Moisture, Wax, Bugs & Things

Doing Combat with the Ear Canal

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Topics

- Physiology
- Flora
- Cerumen
- Moisture
- Solutions?

Physiology of the External Ear Canal

- The Enemy
  - ✓ Heat
  - ✓ Humidity
  - ✓ Moisture from physical activity
  - ✓ Lack of ventilation of ear canal
  - ✓ Shape
  - ✓ Cerumen
  - ✓ Naturally occurring organisms

Available Literature

- Fabricant, ND, Kolb, LW: External auditory canal and lobule temperature. *Arch Otolaryngol 1961; 74:430:122*
- Bruner, RC, House LR: Thermodynamics of the external auditory canal. *Annals Otol Rhinol Laryngol* 1967;76:9
- Bailey, JW, Valente, M.: Measurements of Relative Humidity & Temperature in Hearing Aids. *The Hearing Journal* 1996; 49 (10): 59-63.
- Agnew, J: Temperature and RH Inside an ITE Hearing Instrument. *The Hearing Journal*, 9/99
- Medical literature related to Pathology

Impact of Climate

- Diffuse otitis externa
  - Swimmer's ear
  - Hot-weather ear
  - Hong Kong & Singapore ear
  - Increased presence especially notable in tropical and subtropical zones (chronic)
- Moisture through condensation due to *changes* in temperature.
- Perspiration a personal issue.

Bugs, Bugs, & More Bugs!

- Saint Louis University School of Medicine's division of audiology conducted a 8/00 study. 10 custom hearing aids were sampled at random. Presence of moderate bacterial growth on 10 of 10 hearing aids and moderate fungal growth on three.
- Staphylococci (various)
- Diptheroids
- Streptococci (various)
- Pseudomonas (various)
- Acinetobacter iwoffii
- Enterobacter cloacae

Clinical Options

- Germicidal wipes such as AudioWipes®.
- Alcohol
- UV light

Germicidal Lamps

- Not sunlamps or “black light” lamps
- Short wave low pressure mercury vapor tubes produce UV wavelengths lethal to micro-organisms.
- 95% of the energy is at 254 nm
  (billionth of a meter)
- Highly lethal to virus, bacteria, and mold spores

How UV Works

- Destroys the nuclei of flora
- Function of time, distance, energy, and temperature
- Dose = time * energy

  t = 480 seconds

35° C (95°F) yields 93% efficiency
40° C (104°F) yields 100% efficiency

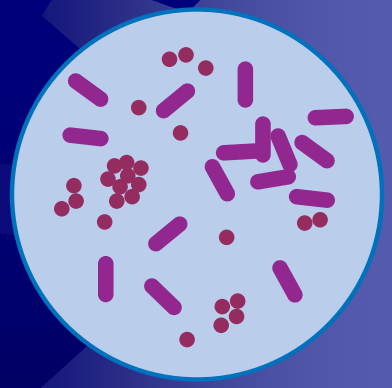
How Much UV is Required?

Effective resistance of micro-organisms to UV varies considerably.

UV (joules per sq meter) needed for 90% kill:

- Pseudomonas aeruginosa 55
- Staphylococci (various) 18-26
- Streptococci (various) 20-62
- Mold Spores 50-1400

(99.99%: multiply by 5 or more)



Research Study Evaluates Effectiveness

- Peter Stephens, M.D., Iowa pathologist, conducted the study over a three month period, using Dry & Store®. Pathology includes chemistry, blood, microbiology.

