

Principles of Motor Learning & Neural Plasticity

Ianessa A. Humbert, Ph.D., CCC-SLP
Associate Professor
University of Florida

Emily Zimmerman, Ph.D., CCC-SLP
Assistant Professor
Northeastern University

Charleston Swallowing Conference 2018

Theories applied to the study movement



Neural Plasticity



Motor Learning



Neural Plasticity

Brain's ability to change

Shorter-term: Habituation

Limb withdrawal from pain

Sherrington 1906





Neural Plasticity

Brain's ability to change

Shorter-term: Habituation

Limb withdrawal from pain

Sherrington 1906

Longer-term: Skill learning

Early skill learning - more brain activity

Repetition of skill - less brain activity

Wiersma-Meems 2005; Floyer-Lea et al 2005; Meister et al 2005





Neural Plasticity

Brain's ability to change

Experience with
success and
failure required

Shorter-term: Habituation

Limb withdrawal from pain

Sherrington 1906

Longer-term: Skill learning

Early skill learning - more brain activity

Repetition of skill - less brain activity

Wiersma-Meems 2005; Floyer-Lea et al 2005; Meister et al 2005



Motor Learning

Improving movements over time

Sensory feedback used for ongoing adjustments in movement. Errors are bad.

(closed loop theory)

(Adams 1971)

Rapid, ballistic movements occur without on-going feedback

Variability of practice leads to improved motor learning

(open loop theory)

(Schmidt 1975)



Motor Learning

Improving movements over time

Experience with
success and
failure required

Sensory feedback used for ongoing adjustments in movement. Errors are bad.

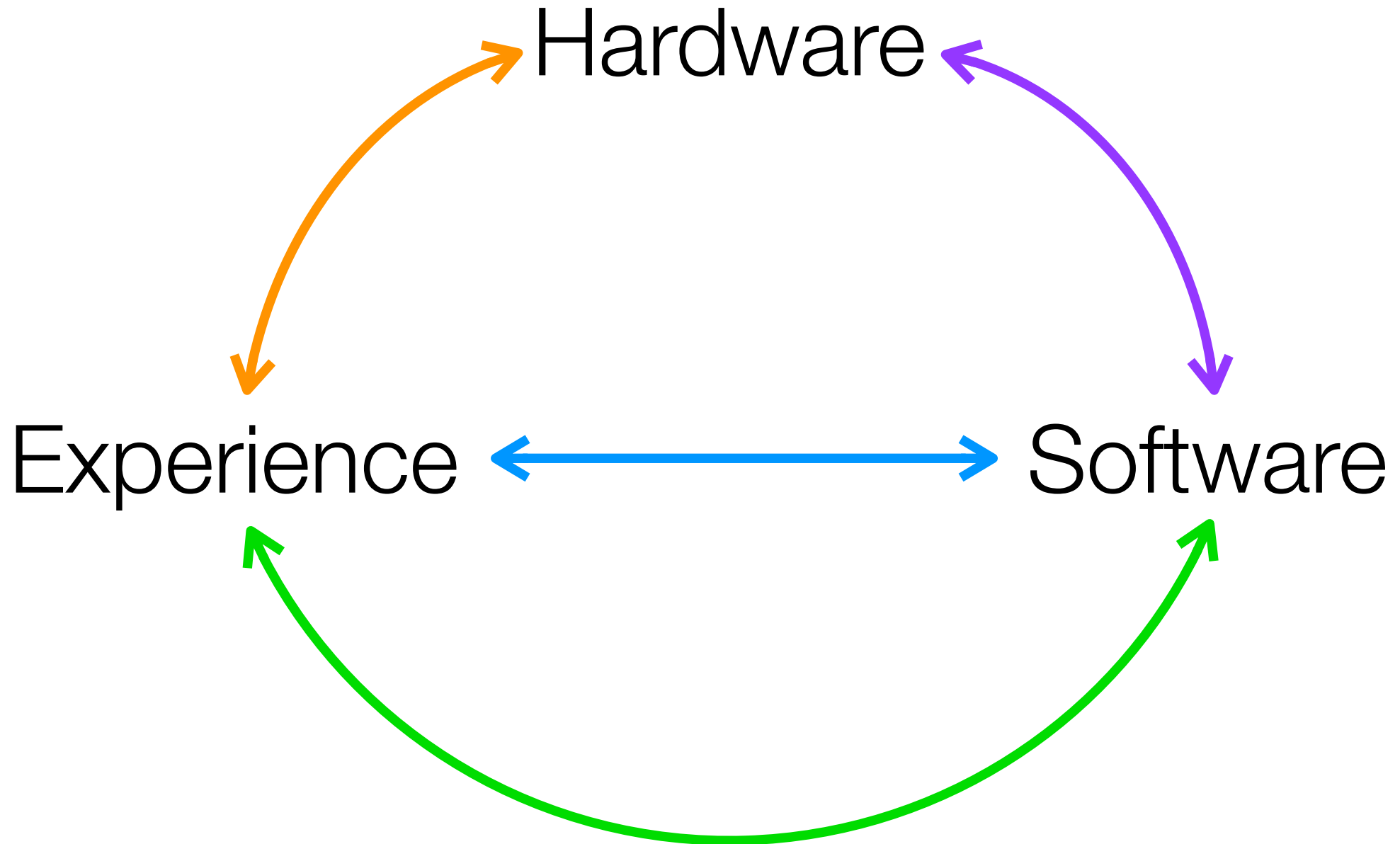
(closed loop theory)

(Adams 1971)

Rapid, ballistic movements occur without on-going feedback

Variability of practice leads to improved motor learning
(open loop theory)

(Schmidt 1975)

