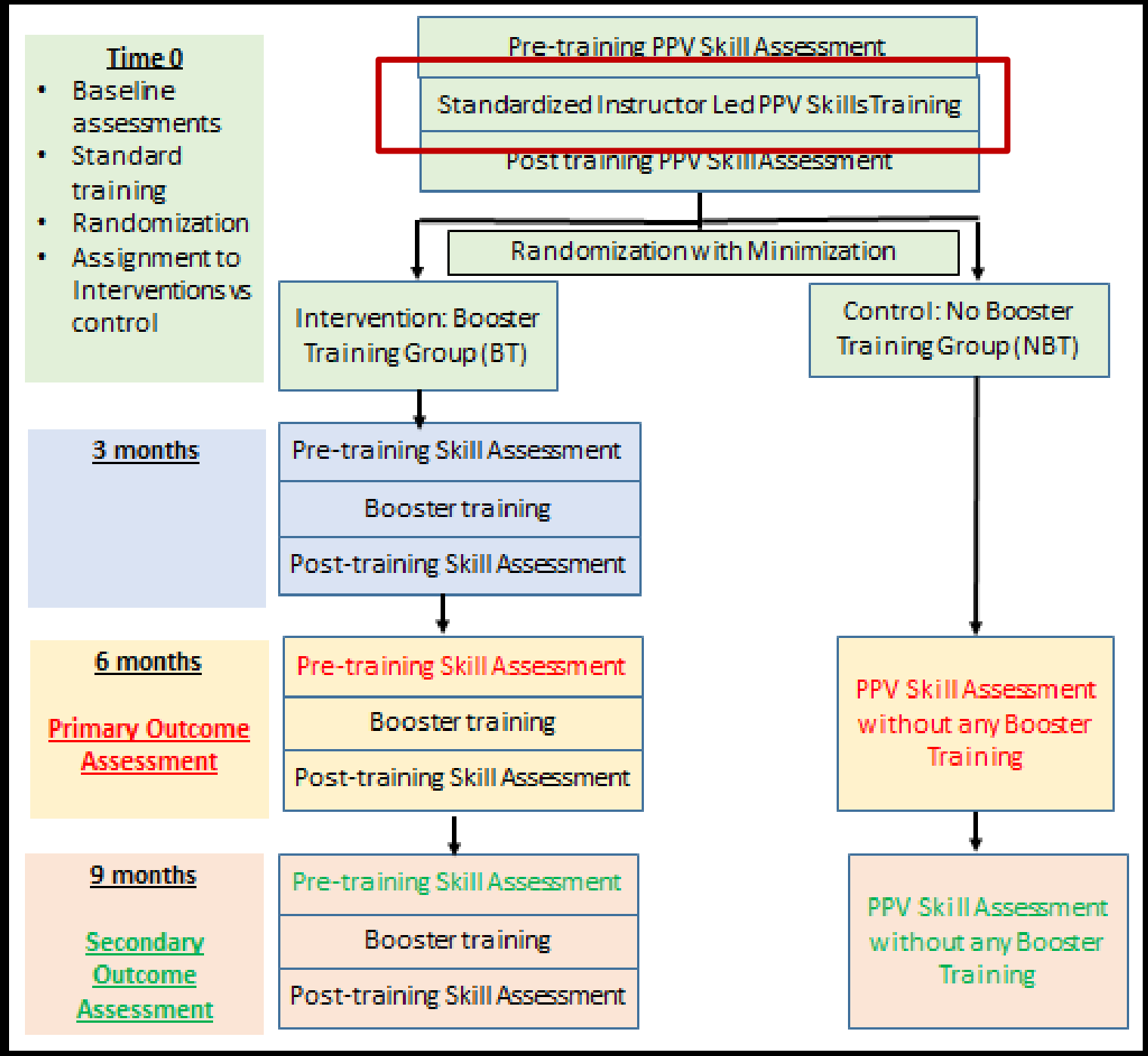


NEO RQI Trial

A Randomized Controlled Trial to Evaluate if Booster Training with RQI NRP Improves PPV Skills

Primary Hypothesis: Quarterly booster training with RQI-NRP will result in better PPV skills in NRP Providers compared to no booster training


