

# Children Should not be Treated like Little Adults

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**SickKids**



# Overview

- Equipment and Environment
- Preparation for testing
- Coaching
- Spirometry
  - Test Procedures
  - Acceptable Maneuvers
  - Reproducibility Criteria
  - Coaching tips
  - Summary

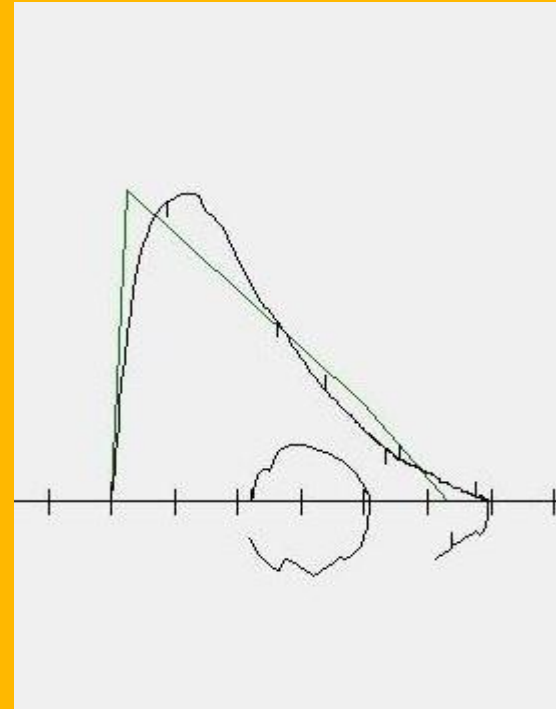
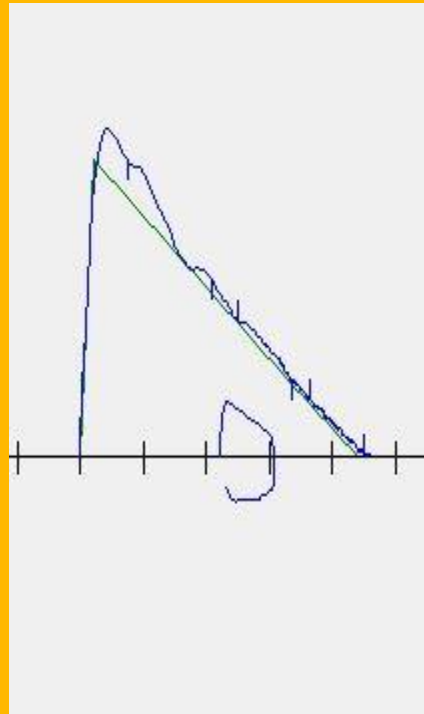
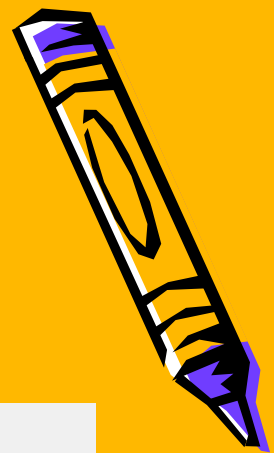


