BigMouth: A multi-institutional dental data repository

Muhammad F Walji, PhD
Outline

• Demonstration of BigMouth
• Data Governance (how to contribute and access)
• Data Standardization in Dentistry
• Examples of Research Projects using BigMouth
• Dental Quality Measurement
BigMouth

- BigMouth contains data from six dental schools
- BigMouth allows non-technical users to query the axiUm data
- Data available - Demographics, Diagnosis, Procedures, Forms, Odontogram, Perio, Medication, Insurance, Practice
Electronic Health Records (EHRs)

- Increased adoption in dentistry
- Large amount and variety of data
- Majority of US Dental Schools use same platform
- Unstructured data
- Data collected for Treatment, Payment, Operations
- Limited standardization
  No diagnostic terminology until recently
Data in axiUm

- Patient Information – Demographics, vitals, height, weight, zip code etc.
- Dental information – Treatments, Diagnoses, Dental History etc.
- Medical information – Medical History
- Medication – Current medication, Prescription etc.
- Tooth level information – Odontogram, DMFS/ DMFT
- Periodontal Chart
- Educational – Students and Residents, Grades
- Financial – Billing, Insurance
Benefits of using EHR data for research

• Lower cost and quicker than traditional clinical research\(^1\)

• Patients rather than research subjects\(^1\)

• Data readily available
  • Potential of using these resource to generate abstracts/proposals
  • Opportunity to develop scholarly portfolio

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Challenges of using EHR data for research

• Clinical notes (free text) are not readily queryable\(^1\)

• Data quality issues\(^1\)
  – Incomplete, Missing (e.g. Ethnicity)
  – Inaccurate (e.g. self reported data)
  – Inconsistent (Coding issues)

• Ethical Issues (e.g. Patient Privacy)

• Data may be idiosyncratic and may not be generalizable\(^1\)

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Welcome to the BigMouth Dental Data Repository

BigMouth is an oral health database developed from partially de-identified electronic health record data contributed by dental schools who are part of the Consortium for Oral Health Research and Informatics (COHRI). Access to the database is provided by 2b2, an open source data warehousing tool.

BigMouth contains data from five dental schools and is hosted at UTHealth | The School of Biomedical Informatics, Houston. The current participants are:

- Harvard | School of Dental Medicine
- Tufts University | School of Dental Medicine
- The University of California, San Francisco | School of Dentistry
- The University of Pittsburgh | School of Dental Medicine
- UTHealth | School of Dentistry
- Coming soon: The University of Michigan | School of Dentistry

https://bigmouth.uth.edu/
## Data in BigMouth

### # of patients

<table>
<thead>
<tr>
<th>Category</th>
<th># of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td>2,178,816</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>301,970</td>
</tr>
<tr>
<td>Procedures</td>
<td>1,223,806</td>
</tr>
<tr>
<td>Forms</td>
<td>462,001</td>
</tr>
<tr>
<td>Odontogram</td>
<td>1,903,625</td>
</tr>
<tr>
<td>Periodontal Chart</td>
<td>227,369</td>
</tr>
<tr>
<td>Prescribed Medication</td>
<td>141,613</td>
</tr>
<tr>
<td>Insurance</td>
<td>444,727</td>
</tr>
</tbody>
</table>
Geographical distribution of Patients in BigMouth
Linking Medical and Dental Records Using an eMPI

The Enterprise-wide Master Patient Index:

- A database of all patients across an organization, each assigned a unique ID.
- Matches patients across systems using “essential data”:
  - Name, Gender, Date of Birth, Race and Ethnicity, Social Security Number, Current address and Contact information
- Necessary for the maintenance of accurate demographic and clinical data