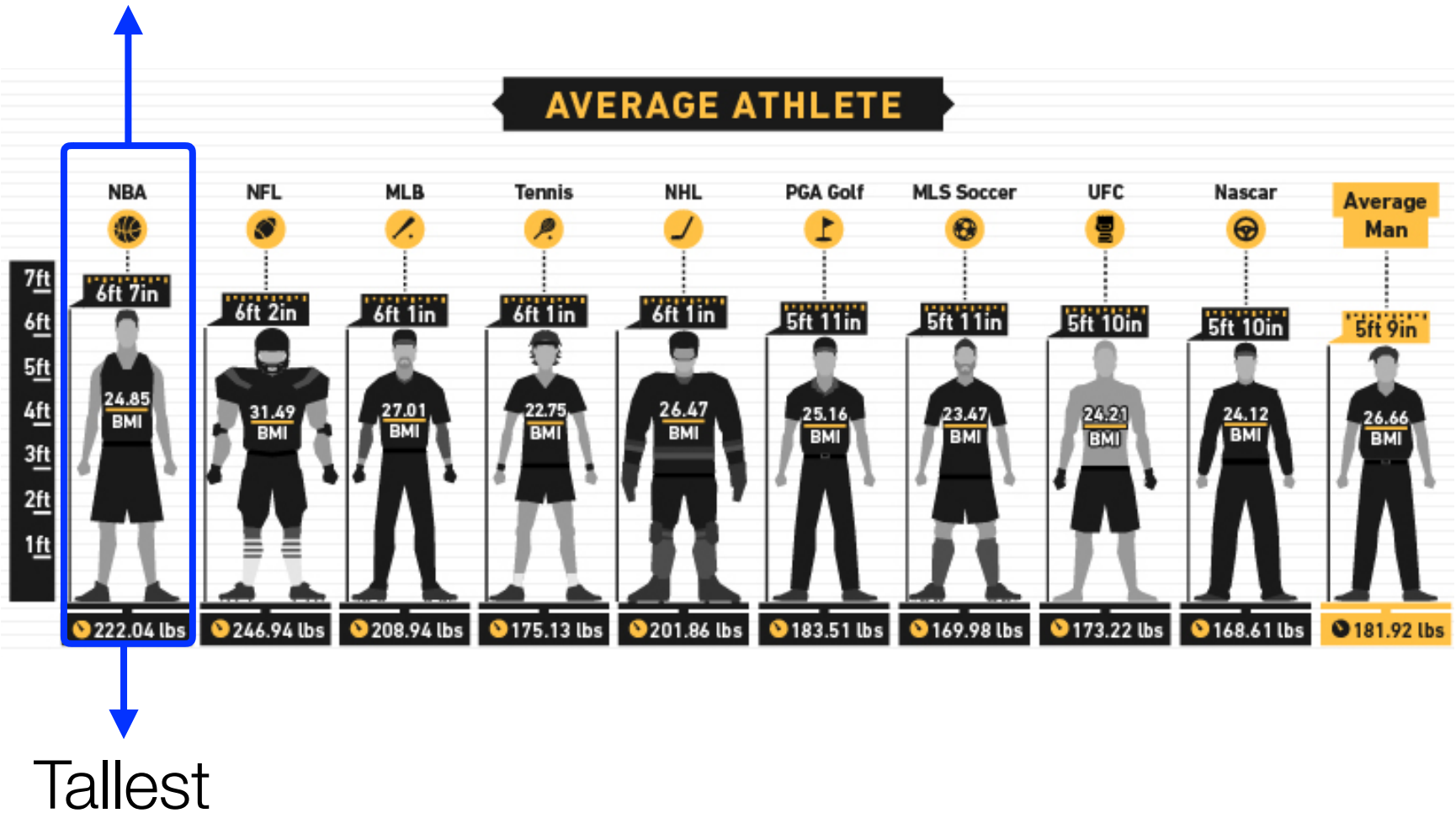


Sports Analogy

Hardware: Height (Required, but not sufficient)

Software: Motor Programming (CNS + PNS planning is not enough)

Experience: Skill learning (practice) (Natural talent alone is not enough)



THEY SAY

“Swallowing is the Best Treatment for Swallowing”



Feeding and Swallowing

Hardware

Oropharyngeal structures

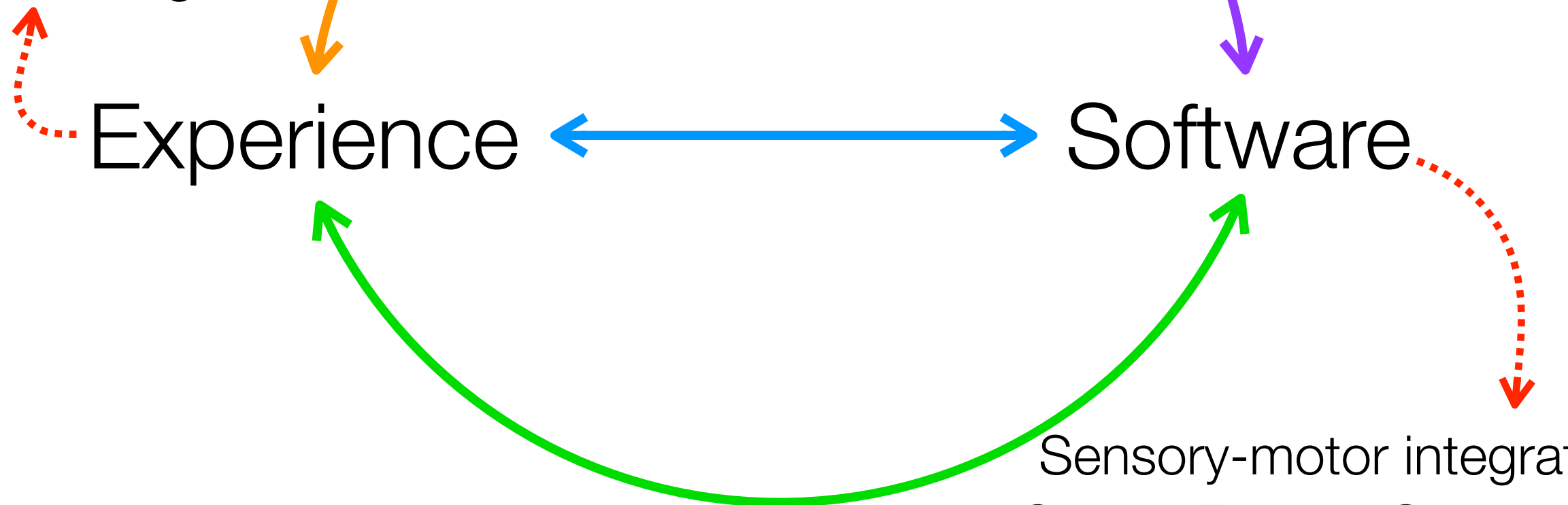
Neural structures

Eating and
Drinking!

Experience

Software

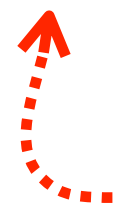
Sensory-motor integration
Central Pattern Generators



Feeding and Swallowing

SLPs control this!

