Vocal fold hydration: Current knowledge and Future directions

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Research Goals

• To identify factors that increase a speaker’s susceptibility to voice disorders?
• To target these factors for prevention and treatment?

Pathogens
Pollutants
Surface drying
Medication
Voice use
Reflux
Systemic drying
Background noise
# Hydration

## Current Knowledge & Future Directions

Central Tenet
Optimal hydration is needed for healthy voice

## "Optimal Hydration"

- Mainstay of all vocal hygiene programs
- Avoid dehydration
  - Mouth breathing, reduced water intake, low humidity, caffeine, alcohol, medication
- Increase hydration
  - Nose breathing, increase water intake, humidity treatments

## Several questions remain

- Optimal hydration of what?
  - Body  Vocal folds
- How does water get to the vocal folds?
  - Vascular  Lymphatic  Neural
- How much hydration is optimal?
  - 8 glasses  12 glasses  3 hrs of humid air?
- What is a healthy voice?
  - Reduced fatigue?
  - Increased endurance?
  - Increased frequency range?
- Should everyone hydrate?
  - Gender, age, occupation?
Why does this matter?

- Challenging to comply with hydration recommendation
- Scientific basis remains unsubstantiated

Hydration

Current Knowledge?

Body hydration

- Maintained with food and fluid intake
- Under temperate conditions maintained within ~ 0.2% over 24 hours.
- Total body water ~ 61% of body weight
- Water loss: kidney, skin, airway, digestive tract
- No consensus on potential for functional improvement with increased fluid intake in adequately hydrated individuals; Hartley & Thibault (2014)
Vocal Fold Hydration

- Maintained by fluid in different compartments
- Systemic: fluid within the vocal folds (lamina propria, muscle)
- Surface: fluid on the top, superficial

Vocal Fold Hydration

**Surface**
- More water
- Less mucus
- Maintained by ion channels, water channels, mucus glands

**Systemic**
- More water
- ↑hyaluronan, ↑protein spacing
- Maintained by blood supply
Vocal Fold Hydration

- Important for maintaining biomechanical properties
  - Viscous and elastic properties
- Dehydration should increase viscoelasticity
- Hydration should decrease viscoelasticity
- This relation holds for excised tissue
- But what about human subjects?

↓Hydration
- Mouth breathing
- Caffeine
- Dry air

↑Hydration
- Nose breathing
- Water
- Mucolytics

↓Hydration and Caffeine

Akhtar et al. (1999)
- 12 healthy subjects
- Male and female
- 250mg pure caffeine in tablet form
- Voice measures pre- and post-1 hour
- ↑Irregularity in fundamental frequency

Erickson-Levendoski & Sivasankar (2011)
- 16 healthy subjects
- Male and female
- Double-blinded research design
- 480mg or 24mg caffeine + vocal loading with loud reading
- Voice measures pre-, post-35 min, and post-70 min loading
- No significant change
↓Hydration with low humidity air

Hemler et al. (1997)
• 8 healthy subjects
• Equal males and females
• Inhaled ambient air in one of the following environments for 10 min:
  – low (2% ± 4%), standard (45% ± 11%), and humid (100%)
• ↑ jitter and shimmer after inhaling dry air

Patel, Walker, and Sivasankar (in press)
• 10 healthy subjects
• Males and females
• 60 min of dry air (< 11%)
• ↓ speed quotient at low pitch phonation
• No change in jitter or other voice measures

↑Hydration with water intake

Yiu et al. (2003)
• 20 amateur singers
• Males and females
• Continuous karaoke singing
  – 1 min vocal rest and 100mL water between each song
  – No vocal rest or water between songs
• Improved ability to sustain singing when provided vocal rest and hydration
• ↑ jitter after singing 10 songs when not provided vocal rest and hydration.

↑Hydration with inhaled treatments

Roy et al. (2003)
• 18 female subjects
• 2ml of each of the following treatments:
  – mannitol, water, Entertainer’s Secret Throat Relief (ESTR)
• ↓ PTP within 20min of treatment with hyperosmotic mannitol.