- Dosage:

  Dry & Store Professional 662.4 j/m^2

  Dry & Store Global >1,000 j/m2

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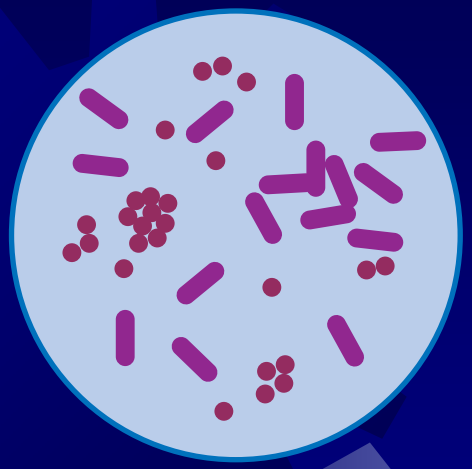
Microbiology



- Bacteria, viruses, fungi
- Bacteria is tiny: use 1K microscope to see.
- So small that there must be millions to cause cloudiness in a solution, so…
- Use MacFarland standards: estimates amount of microorganisms based on turbidity of solutions.

Methodology

- Prepared 40 microliter bacterial suspensions of both pseudomonas and staph (~ 1 drop), placed on cover slides.
- Placed in Dry & Store overnight: solution dried.
- Used sterile swab with saline solution; wiped cover slip and put swab in nutrient medium.

Results

- Nutrient medium stayed clear on 10 out of 10 slides with staphylococcus.
  - 9 of 10 pseudomonas showed zero bacteria.
  - One pseudomonas slide was recultured with heroic scrapings; only 5 bacteria left.
- Conclusion: Dry & Store's UV cycle is lethal!

Cerumen

- Plugs up the works
- Contributes moisture
- Removal
  - **Suction**
  - **Dissolving & drying**
- Barriers: prophylactics

  Sergei Kochkin is studying these currently.
- Drying as a preventive
  - **Volume Reduction**
  - **Survey Results - 86% Yes**

Moisture - Causes

- Environmental: temperature and RH
- Mother Nature (rain)
- Perspiration
- Cerumen
- Negligence

How’s It Get Inside?

- Vapor in the air spaces
- Capillary action - condensed as liquid and wicked in.

Condensation Basics

- Vapor pressure for water in air (p)
- Saturated vapor pressure (p_{sat})
- Absolute humidity (AH)
- Relative humidity (RH)
- Dew Point (temperature)

Surface Tension

- Molecules at the surface of a liquid are more strongly attracted to those molecules in close proximity beneath the surface than to those molecules in the vapor phase.
- This inward attraction causes the surface to contract, which results in the formation of droplets and the rise of water in a capillary.
- Small diameter tubing in a hearing aid can easily act as capillaries, pulling moisture into the tube.

Impact on Hearing Aids

- Corrosion
- Switch Problems
- Failure of microphones and speakers
- Distortion
- Total failures caused by shorts, etc.
- Loss of frequency response
  - Dry & Store user survey-subjective quality
- Shortened battery life
  - Energizer study

Loss of Frequency Response

- Receivers
- Microphones
- Dual Microphones
  - Mismatch and drift (dual (now tri) omnidirectional mics)
  - Repair issues

Battery Life

- Factors to Consider
- Experience vs. Manufacturer Recommendations
- Testing
  - ETC
  - Energizer®

Drying

Laundry & Hearing Aids

Technology

- Heat
- Moving Air
- Desiccant (substance which absorbs or adsorbs)
- Surface Area