# Overview (con't)

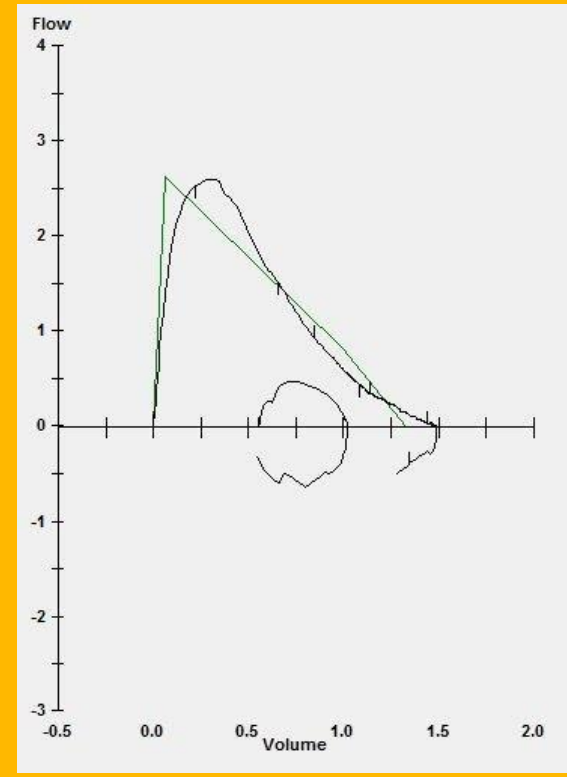
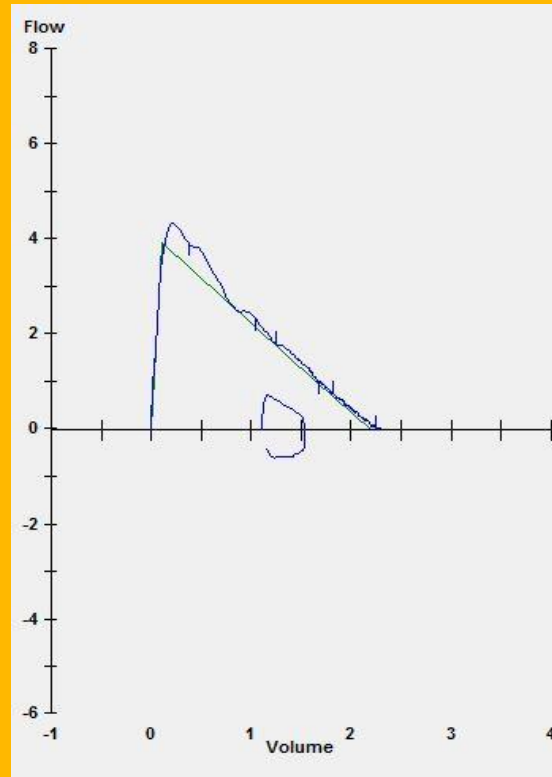
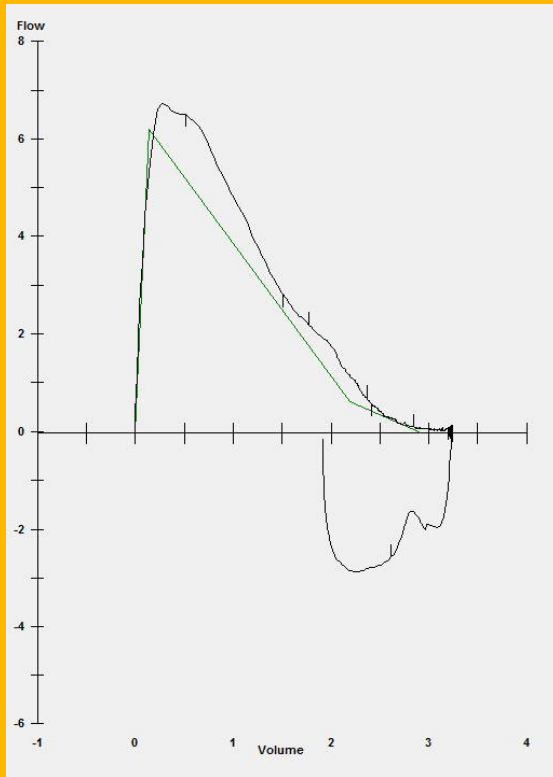
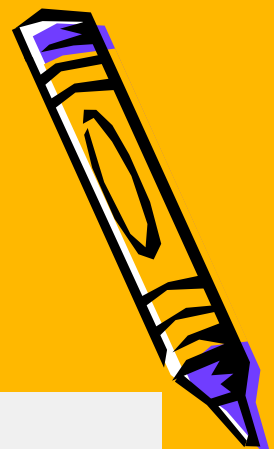
- Plethysmography/Dlco
  - Common Problems
  - Coaching tips
  - Summary
- Choice of Reference Sets
- Interpretation



Final outcome is the same



# Labelled final outcomes



# Environment and Equipment

- Environment: friendly, pictures on the wall, bright colors, little table for coloring while waiting during BD.
- Equipment: noseclips that are different colors, have spongy ends
- mouthpiece:
- Chairs that don't swivel, can't really use small ones



# Preparation for Testing

- How young can child be for testing?
  - 5 years old for Spirometry, little older if trying to do complete (Box, DL<sub>co</sub>)
- General overview of what is going to occur. They are going to "huff and puff"
- Nothing hurts, no needles



# Preparation for testing (con't)



- Explanation of test - keep it simple
- Demonstrate - actions speak louder than words
- Practice - off and on the equipment