Tanner et al. (2007)
• 60 vocally healthy females
• 15 min laryngeal desiccation (<1% RH) followed by treatment
  – nebulized isotonic saline, saline, water, no treatment
• ↑ PTP after laryngeal desiccation in all subjects
• ↓ effort after laryngeal desiccation
• ↔ PTP or PPE after any treatment
↑ **Hydration with breathing mode**

- 36 healthy females (20 vocally normal and 18 vocal fatigue)
- Exposure to one of the following challenges at 35% ± 3%:
  - 15 min of oral breathing or 15 min of nasal breathing
- Greater ↑ in PTP and PPE after oral breathing (fatigue > control)
- ↓ PTP with nasal breathing (controls > vocal fatigue)

Sivasankar & Erickson-Levendoski (2012)
- 63 healthy adults (32 vocally normal and 31 with fatigue)
- 15 min of mouth breathing at low (< 30%) or high (> 50%) during:
  - Reading, Exercise, Alone
- ↑ in PTP after reading and exercise

↑ **Hydration with humid air**

Vintturri et al. (2003)
- 80 vocally healthy individuals
- Males and females
- Three 45 min reading sessions; break, two 45 min reading sessions:
  - 65% ± 5% ambient air and water; 25% ± 5% ambient air and no water
- ↑ symptoms of dry mouth and throat and
- ↑ fatigue of neck, shoulders, and back, in low as compared to high humidity.

Erickson-Levendoski, Sundarrajan, Sivasankar (2014)
- 40 individuals (20 vocally normal, 20 reporting vocal fatigue)
- Males and females
- 2 hours of mouth breathing in low and high humidity
- ↑ PTP after low humidity challenge that reversed after high humidity
Hydration and Fatigue

Solomon et al. (2000; 2003)

• 4 untrained vocally healthy females
• 2 hrs loud reading in counterbalanced order
  – high humidity day (five 16-oz bottle of water/day)
  – low humidity day (one 16-oz bottle of water/day)
• ↑ PTP in low as compared to high hydration condition in 75% of subjects.

• 4 untrained vocally healthy men
• 2 hrs loud reading in counterbalanced order
  – high humidity day (five 16-oz bottle of water/day)
  – low humidity day (one 16-oz bottle of water/day)
• ↑ PTP in low as compared to high hydration condition in 50% of subjects.

Hydration and Illness

Fisher et al. (2001)

• 8 subjects with end-stage renal disease/controls
• Males and females
• Single-subject reversal design
• Voice measurements repeated at either 1.0 L or 0.5 L fluid removal intervals.
• ↑ phonation threshold pressure after 3%-4% reduction in body fluid volume in 4/6 subjects.

Tanner et al. (2013)

• 11 female subjects with primary Sjogren syndrome
• Double-blinded research design
• 15 minute desiccation challenge (<1% relative humidity)
• ↑ phonation threshold pressure, vocal effort, and dryness ratings

Hydration and Voice Disorders

Verdolini-Marston et al. (1994)

• 6 female subjects with vocal nodules or vocal polyps
• 5 days of hydration/placebo treatments in counterbalanced order
  – Hydration: eight 16-oz glasses of water, one teaspoon of mucolytic expectorant three times/day and exposure to 90% relative humidity for 2hr/day
  – Placebo treatment
• Greater ↓ in PTP, PPE, and jitter following hydration treatment as compared to placebo treatment.
Hydration Summary

• Excised tissue research
  – Dehydration is detrimental to vocal function
  – Hydration is beneficial to vocal function

• Human subject research
  – Data are variable
    • Homeostatic mechanisms
    • Vascular, neurological, endocrinal input

Which hydration treatment should I recommend?

• Increase water intake?
• Humidify ambient air?
• Encourage nose breathing?

• What is the underlying mechanism:
  – Systemic? Surface?
• Am I targeting this mechanism?
• Referral to specialist?

Which hydration treatment should I recommend?

• Assess on a case-case basis
• One answer does not fit all
  – C/O sleep apnea: humidifier
    : 8 glasses of water
    : nose breathing

  – C/O heavy caffeine drinker: ↑water consumption
    : humidifier

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  – C/O heavy caffeine drinker: ↑water consumption
    : humidifier
Future Directions

• Develop a model to test hydration/dehydration
  – Accurate model for testing
  – Animal model
    • Do not produce voice on command
    • Limited vocal range
• What mechanism is changing and why?
• Neural input? Perception?
• What is the interaction between all the variables:
  – Reflux, benign lesions, voice use

Thank you!

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