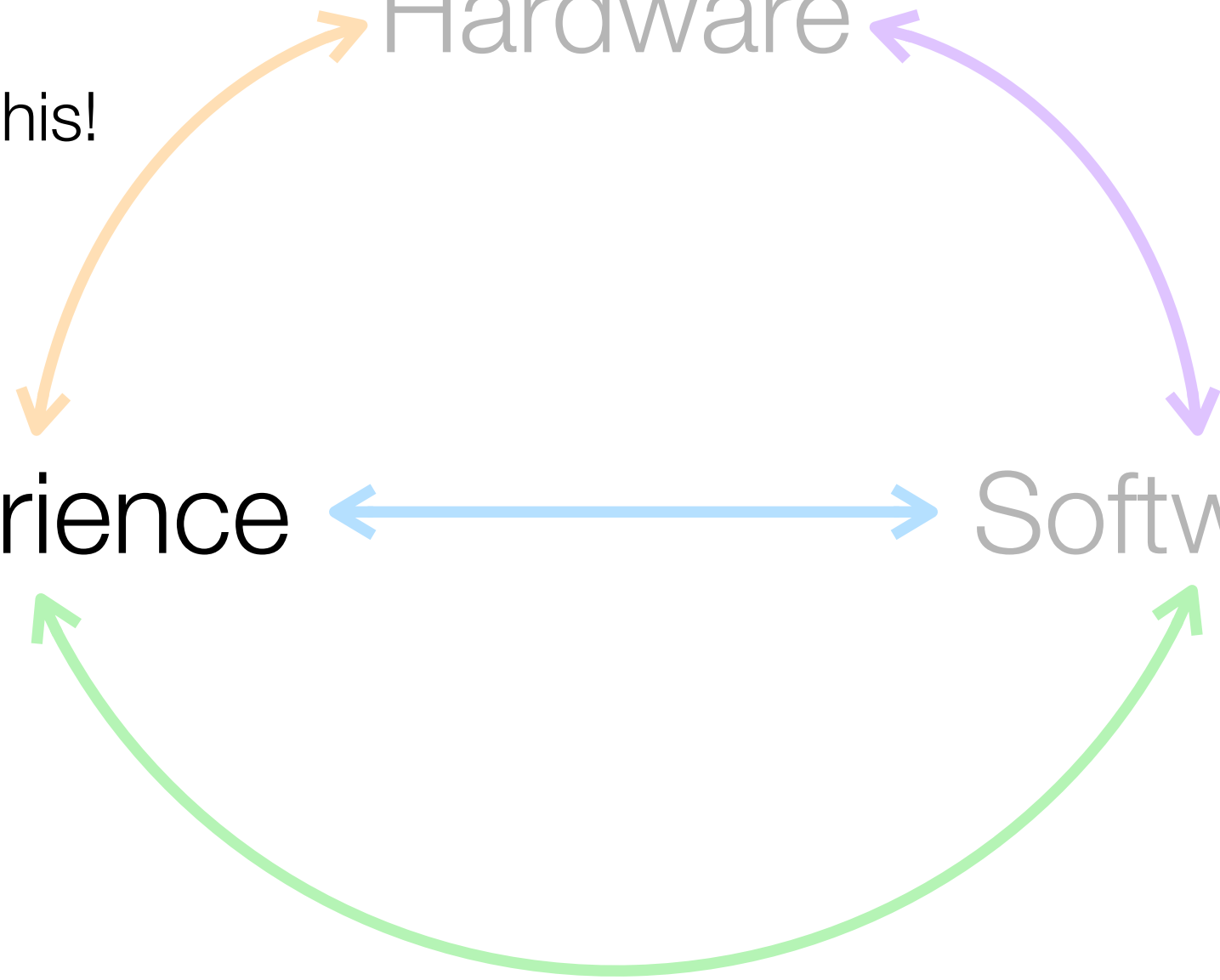
Eating and
Drinking!



Experience

Hardware

Software





Normal



Functional



Disordered

Normal Swallowing 101: Clinical Workshop

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55 year old male originally from Raleigh who was admitted on April 3rd from Charlotte Medical Center and Pineville on April 3. Flight out from St. Thomas after a weekend long vacation. That same day his wife noted that he has been complaining of lightheadedness and dizziness followed by persistent vomiting during the flight. EMS was called as soon as they arrived in Charlotte and he was taken to the emergency department. It is thought that he had a possible gastroenteritis. A CT of the abdomen showed chronic findings, nothing acute. He continued to have nausea and vomiting despite antiemetics and he was thought to have aspirated, unfortunately becoming hypoxic and requiring supplemental oxygen. He had rapid response on the early morning of the third.



Normal

Functional

Disordered

Normal Swallowing 101: Clinical Workshop

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He did have a CT head performed on April 3 which showed no acute intracranial abnormality. Unfortunately, he does not get any additional imaging studies performed because of his persistent nausea and vomiting whenever he laid flat. His symptoms have been refractory to medications.

Patient elected to be transferred to another facility and it was there, on 4/8/16, that an MRI was conducted, confirming medullary stroke

Importance of ordering the right imaging



Normal



Functional



Disordered

Normal Swallowing 101: Clinical Workshop

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Patient reported SLP recommended: "Strict" NPO status and skilled SLP rehabilitation for severe dysphagia



Alicia K. Vose, Ph.D., CCC-SLP



Normal

Functional

Disordered

Normal Swallowing 101: Clinical Workshop

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2016

2017

April

May

June

July

Aug

Sept

Oct

Nov

Dec

Jan

Feb

March

April

May

June

July

SLP Dysphagia Therapy

1st visit to our lab

**Applying Motor Learning Principles
to Dysphagia Rehabilitation**

R01DC014285

NIDCD

Thanks [ClinicalTrials.gov!](https://clinicaltrials.gov/)



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Functional

Disordered

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2016

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April

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Jan

Feb

March

April

May

June

July

Initial

1st
F/U

2nd
F/U

3rd
F/U

update

2017

2018

July

Aug

Sept

Oct

Nov

Dec

Jan

Feb

March

April

May

June

July

Aug

Sept

Dec

Ok go ahead and take a sip..... and swallow



1st Swallow
 1st Visit
 Thin Liquid Barium Cup Sip

Initial
↑

2017									2018						
July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Dec

✓ Thin cup sip

Why reclined, supine?

Initial



2017									2018						
July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Dec

Why reclined, supine?

Find position that facilitates most swallowing practice with least aspiration



Tbsp pudding supine with pillow

Initial
↑

2017					2018										
July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Dec

- ✓ Thin cup sip
- ✓ Nectar cup sip
- ✓ Nectar cup sip reclined 32°
- ✓ Nectar cup sip reclined 45°
- ✓ Nectar cup sip upright AP
- ✓ Nectar cup sip upright AP left head turn
- ✓ Straw sip nectar reclined left head turn 45°
- ✓ Straw sip nectar supine
- ✓ Straw sip nectar supine with pillow
- ✓ Table spoon pudding supine with pillow

Observations (Initial Visit)	
1	
2	
3	
4	
5	

Initial



2017									2018						
July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Dec



Observations (Initial Visit)	
1	Diminishing UES opening (across swallows)
2	Prolonged Inter-swallow-intervals
3	Excess secretions (also imaged with FEES)
4	Absent or late aspiration response
5	NO LVC pharyngeal squeeze, lingual propulsion

Initial



Theory
Tested

● Target volitional
laryngeal closure?

Suggested
Home Activities

Valsalva (30 daily)

Observations
(Initial Visit)

- 1 Diminishing UES opening
(across swallows)
- 2 Prolonged Inter-swallow-
intervals
- 3 Excess secretions
(also imaged with FEES)
- 4 Absent or late aspiration
response
- ⑤ NO LVC pharyngeal squeeze,
lingual propulsion

Initial



2017

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July

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2017

2018

July Aug Sept Oct Nov Dec Jan Feb March April May June July Aug Sept Dec

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Theory
Tested

● Target volitional
laryngeal closure?

Suggested
Home Activities

Valsalva (30 daily)

EMST (5 sets of 5 daily)

Observations
(Initial Visit)

1	Diminishing UES opening (across swallows)
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Initial



2017

2018

July

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June

July

Aug

Sept

Dec

Theory Tested

- Target volitional laryngeal closure?
- Target clearance of aspirated material, secretions?