Data Availability

UTP: AllScripts - 1,234,423 patients

SOD: axiUm - 327,175

Patient overlap 44,188 patients

As of 01/17/2017
Query Tool

Query Name: UTPhysicians@17:35:46

Temporal Constraint: Treat all groups independently

Group 1
- Dates
- Occurs > 0x
- Exclude

Treat Independently

UTPhysicians

one or more of these

AND

drop a term on here

Group 2
- Dates
- Occurs > 0x
- Exclude

Treat Independently

Group 3
- Dates
- Occurs > 0x
- Exclude

Treat Independently

Run Query  Clear

1 Group

Show Query Status  Graph Results  Query Report

Number of patients

44188

For Query "UTPhysicians@17:35:46"
Query Name: Diabetes mellit@17:38:22

Temporal Constraint: Treat all groups independently

Group 1
- Diseases: Diabetes mellitus
- Occurs > 0x
- Exclude
- Temporarily Treat Independently

Group 2
- Temporarily Treat Independently

Group 3
- Temporarily Treat Independently

Result: 3837 patients for Query "Diabetes mellit@17:38:22"
Data Governance

1. Adhere to privacy and security requirements

2. Access provided to those institutions that contribute

3. Each source site retains control/ownership of contributed data

4. Project review committee approval required for use of data for specific research projects

5. Continuously assess and improve the quality of data
Data Governance 2.0

1. Adhere to privacy and security requirements

2. Access provided to researchers from non-profit institutions

3. Each source site retains control/ownership of contributed data

4. Project review committee approval required for use of data for specific research projects

5. Continuously assess and improve the quality of data
How to Access BigMouth

• Contributing Institution
  – Signup at https://bigmouth.uth.edu/

• Level 1 Access
  – Explore the data using the BigMouth Workbench

• Level 2 Access
  – Submit proposal to Research Review Committee
    • IRB Approval
  – Receive dataset to conduct analysis
    • Fill out the research data request template
How to become a Contributing Institution

• COHRI member institutions eligible

• Complete a data use agreement

• IRB approval
VISION

To be leading experts in informatics for oral health research, education, and patient care

MISSION

COHRI will:

- Create, standardize, integrate and share data using electronic health records

- Improve informatics utilization in dental education, health care, and research

- Work collaboratively to develop research projects to promote evidence based dentistry
Current Member Institutions (n = 40)

<table>
<thead>
<tr>
<th>Academic Centre for Dentistry (ACTA)</th>
<th>University of Illinois</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baylor University</td>
<td>University of Kentucky</td>
</tr>
<tr>
<td>Columbia University</td>
<td>University of Louisville</td>
</tr>
<tr>
<td>Creighton University</td>
<td>University of Michigan</td>
</tr>
<tr>
<td>Harvard</td>
<td>University of Minnesota</td>
</tr>
<tr>
<td>Indiana University</td>
<td>University of New England</td>
</tr>
<tr>
<td>LECOM Bradenton</td>
<td>University of Nevada Las Vegas</td>
</tr>
<tr>
<td>Loma Linda</td>
<td>University of Oklahoma</td>
</tr>
<tr>
<td>Medical University of South Carolina</td>
<td>University of Pacific</td>
</tr>
<tr>
<td>Meharry Medical College</td>
<td>University of Puerto Rico</td>
</tr>
<tr>
<td>Midwestern University Downers Grove</td>
<td>University of Pittsburgh</td>
</tr>
<tr>
<td>New York University</td>
<td>University of Sharjah, UAE</td>
</tr>
<tr>
<td>Nova Southeastern University</td>
<td>University of Southern California</td>
</tr>
<tr>
<td>Oregon Health &amp; Science University</td>
<td>University of Tennessee</td>
</tr>
<tr>
<td>Southern Illinois University</td>
<td>University of Texas, Houston</td>
</tr>
<tr>
<td>Temple University</td>
<td>University of Texas, San Antonio</td>
</tr>
<tr>
<td>Tufts University</td>
<td>University of Washington</td>
</tr>
<tr>
<td>University of California, San Francis</td>
<td>Virginia Commonwealth University</td>
</tr>
<tr>
<td>University of Colorado</td>
<td>West Virginia University</td>
</tr>
<tr>
<td>University of Florida</td>
<td>Willamette Dental Group</td>
</tr>
</tbody>
</table>
COHRI Resources

1. Adult medical and dental histories
2. Pediatric medical and dental histories
3. Problem list
4. Dental Diagnostic System (DDS)
5. Caries risk assessment (long + short)
6. BigMouth Dental Data Repository
Toward a Diagnosis Driven Profession 2016

By: Harvard School of Dental Medicine
So many terms.

