



**TELEGENISYS INC.**

Research Paper On Medical Data Analysis

# Making Sense of PDF Medical Records- A Research Report

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# TABLE OF CONTENTS

EXECUTIVE SUMMARY

APPROACH & METHODOLOGY

BENEFITS

HOW PEOPLE STUDY MEDICAL RECORDS

ILLUSTRATIVE WORK MODEL

NEXT STEPS

SOLUTION



## EXECUTIVE SUMMARY

Medical data only makes sense when its ordered over timelines. Most people who develop medical chronologies attempt to time order medical data and present it in tables that are hyperlinked to medical records in order to create an audit trail of information, Our research found this woefully inadequate to provide the basis for comprehensive and rapid review of medical facts.

Speed and comprehensive review were the challenges we set out to address two years ago when this journey started. While we have built this tool to visualize medical records but, the intent of this white paper is to provide an overview of our research and challenges in constructing better chronologies.

Telegenisys reviews medical data for Insurance, Pharma, Personal Injury Law, Specialist support and Medical Research. In process of these reviews it's vital to examine data from a variety of files. Each year Telegenisys reviews several million pages of medical information for medical data extraction and summarization. While arranging and indexing medical data are important to get a time-ordered view of medical events, there are other needs.

### **Disease or injury-related treatment progression**

- Progression of medical events with the same specialist.
- Progression of medical events for similar providers

**Incidence of event types ordered over time** provides trauma, surgical interventions, radiology and labs ordered in time and easy to examine.

**Specific disease mentions using complete ICD 10 & 9** references provide a clear view of how when these diseases are mentioned in the medical record and by whom.

**Drug indexes** indicate the use of disease-associated drugs ordered over time. Examining dosage changes can develop the disease significance further bearing relevance in pharma, litigation, insurance, and treatment.

**Custom medical term indexes** allow us to track mentions of key phrases ordered over time. In case of insurance, these help us identify disease severity. For personal injury chronologies they help identify time stamp records of specific trauma and subsequent treatment. In Pharma research, we are using such custom terms to track specific disease symptoms. In genetic testing, we track specific chemical indicators of genetic mutations to help researchers react.

These are simply dimensions of looking at the time ordered medical data. In order for this volume of information to be useful, it has to be easy to use and accurate. This is what we set out to achieve. Where we are today in analyzing medical data is truly amazing.



## APPROACH & METHODOLOGY

We set out with a clear understanding that the records we receive are mostly pdfs. While some sources have sent us XML data we are used to working with records that vary greatly in quality. Other challenges we dealt with:

**Standardized data sources** to build reference data that was easy to use and everyone would understand. We turned to the US National Library of Medicine who manages the Unified Medical Language System® (UMLS®), the largest and most authoritative database of medical terminology in the world. References are built in compliance with their license and provide credibility to chronologies created by using exhaustive references.

**Hybrid or artificial intelligence:** In examining millions of pages of medical data we chose a hybrid solution to break down medical pages into medical events. The cohesive nature of the medical event definition allowed us to create a foundation for the reference model.

Initially, we organized records by hand and its indeed possible but laborious. This got us in the software business to build a solution to generate thousands of indexes/references within seconds.

To make the solution manageable we turned to Acrobat dual reference model of bookmarks and page links. Using this combination allows us to deliver rapid medical event navigation to our own data extraction teams. In addition to this medical data is delivered in an excel grid and JSON (XML) files which allow for analysis and graphic evaluation of the medical events.

As our approach and methodology developed we ended up with a massive display of data so our visualization team spent a lot of time to develop easy to follow indexes and bookmark trees that make it simple to navigate through data while understanding its relative significance to the patient/client. Spreadsheets further simplify the navigation using specialized link modules that allow our clients to navigate medical events while reviewing and sorting spreadsheet data to their own special needs.



## BENEFITS

Converting a medical record into a medical database has an incredible number of uses. At a basic level, this process unifies the medical record from doctors, hospitals, pharmacies and a wide variety of medical providers. Bringing data into one place has immense significance in any analysis of records. Other than completeness this diverse data often completes the condition assessment of the person, points to missing records and develops a cohesive view of all medical providers. While these are important, our teams have noted the following additional benefits.