Observations (Initial Visit)	
1	Diminishing UES opening (across swallows)
2	Prolonged Inter-swallow-intervals
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Initial



2017

2018

July Aug Sept Oct Nov Dec Jan Feb March April May June July Aug Sept Dec

Theory Tested

- Target volitional laryngeal closure?
- Target clearance of aspirated material, secretions?

Suggested Home Activities

Valsalva (30 daily)

EMST (5 sets of 5 daily)



Observations (Initial Visit)

1	Diminishing UES opening (across swallows)
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Initial



2017

2018

July Aug Sept Oct Nov Dec Jan Feb March April May June July Aug Sept Dec

Theory Tested

- Target volitional laryngeal closure?
- Target volitional laryngeal closure?



Observations (Initial Visit)	
①	Diminishing UES opening (across swallows)
②	Prolonged Inter-swallow-intervals
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Initial



2017

2018

July Aug Sept Oct Nov Dec Jan Feb March April May June July Aug Sept Dec

Theory Tested

- Target volitional laryngeal closure?
- Target volitional laryngeal closure?

Suggested Home Activities

Valsalva (30 daily)

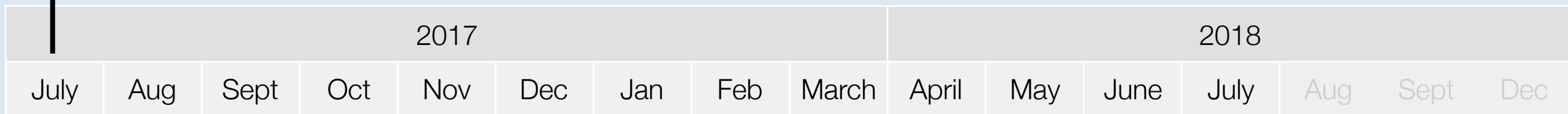
EMST (5 sets of 5 daily)

Supine swallowing exercise
(sour, cold, small thin bolus)

Observations (Initial Visit)

- ① Diminishing UES opening (across swallows)
- ② Prolonged Inter-swallow-intervals
- ③ Excess secretions (also imaged with FEES)
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Initial



Theory Tested

- Target volitional laryngeal closure?
- Target volitional laryngeal closure?
- Swallowing best tx for swallowing?

Suggested Home Activities

Valsalva (30 daily)

EMST (5 sets of 5 daily)

Supine swallowing exercise
(sour, cold, small thin bolus)

Observations (Initial Visit)

- ① Diminishing UES opening (across swallows)
- ② Prolonged Inter-swallow-intervals
- ③ Excess secretions (also imaged with FEES)
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Initial



2017

2018

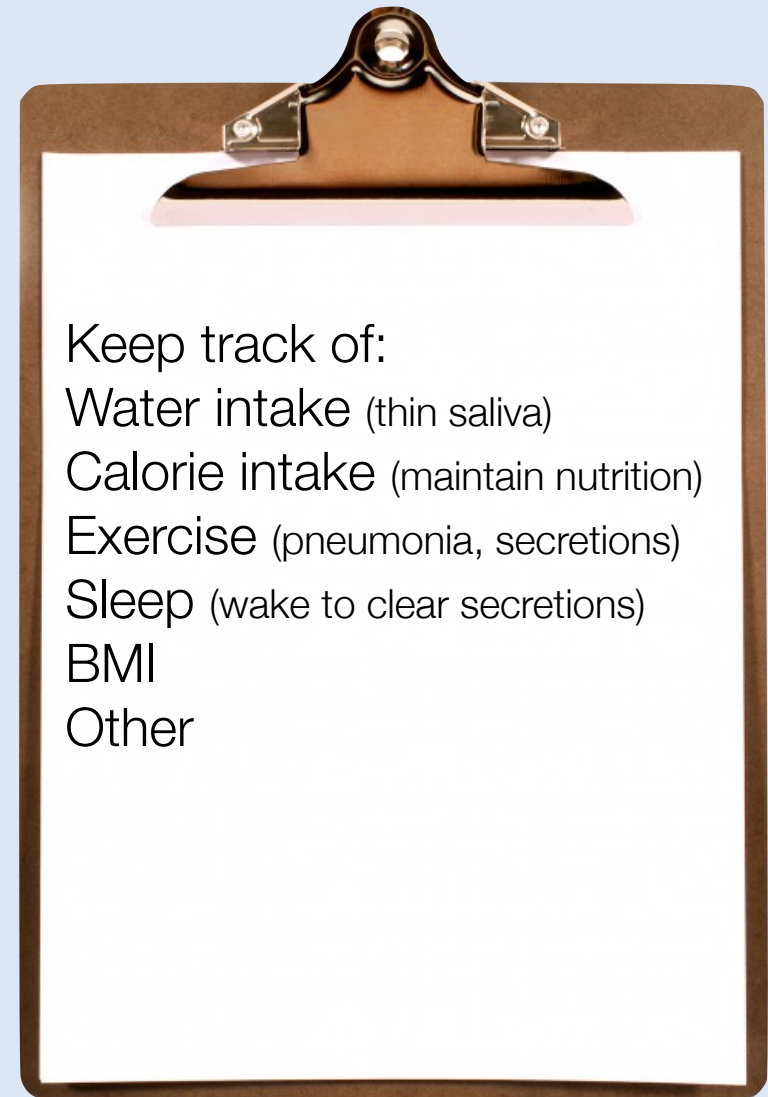
July Aug Sept Oct Nov Dec Jan Feb March April May June July Aug Sept Dec

Suggested Home Activities

Valsalva (30 daily)

EMST (5 sets of 5 daily)

Supine swallowing exercise
(sour, cold, small thin bolus)



Keep track of:
Water intake (thin saliva)
Calorie intake (maintain nutrition)
Exercise (pneumonia, secretions)
Sleep (wake to clear secretions)
BMI
Other

Initial



2017									2018						
July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Dec



Normal

Functional

Disordered

Normal Swallowing 101: Clinical Workshop

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Patient
reported no
pneumonia
since Visit 1