Interface Terminology

- Clinical Usability
- Flexibility
- Common phrases
- Expressive

- Potential for nonsense terms
- Formally defined concepts
- Rigidly defined inter-relationships

USER

So many terms.

FORMAL TERMINOLOGIES
SNOMED CT

SNO Dent
Dental Diagnostic System

SNO DDS

SNO DDS GD

ANSI Approved Standard
Examples of Research Projects

The Value of Using a Dental Diagnostic Terminology in an Electronic Health Record – Kalenderian et al.

- Goal: Find patients diagnosed with moderate chronic periodontitis who received treatment according to current American Academy of Periodontology (AAP) guidelines.
- Data used: Diagnosis and Procedures

Tx for Generalized Chronic Moderate Periodontitis

- Prophy: 13%
- Perio Maint.: 4%
- Prophy & Maint.: 3%
- SR/P: 28%
- SR/P & Maint.: 15%
- SR/P & Prophy: 11%
- SR/P & PM & Prophy: 18%
- No Treatment: 18%
Efficacy and accuracy of pre-doctoral periodontal education in the US: An evaluation of the generalist and specialist teaching models on periodontal education – Ali Sajadi, DDS

- Goal: To understand the accuracy of diagnosis by analyzing clinical charting parameters and diagnostic codes by final year students
- Data used: Diagnosis
Partial-mouth periodontal examination protocol for estimation of prevalence, severity and extent of periodontitis – Tran et al.

• Goal: This project aims to identify a partial-mouth periodontal examination protocol which closely approximates a full-mouth periodontal examination protocol in estimating prevalence, severity and extent of periodontitis in population

• Data used: Perio, Forms
Association between obesity and periodontitis: Cross-sectional study on patients visiting universities' dental clinics - Tran et al.

- Goal: Evaluate perio initial exam of obese patients.
- Data used: axiUm (Perio, medical and dental history and Missing teeth) and AllScripts (Diagnosis, medical history etc.)
Statin Use is Inversely Correlated with Symptomatic Endodontic Diagnoses – Kanwal et al.

• Goal: The purpose of this retrospective study was to verify if correlations exist between endodontic diagnoses and statin use.

• Data used: Forms, Procedure
Assessment of Diagnosed Temporomandibular Disorders and Orofacial Pain Conditions by Pre-doctoral Dental Students – Adibi et al.

- **Goal**: The purpose of this study was to assess the degree to which 1) patients report signs and symptoms of TMD/OFP, 2) if pre-doctoral dental student diagnose TMD/OFP, and 3) if patients receive any treatment for TMD/OFP.

- **Data**: Forms, Procedures, Diagnosis, Provider

Implementing Dental Quality Measures in Practice

- R01, 5-Year NIH/NIDCR Grant
- UT Houston, HSDM, UCSF, WDG
- March 01 2015 – February 28 2020

1. Assess dental quality measure implementation feasibility and validity across 4 core sites.
2. Implement valid dental quality measures across all 11 sites and assess inter-site variation.
3. Develop useful and usable Dental Quality Measure dashboard views and functionality to support the interpretation of dental quality measures
What is Quality?

“The degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.”

IOM

What are Clinical Quality Measures?