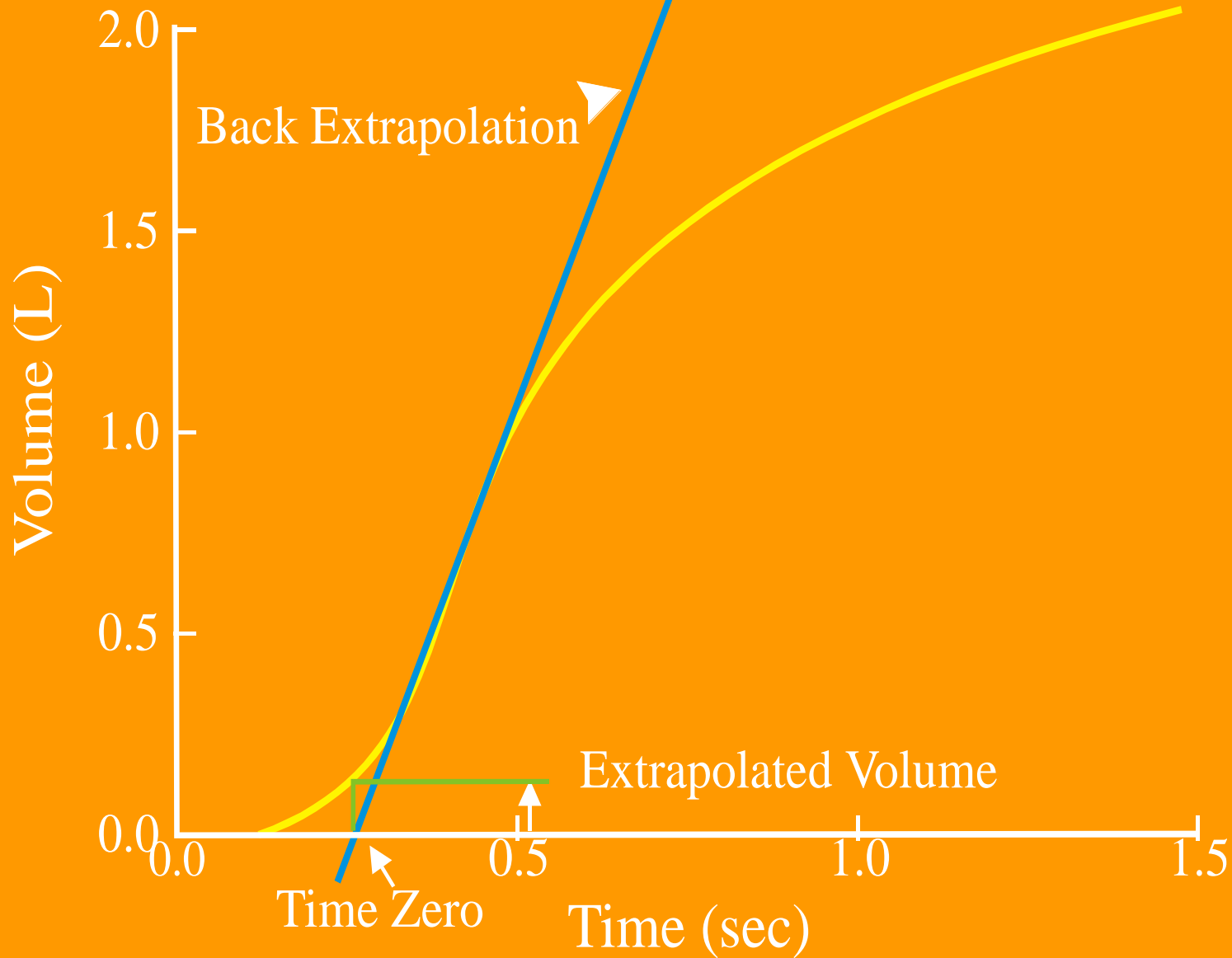
# Acceptable Maneuvers ATS/ERS 2005



- Start of Test Criteria - same as adults. Back Extrapolation Volume (BEV)  $< 5\%$  of VC or 150 ml whichever is greater.
- Maybe 80 ml more appropriate
- This can be a problem for young children with FVCs less than 1.5 L



# Start of Test Criteria



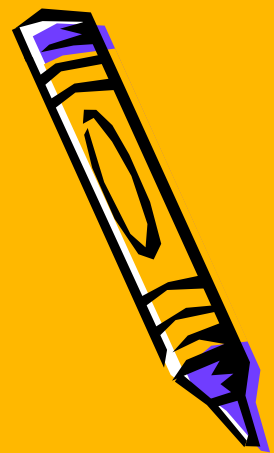
# Inspiratory Maneuver



- The time course previous inspiration will affect the subsequent expiration, especially in disease
- It should be rapid with no breath hold at TLC
- It can be a challenge to know if a small child is at TLC