Initial
1st
F/U

2017

2018

July

Aug

Sept

Oct

Nov

Dec

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March

April

May

June

July

Aug

Sept

Dec

7cc cold, sour
cup sip upright



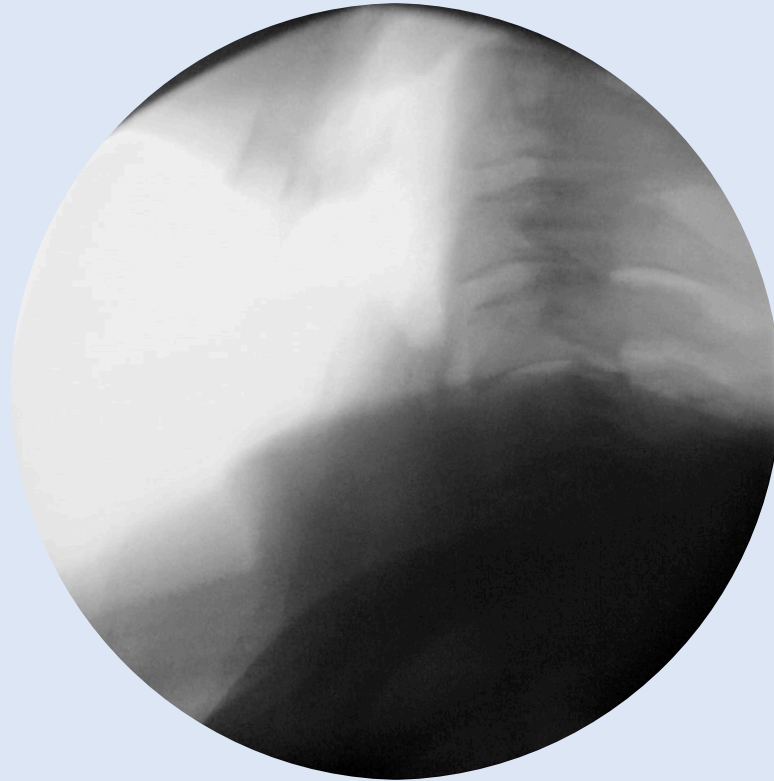
Normal

Functional

Disordered

Normal Swallowing 101: Clinical Workshop

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Initial
↑
1st
F/U
↑

2017

2018

July

Aug

Sept

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March

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July

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Sept

Dec



Normal

Functional

Disordered

Normal Swallowing 101: Clinical Workshop

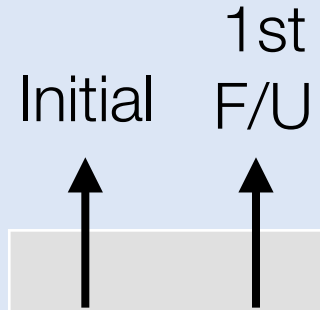
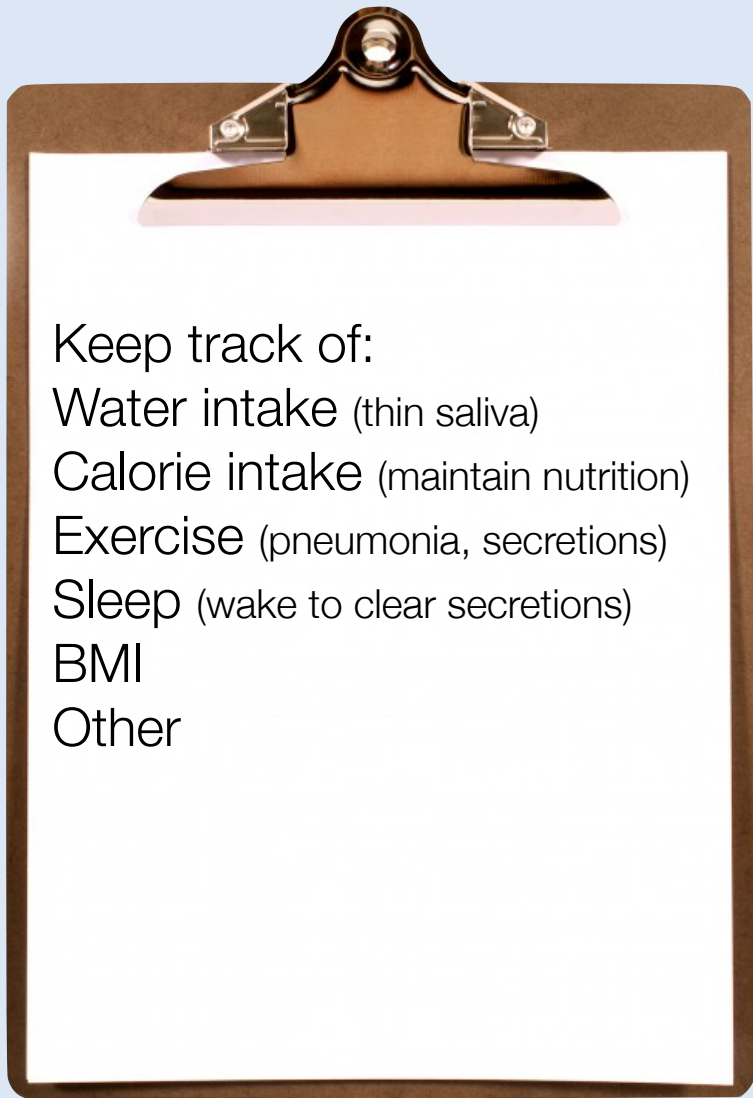
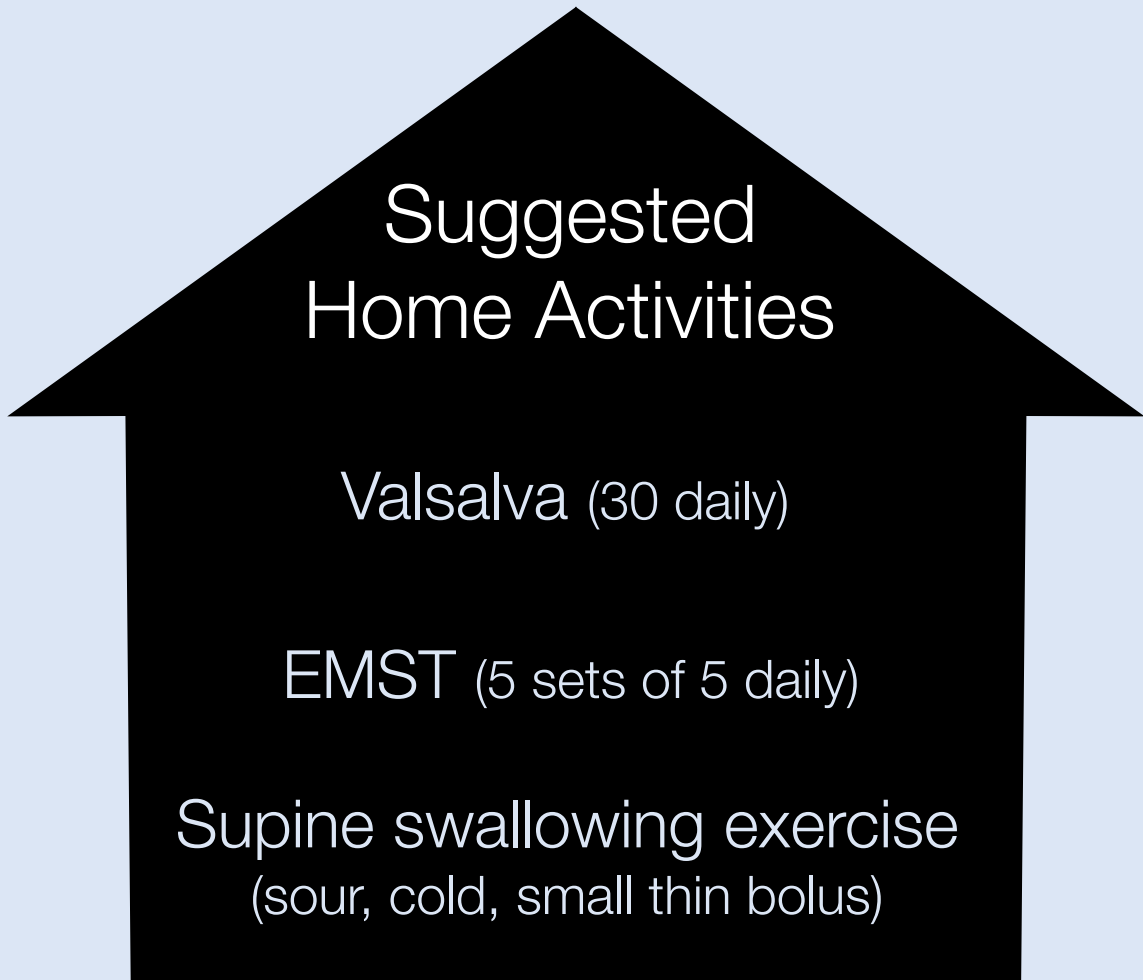
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6 week interval between 1st and 2nd follow up...