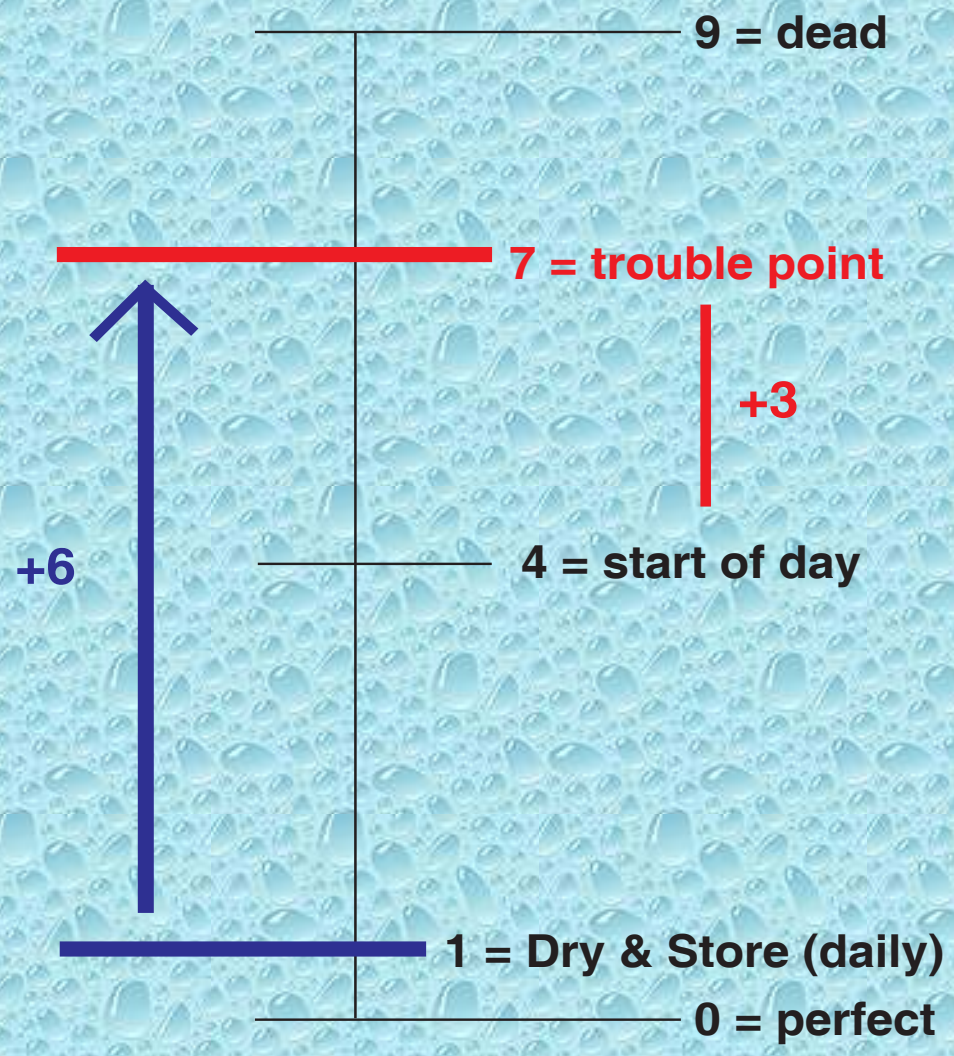
Products

- Dry Aid Kits
- Heated Boxes
- Dry & Store® Hearing Aid Conditioning System

The Threshold Reduction Concept

- Reducing the daily moisture threshold is the key element in hearing aid care.
- Mother Nature usually wins because she has a head start.

Threshold Reduction



Mother Nature Loses
You & Your Patients Win

Why Should You Care? 101

- We asked:
  - 98.9% sold because of patient satisfaction
  - 85.7% sold because of reducing failures & saving time.
  - 56.2% sold because it added value and/or increased their market position.
  - 13.2% sold because of the increased profits.

Why Should You Care? 201

Customer Satisfaction with Single and Multiple Microphone Digital Hearing Aids

Sergei Kochkin, Ph.D.
Knowles Electronics

January 9, 2001

Top ten correlates of overall satisfaction (in rank order)

1. Perceived benefit
2. Sound clarity
3. Value (price/performance)
4. Reliability
5. Use in leisure activities
6. Natural sounding
7. Use in noisy situations
8. Use in large groups
9. Use in restaurants
10. Use outdoors

Questions?

Dry & Store

THE AMAZING
get-it-drier-than-you-can-imagine,
cerumen-flaking, germ killing,
itch-ending, battery-extending,
odor-eating, and
secure-storing system
that’s easy to use.