AudGenDB: a Public, Internet-Based, Audiologic - Otologic - Genetic Database for Pediatric Hearing Research

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AudGenDB Webinar

• Overview of AudGenDB
• Live Demonstration
  – General Capabilities
  – Specific case examples
• Questions from audience
Introduction

• Pediatric hearing research integrates complex data from varying specialties, on large numbers of patients.

• Examples of such data:
  – Audiogram
  – Evoked responses (e.g. ABR)
  – Speech and language performance
  – Medical and surgical history
  – Temporal bone imaging
  – Ancillary laboratory studies
  – Clinical genetics, dysmorphology
  – Genotype for known HL genes
  – Genomic data.

• Large-scale hearing research projects would benefit from an integrated electronic database that incorporates these varied data.
Projects that could benefit from a large-scale database:

- Risk factors for hearing loss progression
- Study of rare patterns of hearing loss
- Outcomes in mild or unilateral HL
- Anatomy and genetics of inner ear malformations.
- Identification of novel genes for distinct patterns of HL
- Correlation of genotype with phenotype (audiologic data)
At The Children's Hospital of Philadelphia (CHOP), we have developed just such a database – the AudGenDB.

Our ultimate goals are to:

• create a national repository of data for tens of thousands of children from a consortium of institutions
• make it freely available to researchers worldwide
• Protect the privacy of the included subjects.
Scope of AudGenDB

• Web-based, relational database
• Automatically extracts data from the electronic medical record - Audiologic, otologic, radiologic, genetic
• All patients who have undergone audiologic testing at CHOP since 2006.
  – 37,273 children
• Intuitive, web-based interface.
• Anonymized patient information.
Data Residing in AudGenDB

Audiology
- Complete audiograms, including speech and tympanometry (>57,000)
- ABR results (16,784 datasets)
- OAE data
- Use of hearing aids, cochlear implants

Otology
- Chronic medical diagnoses, otologic diagnoses
- Surgical procedures (>22,000)*

*upcoming release
Data Residing in AudGenDB

Radiology
- Actual CT and MRI images (>1000 studies)
- Temporal bone CT and MRI reports (15,059 studies)*

Genetics
- Clinical genetic data – known genes (>1,000 patients)
- Existence of high-resolution genomic data (> 500 pts.)
- Access to raw genomic data, and links to original DNA samples.*

*upcoming release
<table>
<thead>
<tr>
<th>Category</th>
<th>Searchable Parameter</th>
<th>Example of Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic</td>
<td>Age, gender, ethnicity</td>
<td>Prelingual at diagnosis</td>
</tr>
<tr>
<td>Audiologic</td>
<td>Type of hearing loss</td>
<td>SNHL, conductive, mixed</td>
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<tr>
<td></td>
<td>Laterality/ symmetry</td>
<td>Unilateral, Bilateral, Asymmetric</td>
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<tr>
<td></td>
<td>Severity of loss</td>
<td>Mild hearing loss only, Severe-profound only</td>
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<td></td>
<td>Loss at specific frequencies</td>
<td>High frequency HL</td>
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<tr>
<td>Otologic</td>
<td>Surgical</td>
<td>Identify patients who have undergone cochlear implantation; myringotomy tubes</td>
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<tr>
<td></td>
<td>Medical</td>
<td>Bacterial meningitis</td>
</tr>
<tr>
<td>Radiologic</td>
<td>Existence of imaging</td>
<td>Identify only patients who have imaging studies available</td>
</tr>
<tr>
<td>Genetic</td>
<td>Genotype</td>
<td>SLC26A4 mutations, GJB2 heterozygotes</td>
</tr>
<tr>
<td></td>
<td>Existence of genomic SNP array data</td>
<td>Identify patients genotyped on whole-genome SNP arrays</td>
</tr>
</tbody>
</table>
Distribution of Pure Tone Average

Pure Tone Average (PTA) is between 41.2 and 120.0 and Exclude PTA's with one or more 'no response' values is equal to Yes

Has Sensorineural Loss? is equal to Yes

Unilateral/Bilateral is equal to Unilateral

Has at least one Radiology Study is equal to Yes

Age Hearing Loss Identified is between 0.0 and 2.5

Pure Tone Average is between 41.2 and 120 in either ear

Exclude PTA's with one or more 'no response' values

Add Condition
Patient-level data

P217336
White · Female

Ago: 6y, 5m

Ago: 5y, 11m

Ago: 5y, 3m

Patient record added on Dec. 8, 2009, last updated on Nov. 4, 2019
Temporal Bone Imaging

• TB CT, TB MRI, IAC MRI, brain MRI, brain CT.
• Direct viewing of original images.
  – Modified DICOM viewer
  – scrolling through image stacks, adjust contrast, zoom.
  – length measurement (<0.1 mm).