• Clinical quality measures, are tools that help measure and track the quality of health care services provided

• CQM Measure:
  – health outcomes
  – clinical processes
  – patient safety
  – efficient use of health care resources
  – care coordination
  – patient engagements
  – population and public health
  – adherence to clinical guidelines
Measure domains

Clinical quality measures:

**Process**  
*Percentage of elevated caries risk patients who were prescribed a high concentration fluoride toothpaste*

**Access**  
*Percentage of elevated caries risk patients who visited a dental clinic*

**Outcomes**  
*Percentage of elevated caries risk patients who remained disease free in the past year*

**Structure**  
*Does the health care facility uses EHRs?*

**Patient Satisfaction**  
*Patient reports the dentist communicated well with him/her*

https://www.qualitymeasures.ahrq.gov/about/domain-definitions.aspx
Ten Dental Quality Measures

1. Diabetes and Annual Oral Evaluation
2. Sealants
3. Tobacco Screening and Cessation Counseling Intervention
4. Caries Risk
5. Caries Treatment
6. Caries Outcomes
7. Periodontal Risk
8. Periodontal Treatment
9. Periodontal Outcomes
What percentage of diabetics receive an annual oral examination?

**NUM**: Number of diabetics who received the following dental examination procedures: D0150, D0120 & D0180 in the measurement period

**DEN**: Dental patients, who reported having diabetes, of record in the dental clinic in the reporting year

Claims data → EHR
Approach for Evaluating DQM

1. Development of EHR query
2. Calculate sample sizes needed to review
3. 2 Reviewers independently reviewed 50 charts
4. Inter-rater reliability
5. Single review of remaining charts
6. Calculation of sensitivity, specificity, NPV, PPV and Kappa
7. Identification of why patients did not receive oral evaluation
8. Develop and evaluate improved measure
Initial EHR-Measure results:

**NUM:** How many received the following procedures: D0150, D0120 & D0180 in the measurement period

**DEN:** Dental patients of record, who reported having diabetes, in the dental clinic in the reporting year

Measure Score
- 60.3%* Manual Review
- 71.7%** Automated query
<table>
<thead>
<tr>
<th>Overall Score</th>
<th>Manual Review (n= 1,242)</th>
<th>Measure rate: 60.3% (95% CI; 58-63%)</th>
<th>( P&lt;0.001 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Query (n=12,960)</td>
<td>Measure rate: 71.7% (95% CI; 71-72%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Sensitivity | 93% (95% CI; 90.7-94.5) of the time that manual review revealed Oral Evaluation, the query identified Oral Evaluation |
| Specificity | 100% (95% CI; 100-100) of the time that the manual review did not reveal Oral Evaluation, the query did not identify Oral Evaluation |
| Positive Predictive Value | 100% (95% CI; 100-100) of the time that the query identified Oral Evaluation, the manual review revealed Oral Evaluation |
| Negative Predictive Value | 100% (95% CI; 100-100) of the time that the query did not identify oral evaluation, the manual review did not reveal oral evaluation |
Why did Diabetics Not Receive an Oral Evaluation?

- Group 1: Reasons that justified the patient being excluded from the denominator

<table>
<thead>
<tr>
<th>Group</th>
<th>Category – Reasons for Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Patients were discontinued</td>
</tr>
<tr>
<td>2</td>
<td>Edentulous</td>
</tr>
<tr>
<td>3</td>
<td>Patient reported for limited/emergency/urgent./specialist care only</td>
</tr>
<tr>
<td>4</td>
<td>Less than a year of visit</td>
</tr>
<tr>
<td>5</td>
<td>Miscoded</td>
</tr>
</tbody>
</table>

- The selection of eligible patients in the initial measure did not follow an exclusion criteria
Why did Diabetics Not Receive an Oral Evaluation?

• Group 2: Reasons that justified the patient being included in the numerator

<table>
<thead>
<tr>
<th>Category – Reasons for Inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other acceptable Periodontal care:</td>
</tr>
<tr>
<td>Adult Prophylaxis (D1110)</td>
</tr>
<tr>
<td>Periodontal maintenance (D4910)</td>
</tr>
<tr>
<td>Full mouth debridement (D4355)</td>
</tr>
<tr>
<td>Scaling and root planing of one to three teeth (D4342)</td>
</tr>
<tr>
<td>Scaling and root planing of four or more teeth (D4910)</td>
</tr>
<tr>
<td>Periodontal Chart <em>Completed or In Progress</em></td>
</tr>
<tr>
<td>Dental Procedures under <em>Planned</em> and in conjunction with the DDS terminology</td>
</tr>
</tbody>
</table>

• To include only comprehensive periodontal evaluation OR comprehensive oral evaluation OR periodic oral evaluation may underestimate the care patients received
Figure 1. Numerator and Denominator workflow for Initial and Revised EHR-Measures:

**Initial EHR-Measure**

- Age 18+ years?
- Patient of Record? (D0100-D9999)
- Reported history of diabetes?