Time 0
Baseline assessments
Standard training
Randomization
Assignment to Interventions vs control
Pre-training PPV Skill Assessment
Standardized Instructor Led PPV Skills Training
Post training PPV Skill Assessment
Randomization with Minimization
Intervention: Booster Training Group (BT)
Control: No Booster Training Group (NBT)
3 months
Pre-training Skill Assessment
Booster training
Post-training Skill Assessment
6 months
Primary Outcome Assessment
Pre-training Skill Assessment
Booster training
Post-training Skill Assessment
PPV Skill Assessment without any Booster Training
9 months
Secondary Outcome Assessment
Pre-training Skill Assessment
Booster training
Post-training Skill Assessment
PPV Skill Assessment without any Booster Training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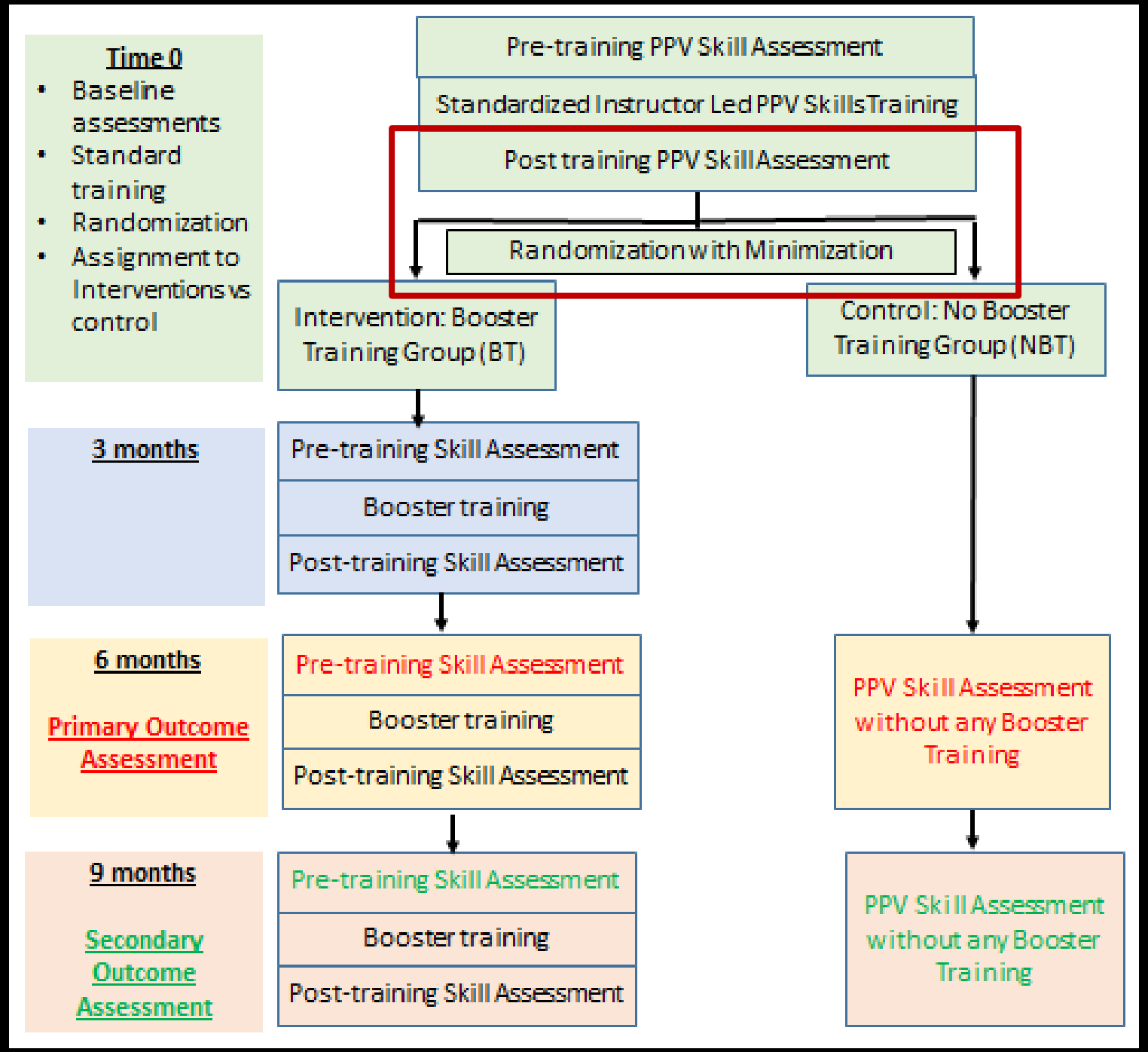
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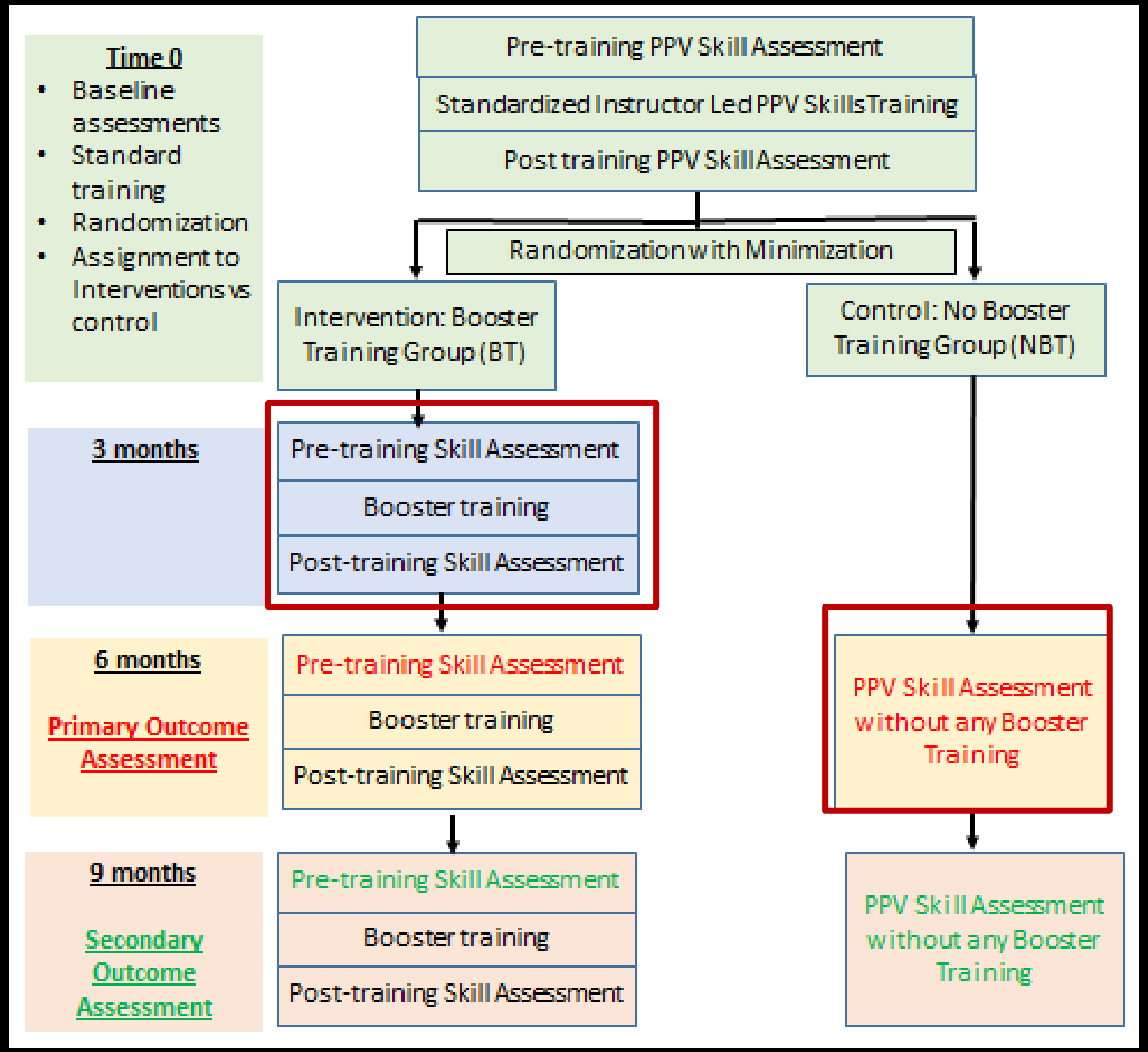
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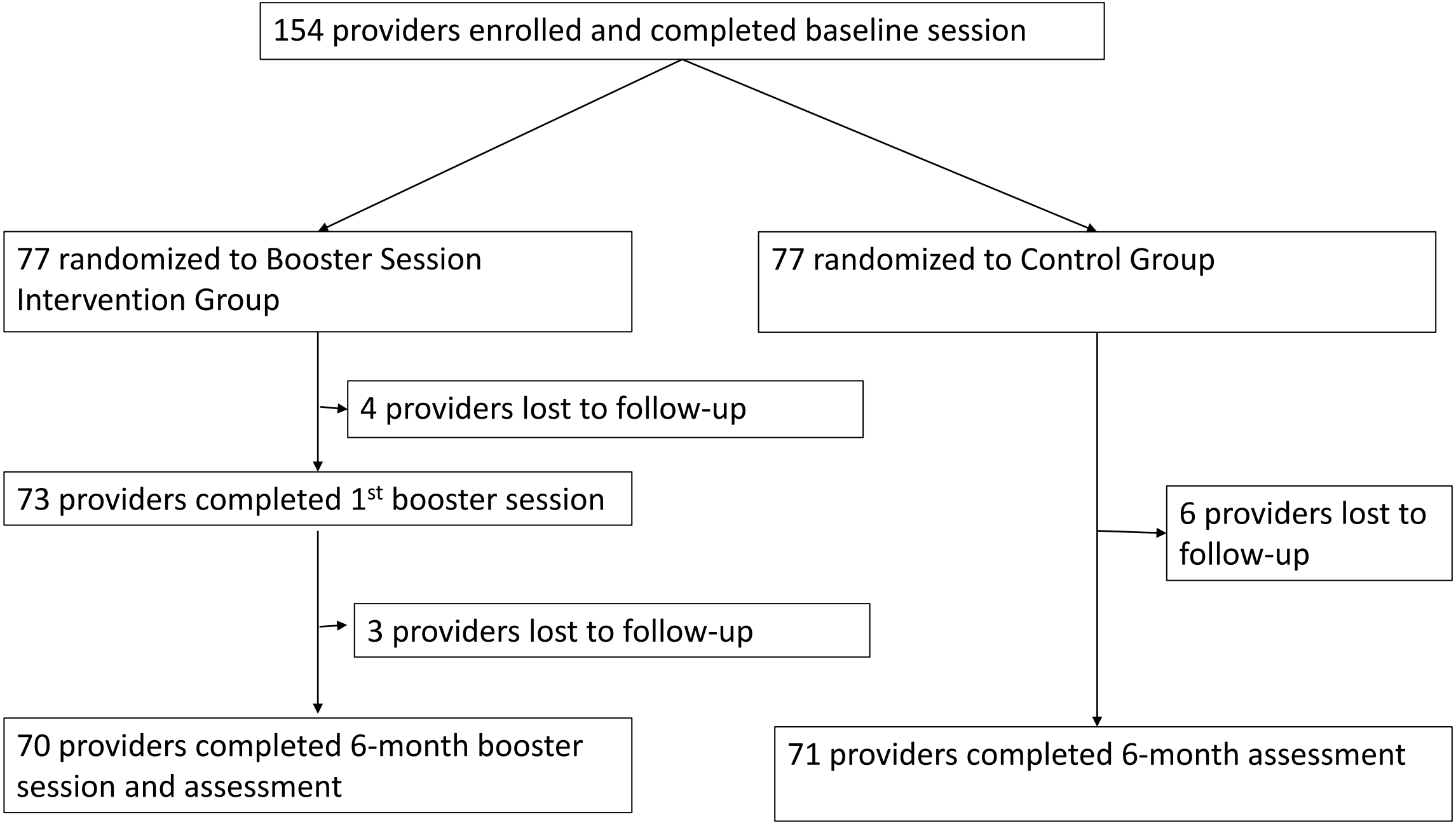
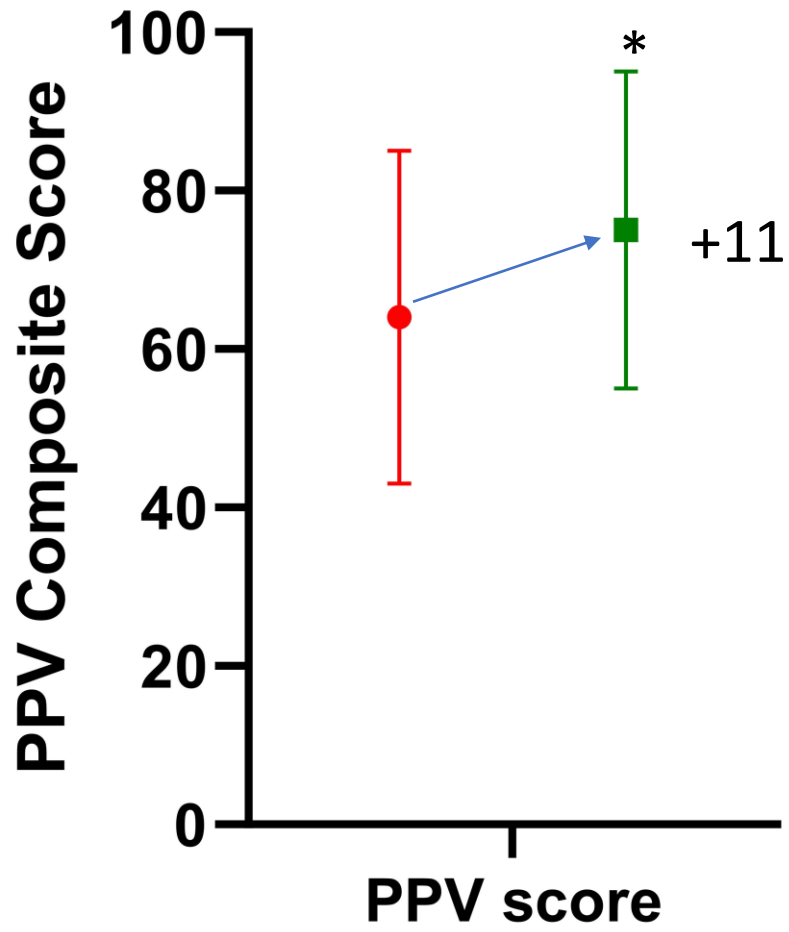