# Acceptable Maneuvers ATS/ERS 2005

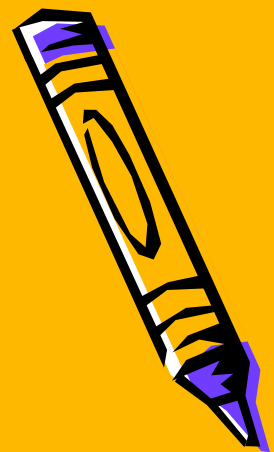


- End of Test Criteria - <10 yrs old , sustain effort (plateau) for >3 secs
- No flow is < 0.025 L in 1 sec
- No cough during first second
- No Valsalva maneuver



# Acceptable Maneuvers ATS/ERS 2005

- No hesitation during exhalation
- Maximal effort
- No extra breath
- No leak



# Reproducibility Criteria



- To have reproducible maneuvers is not usually a problem in children, when they get it.
- If  $FVC < 1.0\text{ L}$ 
  - Two highest FVC and FEV1 must be within 100 ml
- If  $FVC > 1.0\text{ L}$ 
  - Two highest FVC and FEV1 must be within 150ml



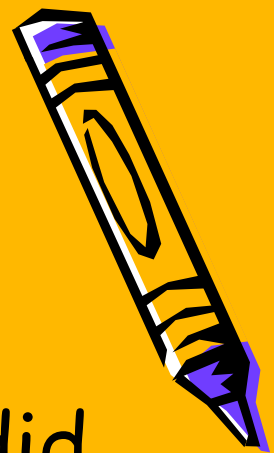
# General Coaching Tips



- Be Positive and non-intimidating
- Let them play with mouthpiece. They are often anxious to try the test.
- Add the noseclips once they are comfortable with mouthpiece.
- After a simple explanation; big breath in, blow out hard and blow long. Have them try it. Then see what they understood or did not understand.



# General Coaching Tips



- Focus on fixing what they didn't understand and praise what they did correctly
- Fix one thing at a time
- You may have to say things differently
- Children don't tire out quickly. May need more than 8 attempts.





# Coaching for PEF and no hesitation



- Quick and hard go together
- Don't yell.....
- Often use their throat. Demonstrate
- Blow out hard and try to break my machine
- Blow out like you are mad
- Blow out like a punch in the stomach



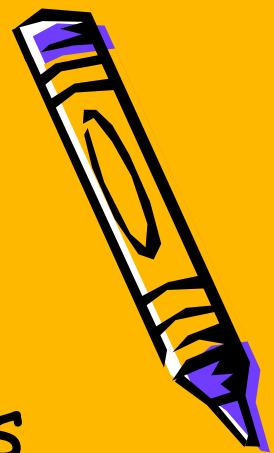
# Coaching for PEF and no hesitation (con't)



- Some respond well to visual cues
- Use the predicted curve as a goal
- Can show them their multiple efforts



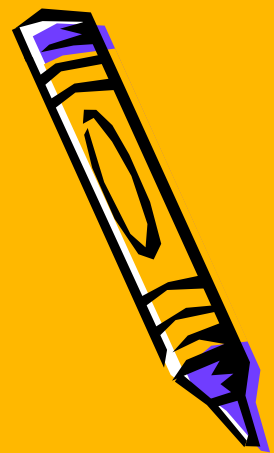
# Coaching for 3 seconds and Plateau



- Understanding to blow out to RV is the most difficult criteria
- Continuous encouragement while blowing out.
- Blow out forever
- Blow out mommy's birthday candles
- Pretend that you are under water



# Coaching for 3 seconds and Plateau (con't)



- Visual Cues:
  - Use markers on the computer screen
    - The 3 or 6 second line
    - Fill up the bar (green)
  - Incentive screens - specifically to help them blow out long - don't always work, distracting



# Uncooperative Patient



- The uncooperative participant:
  - Actually do the test yourself and point out what happens on the computer
  - Playing a game against the computer
  - Making a drawing on the computer with your "breath"
  - Reward incentives, i.e. stickers
  - As last resort, have parent help



# Abandon Test



- Abandon procedure
  - If child does not understand
  - If child becomes upset and/or begins to cry.
  - There are times nothing works.
  - Decide to try later perhaps



# Use of Suboptimal results

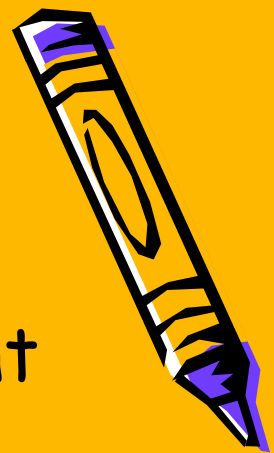


- Hardest for the children is blowing out to RV.
- The PEF and FEV1 can be acceptable and reproducible but the FVC is not.
- Sometimes the unacceptable curve is close to predicted.