**Denominator**

- Of patients with diabetes in the denominator
  - D0120*
    - YES
  - D0150*
    - YES
  - D0180*
    - YES

**Numerator**

*Completed procedures only

**Revised EHR-Measure**

- Age 18+ years?
- Patient of Record? (D0100-D9999)
- Reported history of diabetes?
  - D0150**
  - D0180**
  - D4342**
  - D4910**
  - D4355**
  - Perio chart **

**Denominator**

- Of patients with diabetes in the denominator

**Numerator**

**Completed procedures only**

**Procedures Completed or In Process**
Revised EHR-quality Measure scores:

<table>
<thead>
<tr>
<th>Measure Score</th>
<th>NUM</th>
<th>DEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>82.3 %*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>83.9%**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Manual review  
** Automated query
Measure rates for the Initial and Revised EHR-Measures across four sites for both automated query and manual reviews.

<table>
<thead>
<tr>
<th></th>
<th>Initial EHR measure</th>
<th>Revised EHR measure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manual Review (n= 1,242)</td>
<td>Manual Review (n= 710)</td>
</tr>
<tr>
<td><strong>Overall Score</strong></td>
<td><strong>Measure rate: 60.3%</strong>&lt;sup&gt;1&lt;/sup&gt; (95% CI; 58-63%)</td>
<td><strong>Measure rate: 82.3%</strong> (95% CI; 79-85%)</td>
</tr>
<tr>
<td></td>
<td><strong>Measure rate: 71.7%</strong> (95% CI; 71-72%)</td>
<td><strong>Measure rate: 83.9%</strong> (95% CI; 83-85%)</td>
</tr>
<tr>
<td></td>
<td><strong>P&lt;0.001</strong></td>
<td><strong>P =0.260</strong></td>
</tr>
<tr>
<td><strong>Automation</strong></td>
<td><strong>Manual Review</strong> (n=12,960)</td>
<td><strong>Manual Review</strong> (n= 13,221)</td>
</tr>
<tr>
<td><strong>Measure rate</strong></td>
<td><strong>Sensitivity: 93%</strong>&lt;sup&gt;1&lt;/sup&gt; (95% CI; 90.7-94.5)</td>
<td><strong>Sensitivity: 99%</strong> (95% CI; 98.7-100)</td>
</tr>
<tr>
<td></td>
<td><strong>Specificity: 100%</strong>&lt;sup&gt;1&lt;/sup&gt; (95% CI; 100-100)</td>
<td><strong>Specificity: 90%</strong> (95% CI; 85.0-95.2)</td>
</tr>
<tr>
<td></td>
<td><strong>Positive Predictive Value: 100%</strong>&lt;sup&gt;1&lt;/sup&gt; (95% CI; 100-100)</td>
<td><strong>Positive Predictive Value: 98%</strong> (95% CI; 96.5-99.0)</td>
</tr>
<tr>
<td></td>
<td><strong>Negative Predictive Value: 100%</strong>&lt;sup&gt;1&lt;/sup&gt; (95% CI; 100-100)</td>
<td><strong>Negative Predictive Value: 98%</strong> (95% CI; 94.8-100)</td>
</tr>
</tbody>
</table>

<sup>1</sup> - Relationship between manual and automated queries calculated with two sample test of proportions
<sup>2</sup> - Relationship between validation analysis between the adapted and revised measures calculated with two sample test of proportions.
Diabetes Dental Quality Measure Dashboard