154 providers enrolled and completed baseline session
77 randomized to Booster Session Intervention Group
77 randomized to Control Group
4 providers lost to follow-up
73 providers completed 1st booster session
6 providers lost to follow-up
3 providers lost to follow-up
70 providers completed 6-month booster session and assessment
71 providers completed 6-month assessment

Participant Distribution

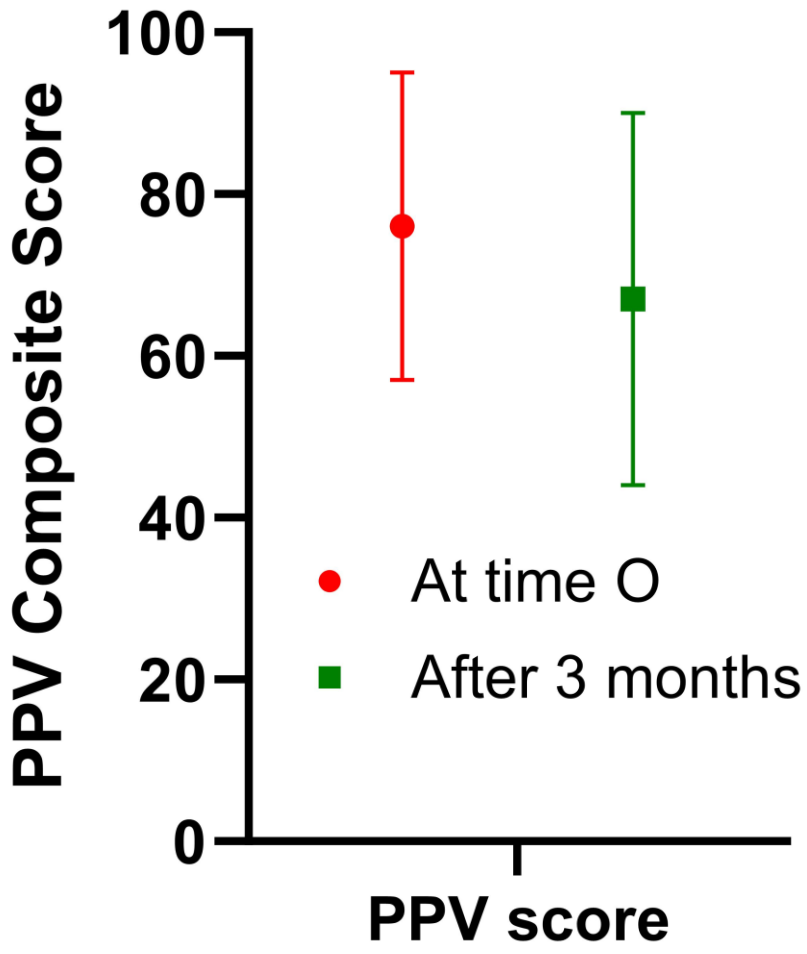
Characteristic	Booster-Training Group (n=77)	Nonbooster Training Group (n=77)
Occupation		
Nurse	35 (47%)	38 (52%)
Nurse Practitioner	16 (22%)	15 (21%)
Respiratory Therapist	5 (7%)	6 (8%)
Resident Physician	3 (4%)	1 (1%)
Fellow Physician	5 (7%)	5 (7%)
Attending Physician	10 (14%)	8 (11%)
Primary Work Environment		
Newborn Nursery	6 (8%)	9 (12%)
NICU	63 (85%)	62 (85%)
Other (Labor & Delivery)	5 (7%)	2 (3%)