# Summary

- Some acceptability criteria are different for children than adults.
- While the outcomes are the same how one obtains the final outcome can be very different as different coaching tools are necessary
- If child is able to adequately perform Spirometry, then he/she should be able to perform the lung volume tests and  $DL_{CO}$





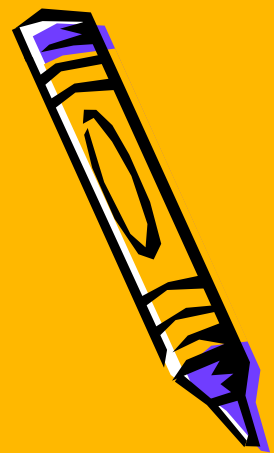
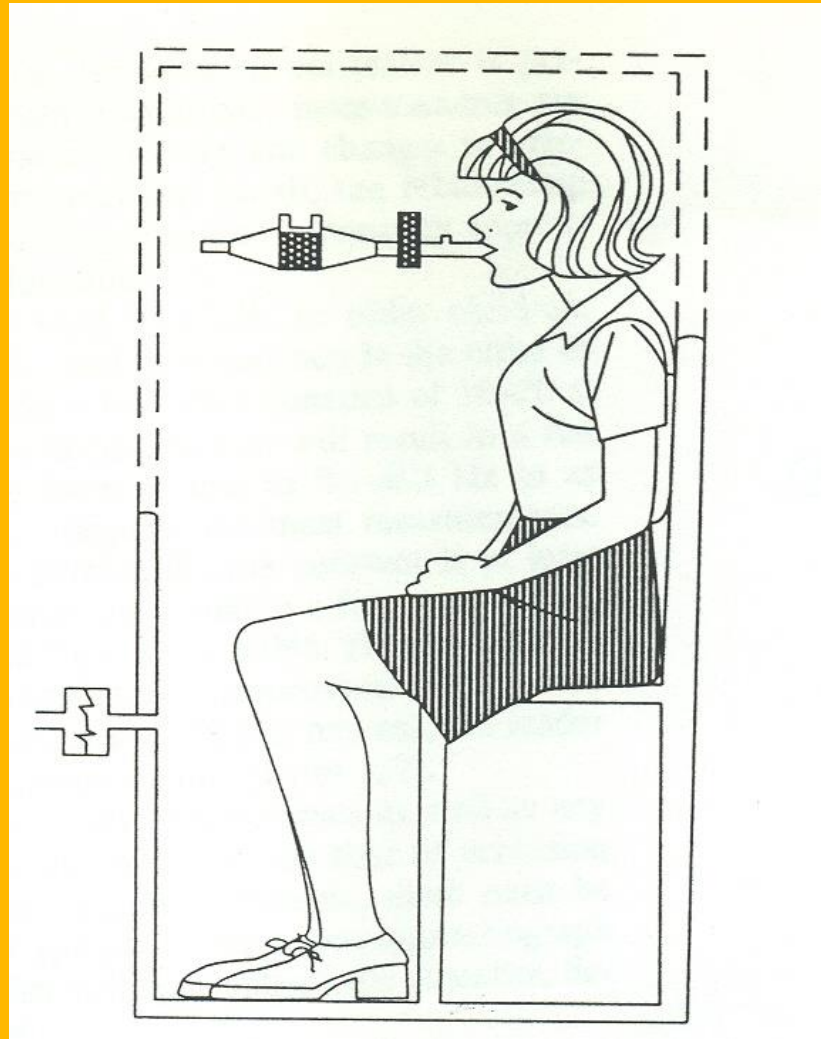
# Plethysmography



- Measures all lung gas including non communicating gas
- Measurements are based on rarefaction and compression of lung gas (Boyle's Law)
- Procedure, acceptability and reproducibility is the same for children and adults



# Patient in the Box



# Common Problems



- Pant frequency is too fast
- Can be difficult to have patient to continue to pant against the closed shutter.
- Without a stable baseline end-expiration, pant maneuver may not be done at FRC (need to correct final value)
- Claustrophobic.