Initial
↑
1st
F/U
↑

2017									2018						
July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Dec

Same...



2017									2018						
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Suggested Home Activities

Valsalva (30 daily)

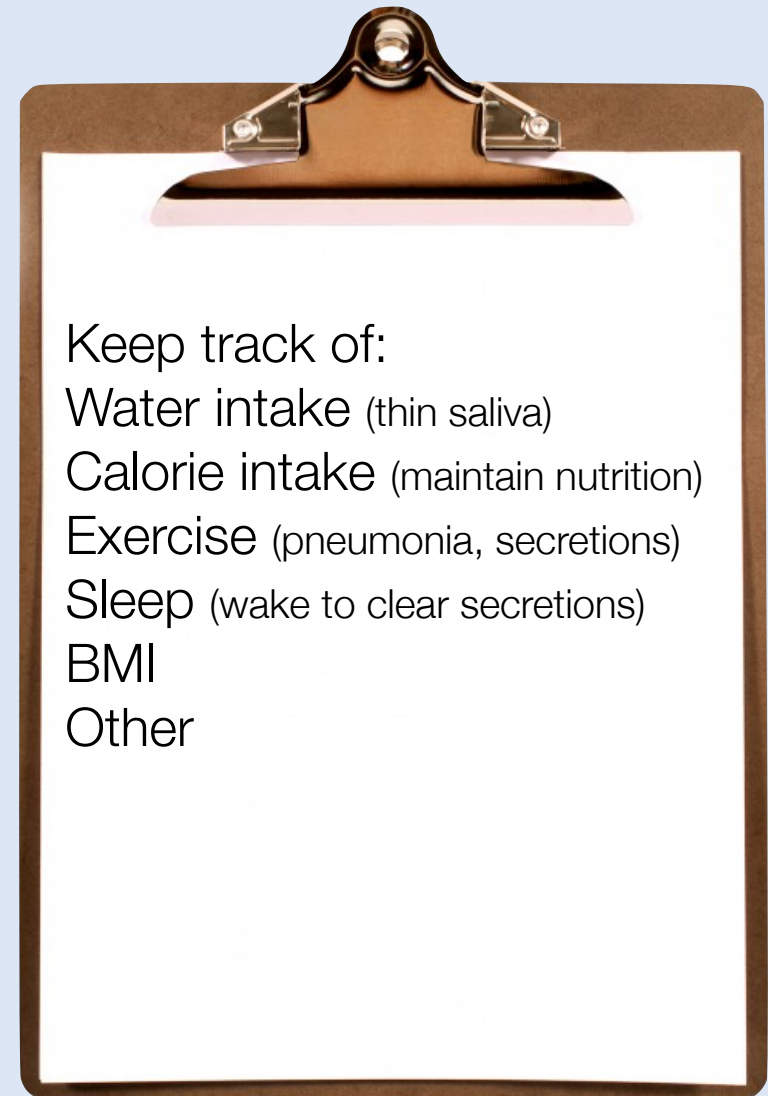
EMST (5 sets of 5 daily)

Supine swallowing exercise
(sour, cold, small thin bolus)

Added...

Suggested ENT intervention for UES during next visit

(behavioral stuff not cutting it!)



Keep track of:

- Water intake (thin saliva)
- Calorie intake (maintain nutrition)
- Exercise (pneumonia, secretions)
- Sleep (wake to clear secretions)
- BMI
- Other

1st

Initial

F/U



2017

2018

July Aug Sept Oct Nov Dec Jan Feb March April May June July Aug Sept Dec



Normal

Functional

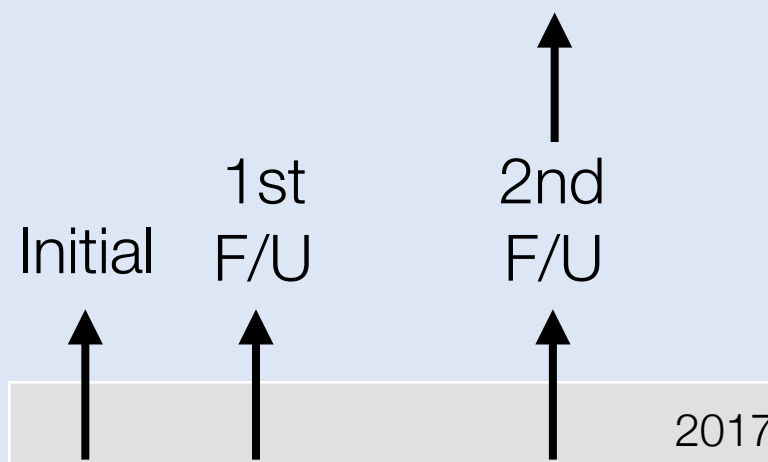
Disordered

Normal Swallowing 101: Clinical Workshop

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Day 1

Day 2



2017

2018

July

Aug

Sept

Oct

Nov

Dec

Jan

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March

April

May

June

July

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Sept

Dec

Thin barium
cup sip, upright



Normal

Functional

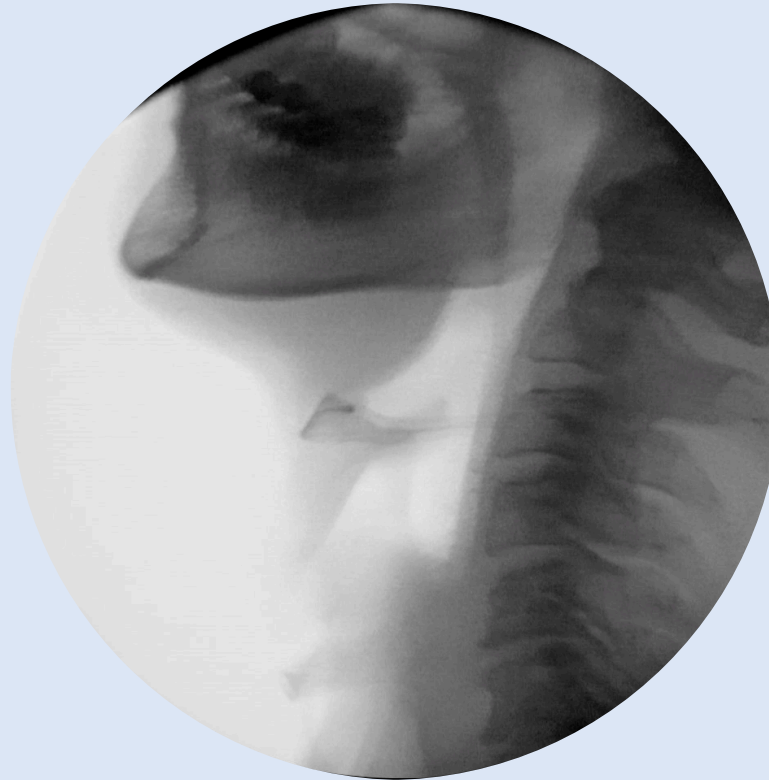
Disordered

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Day 1

MBS
with us



Initial

1st
F/U

2nd
F/U

2017

2018

July

Aug

Sept

Oct

Nov

Dec

Jan

Feb

March

April

May

June

July

Aug

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Thin barium
cup sip, upright