**220% improvement in review team productivity** (and consequent reduction in team cost) through a rapid and comprehensive review of medical data.

### **Export and import of medical event data**

Our clients are exporting structured data from medical databases we produce to:

- *Research Systems in Genomics and Pharma research*
- *Case management / Trial software*
- *Underwriting databases*
- *Business decision systems*

**Update of medical records without having to re-examine old records:**

Often medical assessments require updated medical records over time. Using a database system allows users to add new records and immediately get an updated view of the full record.

**Unimaginable detail in mass tort or patient comparison grids:**

When patient groups need to be compared a database offers the clear advantage for data comparisons. Our life settlement clients can determine what percentage of their portfolios have diabetes or other diseases as developments in research and treatment affect patient groups.

**A Portable yet secure single file can be protected along with its data:**

By attaching the database to a unified medical record, the entire database of medical information is encapsulated and can be protected together. Since Telegenisys is an externally audited HIPAA compliant unit we are particularly careful in storage and access of protected/private health information (PHI).

**Easily safe harbor medical information by unlinking records from data:**

It is often hard to anonymize records for comparisons, research, litigation support, and other uses. Medical databases can be searched and private information can be replaced with redactions. Often companies spend a lot of time and money on this process and it becomes streamlined when using medical databases.

**Record completion assessment as every reference is exposed:**

Incomplete references show discontinuous treatment, diagnosis without resolution, date gaps. Databases allow such issues to be exposed. As an example, we recently found a mention of AAA in one obscure portion of the record. The incidence of "Abdominal aortic aneurysm" was exposed and a surgical record was obtained to complete the medical file.

**Ability to create rapid comprehension overviews:**

Medical database makes data extraction easier allowing us to create multiple views of medical data based on the use case. As an example, we have created medical overviews for research, litigation support, life expectancy evaluations, and life underwriting clients. We continue to customize views so our clients can absorb and use data more rapidly.

**Graph and visualize medical data:**

It's simple to examine medical records by frequency and type of medical events, types of medical events in a file, drug usage, etc.



## HOW PEOPLE STUDY MEDICAL RECORDS

The study of medical records presents two significant challenges we wanted to address. Expertise in the review of medical data, and easy ways to navigate large and detailed medical data sets. Both these challenges have resulted in users of medical data to look through tunnels we call summaries, abstracts, custom data extractions, chronologies, etc. In many cases these tunnels depend on the trust relationship between user and vendor. We think a modern solution must break this often risky barrier by offering full audit control of any assertion made in the data tunnel. This means being able to link assertions in these user documents directly to a certified medical professional's notes and in the context of disease or incident. The need for this link has already been felt by lawyers, underwriters and researchers looking for the source of assertions in summaries/chronologies through hyperlinks.

### Medical Data Users

In order to be useful medical data must be presented in a form that users are accustomed to while providing full attribution trail directly into the medical record. When we interviewed our users the review behavior use cases were:

- **Work with the latest medical event**, extracting past medical history (PMH), Medication Lists, social and family history, diagnosis, treatment plan. Vitals and mobility depending on use case. Typically such users move chronologically through events confirming facts and building their own presentations.
- **Review medical overview typical to their industry**. We have customized formats that deal with legal review, life expectancy, life insurance, Pharma, genome testing and others. Such special use case data is presented in summaries, overviews, and extracts.
- **Special Keyword Deep Data Probes** - We build custom index subsets for medical terms defined by researchers in life settlement, life insurance, pharma and genome testing, etc.,. These phrases allow an in-depth analysis focused on the special use cases.
- **Structured Data with external links navigation** - For users who prefer to work with spreadsheets or databases external links to medical records are important as users sort data to suit their analysis.



# ILLUSTRATIVE WORK MODEL

## Rapid Overview

A rapid overview displays

- Latest medical events with instant navigation
- Latest medical events for each type of provider
- Inventory of disease conditions
- Vitals and mobility status and history
- Instant navigation to labs and radiology arranged by date

This provides a complete picture of the patient. Some added information on insurance, emergency contacts may be important to doctors. The date range of medical records is important for legal and insurance assessments. Add those in and you have a quick overview of a medical record. In addition to this, specific use cases dealing with medical emergencies (legal & insurance) require additional deep medical record probes which create the need for an additional high-level view of records. Here is what we designed for these elements.