PPV Delivery in Clinical Setting		
0 times in past 6 months	19 (26%)	21 (29%)
1-4 times in past 6 months	35 (47%)	34 (47%)
5+ times in past 6 months	20 (27%)	18 (25%)
Time of Last NRP Training		
<6 months ago	19 (26%)	19 (26%)
6 months to 1 year ago	23 (31%)	21 (29%)
1 to 2 years ago	32 (43%)	33 (45%)
Type of NICU Practiced In		
Delivery Unit	45 (61%)	51 (70%)
Referral Unit	29 (39%)	22 (30%)

Instructor Led training Results in Modest Improvement in PPV skills



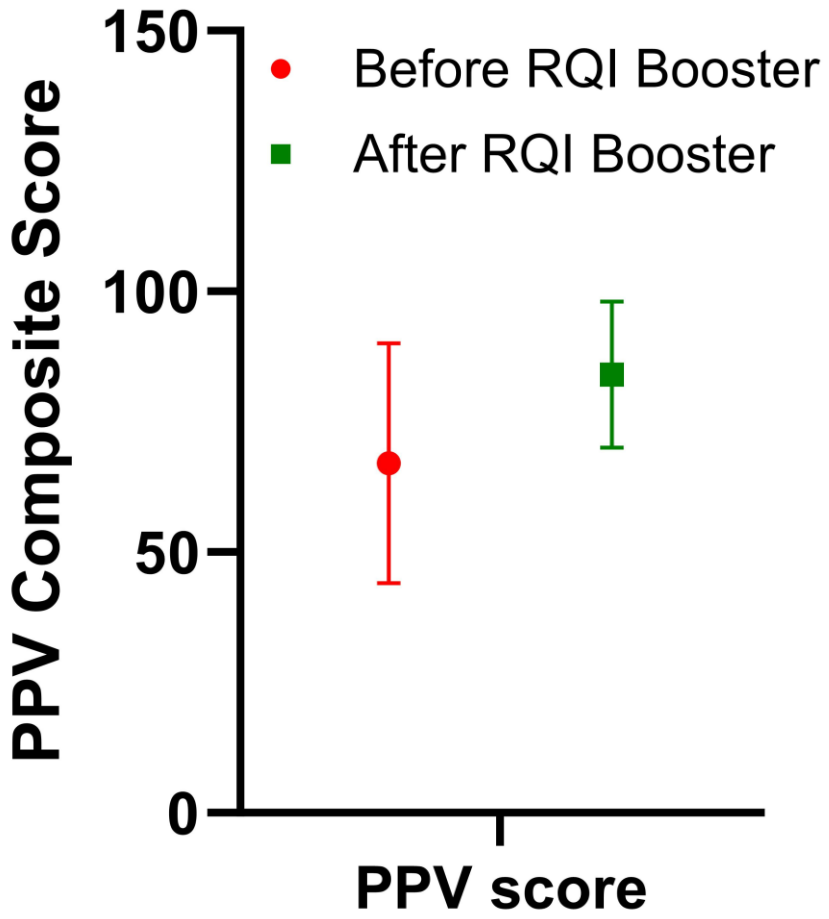
	Before ILT N=154	After ILT N=154	P-value*
Mask Seal score	41 (0, 91)	72 (16, 100)	<0.01
Head Position score	100 (100, 100)	100 (100, 100)	NS
Rate score	62 (6, 96)	88 (22, 98)	<0.01
PIP score	85 (39, 98)	96 (74, 100)	<0.01
PPV Composite Mean ± SD	64 ± 21	75 ± 20	<0.01
Passed Mask Seal , n (%)	48 (31%)	74 (48%)	<0.01
Passed Overall, n (%)	47 (31%)	79 (51%)	<0.01