Normal

Functional

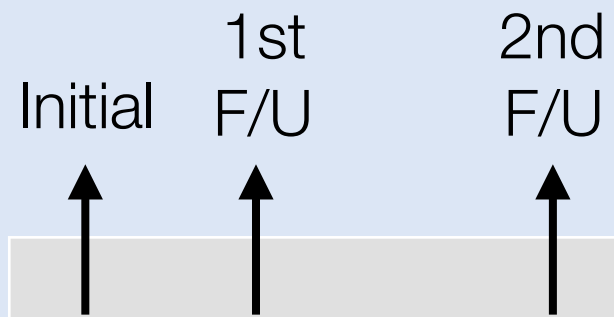
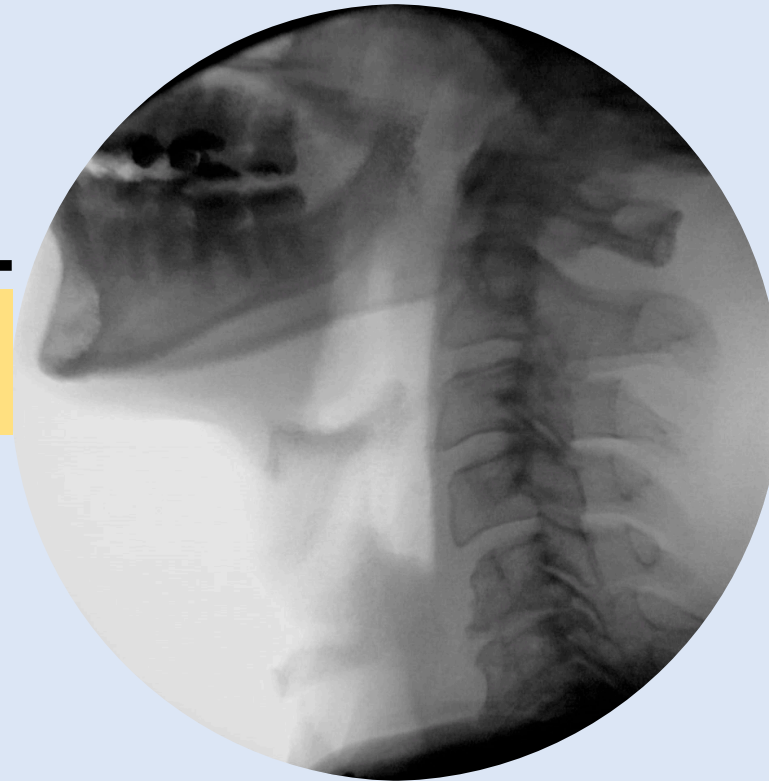
Disordered

Normal Swallowing 101: Clinical Workshop

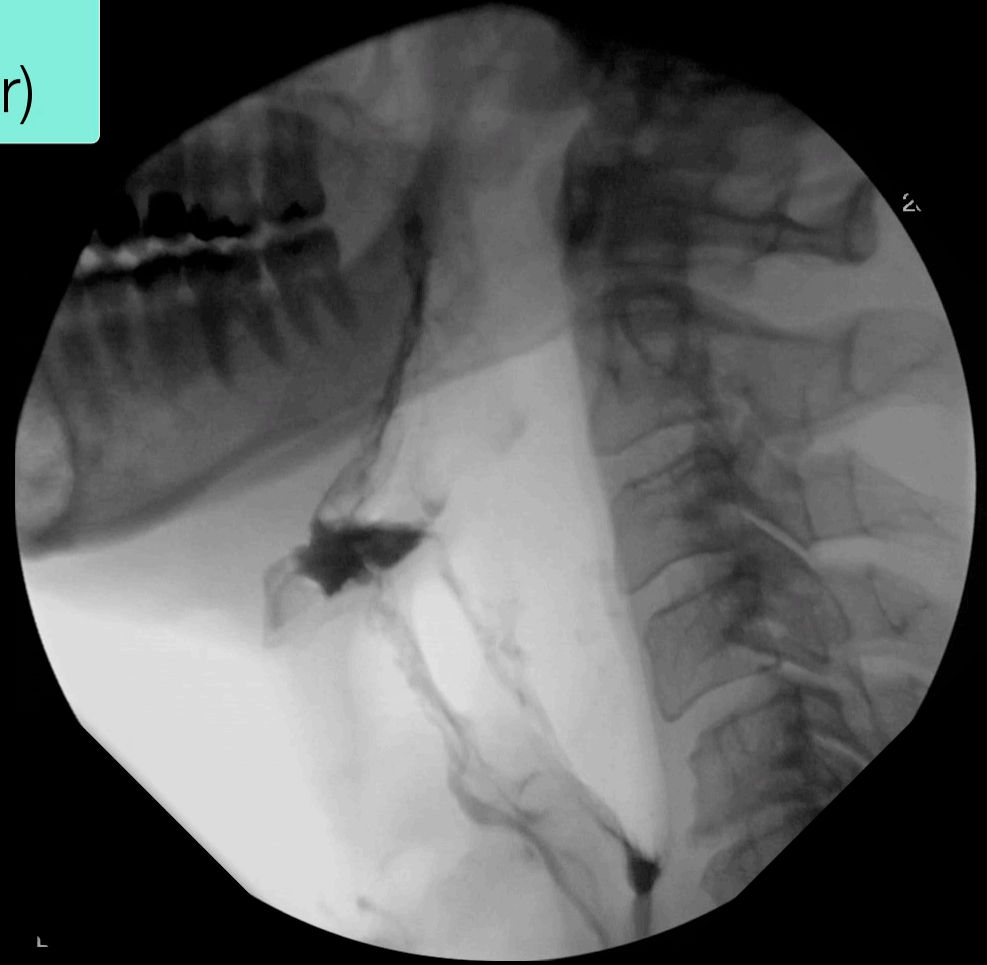
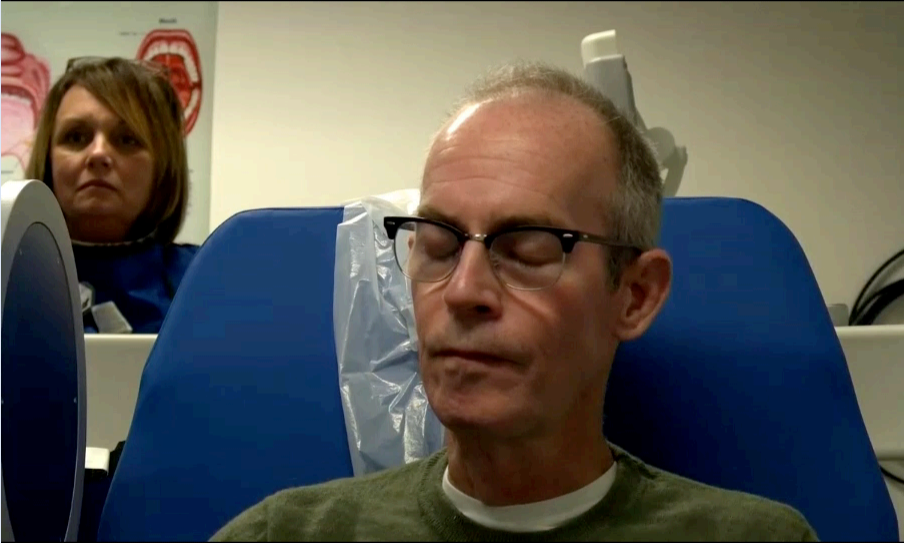
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Day 1