• Radiologist reports - text files*

*upcoming release
Age: 6y, 10m

CT OF THE TEMPORAL BONES [scrubbed date]

HISTORY: Sensorineural hearing loss.

COMPARISON: None.

TECHNIQUE: CT of the temporal bones acquired in the axial plane with 0.75 mm collimation images. Targeted small field of view reconstructions were obtained of each temporal bone, and coronal reformatted images.

FINDINGS: Bilateral myringotomy tubes are present. There is questionable finding of a minor abnormality involving both cochleae, with the apex appearing slightly full raising the possibility of subtle incomplete partitioning. It is unclear whether this finding is due to an actual anatomical abnormality, or perhaps due to the plane of scanning. The internal auditory canals are normal in size, as are the vestibular aqueducts bilaterally. The middle and external ear structures are normal, including the ossicular chains bilaterally.

The mastoid air cells are clear. There is incidental mucosal opacification in the left sphenoid sinus.

IMPRESSION:

No definite abnormality seen. However, there is a questionable abnormality involving the cochleae bilaterally with minimally incomplete partitioning at the apex. Correlation with audiometric testing is suggested.

70480, 76375 END OF IMPRESSION:

DD: [scrubbed date], [scrubbed time] DT: [scrubbed date], [scrubbed time]
Genetic Data

- Genotype for common HL genes – Connexin 26 and 30 (GJB2, GJB6), *Pendred (SLC26A4), *A1555G mitochondrial.
- Clinical SNP microarray results available in report form.
- Deletions or insertions (CNV) “calls” for >100 pts with SNHL*

*upcoming release
Genomic Data

• Goal: to provide access to raw genomic data (SNPs, next-generation sequencing)
• At this time, AudGenDB does yet not provide raw genomic data.
• However, flags to its existence allow the user to contact the CHOP investigator to request access to the data, or the original DNA.
A Public Data Resource

- Public release occurred in July 2011.
- Web-based. `Audgendb.chop.edu`
- Tutorials for new users.
- Access requires only a simple registration process, through the website.
- *IRB approval is not necessary.*

(Access to original DNA would require IRB approval at both institutions)
The Future

• Plans for additional data
• Data from other institutions
Plans for Additional Data

**Sooner:**
- Raw ABR and OAE data
- Genomic Data
- EKGs (tracings and reports)
- Ancillary laboratory values

**Later:**
- UNHS data
- Risk factors for SNHL (e.g., prematurity, hyperbilirubinemia)
- Outcome data
- Temporal bone analysis
Data from Other Institutions

• A central goal has been to integrate data from other pediatric hospitals.

• Facilitated by our ongoing collaborations, Vanderbilt University will be first, followed by Children’s Hospital Boston.

• We seek other institutions who wish to make their data available for future incorporation into this resource.
Conclusions

- AudGenDB represents the first large-scale database resource for pediatric hearing research.
- Contains detailed audiometric, otologic, radiologic, and genetic data - 37,000 children.
- AudGenDB is self-renewing and continually growing, as it automatically imports data monthly from the EMR.
Conclusions

• Intuitive web-based interface serves both beginner and advanced users.
• Available now to all researchers.
• AudGenDB to become multi-institutional with addition of Vanderbilt and Children’s Hospital Boston.
• We welcome additional centers to help expand this resource nationally.

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– Bryan Crenshaw  crenshaw@email.chop.edu
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  – Genetics and Otology - Margaret Kenna MD - Boston
  – Medical Informatics - John Pestian PhD – Cincinnati

• LaunchDM, LLC – website development

• Judy Gravel, Ph.D. (1948-2008), whose leadership at the outset of the project ensured its success.