In just 3 months, Significant PPV Skill Decay Noted



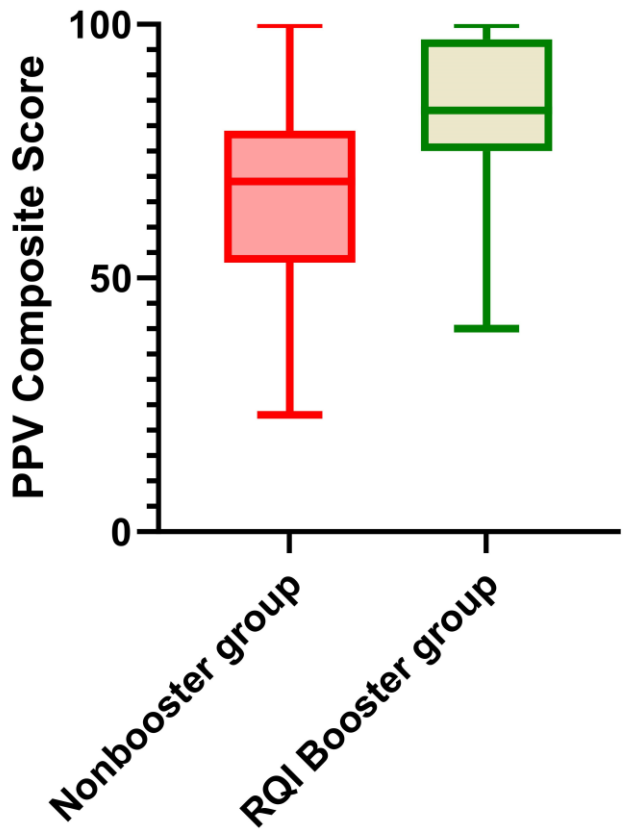
	Time 0 N=77	3 month N=74	P-value*
Mask Seal score	62 (11, 100)	49 (2, 98)	0.10
Rate score	88 (28, 96)	82 (20, 100)	0.58
PIP score	**98 (84, 100)**	**90 (33, 100)**	**<0.01**
PPV composite Score Mean ± SD	**76 ± 19**	**67 ± 23**	**<0.01**
Passed Mask Seal, N (%)	33 (43)	26 (35)	0.33
Passed Overall, N(%)	41 (53)	31 (41)	0.14

RQI Booster Results in Significant Improvement in PPV Skills



	Before RQI Booster N=73	After RQI booster N=73	P-value
Mask Seal score	**49 (2, 98)**	**78 (20, 100)**	**0.01**
Rate score	**82 (20, 100)**	**96 (79, 100)**	**<0.01**
PIP score	**90 (33, 100)**	**100 (93, 100)**	**<0.01**
PPV composite Score, Mean ± SD	**67** ± 23	**84** ± 14	**<0.01**
Passed Mask Seal, n (%)	26 (35)	35 (48)	0.12
Passing Overall, n (%)	**31 (41)**	**60 (81)**	**<0.01**