- Patients seen at UT: 31,242
- Diabetics seen at UTSD: 1,035
- Percentage of Diabetics seen at UTSD: 8.8%

- % of Diabetics in Houston: 10.8%
- % of Diabetics in Texas: 10.9%
- % of Diabetics in USA: 9.3%

Percentage of Diabetics Evaluated - By Year

Percentage of Diabetics Evaluated - By Age

Percentage of Diabetics Evaluated - By Gender

Percentage of Diabetics Evaluated - By Race

Providers Evaluating Diabetics

Year of Oral Eval Data, 2014

Type of Evaluation by CDT Codes

CDT Code: DO120, DO150, DO180

Percentage of Diabetics Evaluated: 62.8%, 37.1%, 17.2%
Next Steps

• Scalability

• Standardization

• Sustainability

• Linking to Medical Data

• Linking to Genomic Data
BigMouth Team

**UT-Houston**
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- K Simmons
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- T Guy
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**R01DE021051** (NIDCR): A Cognitive Approach To Refine And Enhance Use Of A Dental Diagnostic Terminology

**R01DE023061** (NIDCR): A Whole Systems Approach To Implementing Standardized Dental Diagnostic Terms

**R01DE022628** (NIDCR): Developing a Patient Safety System for Dentistry

**R01DE024166** (NIDCR): Implementing Dental Quality Measures in Practice

• Thank you to our research team members!

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Questions?

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BigMouth contains data from six dental schools and is hosted at The University of Texas School of Biomedical Informatics at Houston. The current participants are:

- Harvard | School of Dental Medicine
- Tufts University | School of Dental Medicine
- The University of California, San Francisco | School of Dentistry
- The University of Pittsburgh | School of Dental Medicine
- UTHSC | School of Dentistry
- The University of Michigan | School of Dentistry
UTHealth Authentication

UT ID: mwalji
Password: ************

Login

change password | password help

WARNING! You are currently accessing a protected information resource. Unauthorized use is PROHIBITED! Usage of this system may be subject to security testing and monitoring. Misuse is subject to criminal prosecution. There is no expectation of privacy except as otherwise provided by applicable privacy laws.

privacy & security | contact | UTHealth
date last modified: July1, 2010
BigMouth Dental Data Repository / i2b2 Query & Analysis Tool

Query Tool

Query Name: Chronic-YES@22:16:56

Temporal Constraint: Treat all groups independently

Group 1

<table>
<thead>
<tr>
<th>Dates</th>
<th>Occurs &gt; 0x</th>
<th>Exclude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Periodontitis - 79092</td>
<td>Treat Independently</td>
<td></td>
</tr>
</tbody>
</table>

Group 2

<table>
<thead>
<tr>
<th>Dates</th>
<th>Occurs &gt; 0x</th>
<th>Exclude</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES - 23630</td>
<td>Treat Independently</td>
<td></td>
</tr>
</tbody>
</table>

Group 3

<table>
<thead>
<tr>
<th>Dates</th>
<th>Occurs &gt; 0x</th>
<th>Exclude</th>
</tr>
</thead>
<tbody>
<tr>
<td>drop a term on here</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Previous Queries

- Chronic-YES@22:16:56 [1-18-2017] [mwalji@uth.tmc.edu]
- Chronic-179 - Y@22:09:49 [1-18-2017] [mwalji@uth.tmc.edu]
- Prescribed Medi@17:35:22 [1-18-2017] [mwalji@uth.tmc.edu]
- Prescribed Medi@15:11:31 [12-19-2016] [mwalji@uth.tmc.edu]
- ABNORMA-Male@11:50:09 [12-16-2016] [mwalji@uth.tmc.edu]
- ABNORMA-Male@11:49:41 [12-16-2016] [mwalji@uth.tmc.edu]
- Vicodin@15:36:28 [12-9-2016] [mwalji@uth.tmc.edu]
- Vicodin@15:32:49 [12-9-2016] [mwalji@uth.tmc.edu]

Number of patients

2484

For Query "Chronic-YES@22:16:56"