# Coaching Tips

- Children have less difficulty with this test. They do it naturally.
- Pant like a tired puppy dog, must demonstrate.
- Often difficult to obtain an end expiration baseline. Sing a song, play a video, etc.
- Sometimes scared but rarely claustrophobic. Explain that door is not locked and demonstrate how they can open it. Sitting in a kind of spaceship



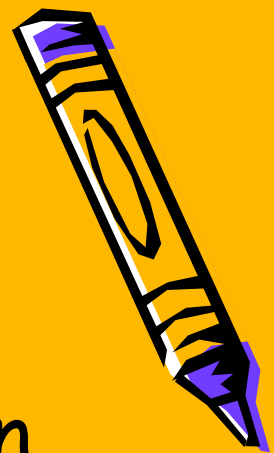
# Summary



- Is fairly easy for children to do
- Done correctly, plethysmographic measurements are reliable and can be verified by repeatability



# DL<sub>co</sub>



- The principles for measurements in adults applies to children.
- If patient is able to do Spirometry, they should not have any problem with this test if they have a VC of more than 1.5 L.



# Common Problems



- The equipment is very "size" sensitive so in small children, not matter how cooperative, small lung volumes may limit applicability
- While there are ways to "adjust" the standard measurement for size, there are still limitations
- Switching to source of test gas at RV can be difficult but does not affect  $DL_{CO}$  if one is able to get patient to fill up to TLC. Difficult to judge this.



# Coaching Tips

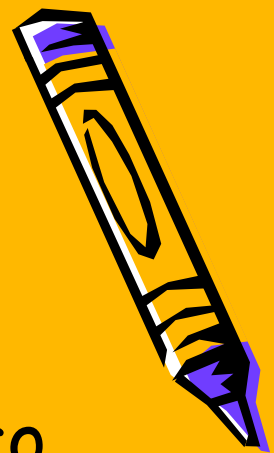


- Follow me, we'll do it together
- Children do not have a problem holding their breath for 10 seconds
- Can you hold your breath long enough to get to the other side of the pool?
- You can use the green line on the screen as goal
- Judging that pt. is at RV can be challenging but if pt. breathes in fully, Dlco still good.





# Summary



- If pt is able to do Spirometry, then Dlco will not be a real challenge.
- Pt. with Vital Capacity less than 1.5 L can't technically perform the DLco



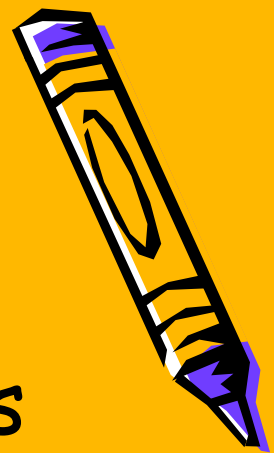
# Reference sets



- Spirometry - The GLI are now considered the reference set of choice for ages 5 and up. Use of LLN instead of % predicted.
- For Lung Volumes choices are limited. Sick Kids uses Rosenthal (1993)
- There are no good choices for DLco. Sick Kids uses Kim (2016)



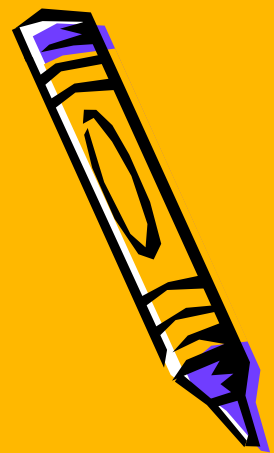
# Interpretation



- Identifying disease is sometimes difficult. Applying adult criteria is not be ideal.
- Must know the age of pt for proper interpretation.
- Degree of severity based on % predicted and based on adult criteria



# Interpretation (con't)



- Difficult to identify presence of disease with poor reference sets for Lung Volumes and Dlco.
- Suboptimal results can be very useful but caution used when interpreting



# Conclusion

- Children can perform PFTS well and results are valid and accurate using the ATS/ERS Guidelines
- Technologist must be trained how to coach a child vs an adult.
- Technologist must recognize the limitations for the child in performing PFTS.
- Special knowledge about a child's respiratory physiology must be used when interpreting PFTS and understanding the limitations with reference sets.