RQI Booster group has better PPV skills at 6 months from time 0 in the trial



	Control group 6 month N=71	Booster group 6 month N=67	P-value
Mask Seal score	**12 (0, 80)**	**80 (8, 100)**	**<0.01**
Rate score, Median (IQR)	**86 (46, 98)**	**100 (90, 100)**	**<0.01**
PIP score	**92 (62, 100)**	**98 (88, 100)**	**0.02**
PPV composite Score	**69 (53, 79)**	**83 (75, 97)**	**<0.01**
Passed Mask Seal, n(%)	**17 (24%)**	**33 (49%)**	**<0.01**
Passed Overall, n (%)	**24 (34%)**	**49 (73%)**	**<0.01**

Main Results: RQI for Booster Improves PPV skills as measured

- The majority of providers failed to provide adequate mask seal and failed on PPV assessment at baseline.
- PPV skills improved with instructor led-session
- At 3 months PPV skills already showed decay/decline.
- RQI booster session improves PPV skills
- Participants randomized to RQI booster session showed better mask seal and better overall PPV skills compared to the ones who did not receive any booster.
- Subgroup analysis show that all these results stay true irrespective of profession, time since the issue of NRP card, type of hospital or the experience of giving PPV to the newborns.

Limitations of Neo RQI trial

- The study was not powered to assess retention of skills over a longer period of time. It is unrealistic to expect higher retention skills after just one booster session. This will need much larger and likely a different study design
- The PPV score used in the study is not validated. Is there room for improvement in PPV score?
- We do not know if the improvement in PPV skills in sim lab transfer to PPV performance in real-life situation in the delivery room
- We do not know if improvement in PPV skills result in improvement in clinical outcomes of a newborn
- There might be a need for additional individualized strategies in addition to the current RQI for NRP cadence to improve PPV skills

Summary

- PPV at birth is a life saving skill and is needed non infrequently
- NRP providers, across various occupations and resuscitation experience show inadequate PPV skills.
- Current education strategy for teaching PPV skills is inadequate.
- RQI for NRP is designed to deliver high frequency low dose, self-directed training using modified RFM for newborns.
- Pilot study shows that it is feasible to provide booster training using such methodology and it can improve PPV skills as measured

RQI for NRP: Work to be done

- RQI for NRP is the first step of many. We need many more steps before we can deliver teaching so that all NRP providers can deliver high quality PPV to all vulnerable newborns who need it.
- Further research is needed to determine
  - Are these right measures? – Tidal volumes?, Flow? Improve manikin for head position assessment?
  - Is the frequency correct?
  - Can such training improve retention of high quality PPV skills?
  - Are skills transferable in the delivery room?
  - Do they improve clinical outcomes?
  - Is this cost-effective?

Changes you may wish to make in practice:

1. Evaluate your own PPV skills with objective data
2. Assess your organization's Neonatal Resuscitation Program teaching methodology with a focus on PPV skills acquisition and retention in all NRP providers.
3. Consider innovative education methodologies such as high frequency low dose training for neonatal resuscitation
4. Participate in neonatal resuscitation research or research on NRP educational methodology to improve outcomes of vulnerable newborns

References

For more information on this subject, see the following publications:

Yeung J, Djarv T, Sawyer T, Hsieh M, Lockey A, Bray J, Bhanji F, Bigham B, Breckwoldt J, Cheng A, Duff J, Glerup Lauridsen K, Gilfoyle E, Iwami T, Ma M, Monsieurs K, Okamoto D, Pellegrino J, Finn J, Greif R on behalf of the EIT Task Force and the NLS Task Force as collaborators. The use of Spaced Learning compared with Massed Learning among learners taking a resuscitation or first aid course Consensus on Science with Treatment Recommendations [Internet] Brussels, Belgium: International Liaison Committee on Resuscitation (ILCOR) Education, Implementation and Teams Task Force, 2020 January 3. Available from: http://ilcor.org

A multi-centre randomised controlled trial of respiratory function monitoring during stabilisation of very preterm infants at birth. van Zanten, Henriëtte A. et al. Resuscitation, Volume 167, 317 - 325

O'Currain E, Thio M, Dawson JA, Donath SM, Davis PG. Respiratory monitors to teach newborn facemask ventilation: a randomised trial. Arch Dis Child Fetal Neonatal Ed. 2019 Nov;104(6):F582-F586. doi: 10.1136/archdischild-2018-316118. Epub 2019 Jan 13. PMID: 30636691.