Day 2

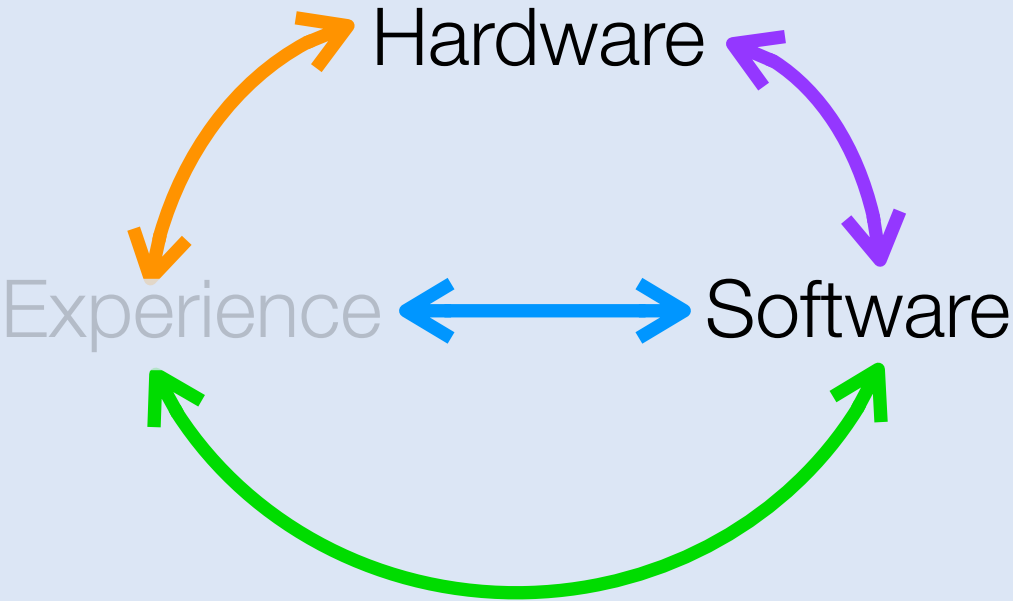


Cup sip thins
(demonstrating how he sips beer)



Sooo.... was swallowing the best treatment for swallowing???

No way to tell!



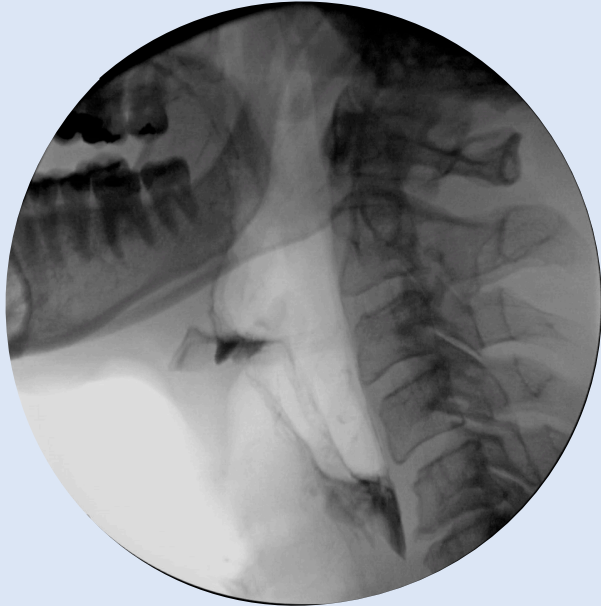
NPO 1yr 4 months

Visit 1
July 2017



Eating, drinking
for 6 months

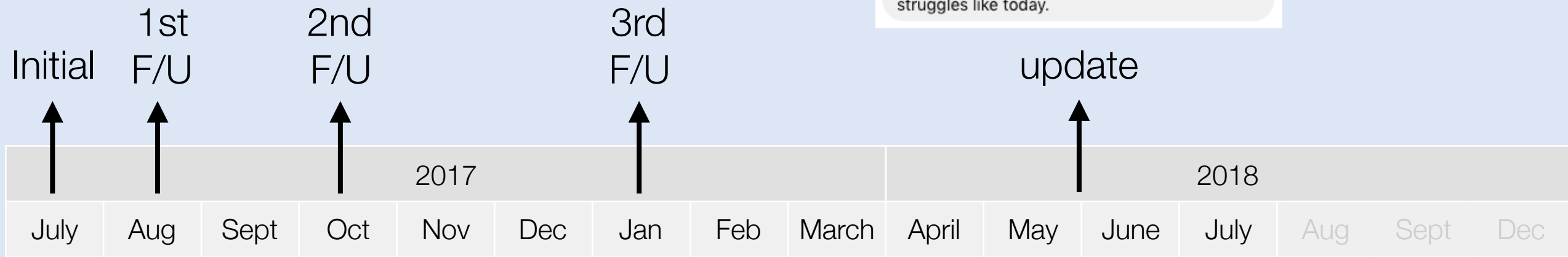
Visit 1
Jan 2018



Dysphagia Awareness Month
(June 2018)

Permission to use his voice in video





Wish I was more poetic than it sucks. But please feel free to use it. I owe you so much more

Can you believe I don't carry a cup around. Today I took my four pills orally and last night ate in front of friends at cookout. Dr. Chheda does great work. For me, every day is a battle some good like yesterday and some are struggles like today.

GIVE HOPE!

Reflections on Living with a Swallowing Disorder



Down
the
Hatch

Deglutition Talk with
Ianessa Humbert &
Alicia Vose

Response to GIVE HOPE!



Special Guest
Ed Bice M.Ed., CCC-SLP

Down
the
Hatch

Deglutition Talk with
Ianessa Humbert &
Alicia Vose