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[For more information click here.](#)

**Medical Record Preview**

**Name: John Doe**  
**Birth Date: 09/30/1988 Age: 30**  
**SSN: 555-555-5555**  
**Case: 23124576985421b**  
**Allergies: Motrin, Pollens, Latex**

**Emergency Contacts**  
 Daryl Hanna | 877-999-888 | Wife  
 Harry Doe | 856-777-2345 | Brother  
 Insurance  
 GLB Medical : Effective 02/12/2008  
 321 Medical Lane, Santa Barbara CA 93101  
 Ph: 800-999-8888 | Grp: DELTA2398 | Pol: 215-345T

**Medical Conditions**  
 Diseases of the circulatory system  
 I31.4 Cardiac tamponade  
 I85.0 Esophageal varices  
 I86.4 Gastric varices  
 Diseases of the digestive system  
 K59.0 Constipation  
 K74.6 Other and unspecified cirrhosis of liver  
 K76.6 Portal hypertension  
 K92.0 Hematemesis  
 K92.1 Melena  
 Diseases of the ear and mastoid process  
 H93.1 Tinnitus  
 H93.13 Tinnitus, bilateral  
 Diseases of the eye and adnexa  
 H14.12 Dry eye syndrome  
 H16.0 Corneal ulcer  
 H16.04 Marginal corneal ulcer  
 H16.041 Marginal corneal ulcer, right eye  
 Diseases of the musculoskeletal system and connective tissue  
 M19.9 Osteoarthritis, unspecified site  
 See More...

**Mobility**  
 11/10/2018 | Patient using a cane to assist.  
 10/20/2018 | Using wheelchair and walker  
 09/21/2018 | Bed confined after automotive accident  
 09/20/2018 | Automotive Accident

**Recent Vitals**  
 10/15/2018 | BP 152/87 | HR 74 | R 14 | TMP 98.6 | WT 243  
 09/11/2018 | BP 148/85 | HR 72 | R 15 | TMP 98.2 | WT 238  
 08/12/2018 | BP 132/82 | HR 68 | R 13 | TMP 98.3 | WT 236  
 05/05/2018 | BP 130/80 | HR 66 | R 14 | TMP 97.8 | WT 234  
 03/10/2018 | BP 129/79 | HR 68 | R 14 | TMP 98.6 | WT 230

**Lab Reports**  
 ORLANDO LABS [05 Jan. 2018 - Pg: 39]  
 ORLANDO LABS [04 Jan. 2018 - Pg: 40]  
 ORLANDO LABS [24 Apr. 2017 - Pg: 31]  
 ORLANDO LABS [03 Feb. 2017 - Pg: 44]  
 ORLANDO LABS [28 Dec. 2016 - Pg: 45]  
 ORLANDO LABS [03 Oct. 2016 - Pg: 46]  
 ORLANDO LABS [20 May. 2016 - Pg: 48]  
 ORLANDO LABS [12 Apr. 2016 - Pg: 37]

**Medications**  
 Endocrine  
 Glipizide  
 Thyroid  
 Musculoskeletal  
 Acetaminophen  
 Allopurinol  
 Ibuprofen  
 Respiratory  
 Albuterol  
 Hydrocortisone  
 See More.....

**Medical Providers**  
 Audiologist  
 Beth Priest, AUD  
 MARK ANDREWS AU.D.  
 ELSA KATZ, AUD  
 Dietetic Technician, Registered  
 ALDRIN DAWSON, MSA, BSN, RN  
 General Practice  
 TIMOTHY WATERMAN MD  
 In Home Supportive Care  
 KAREEMA SNOWDEN, MSN, RN  
 Internal Medicine  
 BETTINA COOPER  
 Internal Medicine - Cardiovascular Disease  
 Leung, Calvin MD  
 LOUIS A HOLLAND ADV MSA  
 VENITA RAMIREZ  
 Optometrist  
 TANIA GREEN  
 See More.....

**Medical Events**  
 20 Sep 2018 | Tommy Jones, MD | Radiology - Diagnostic Radiology  
 20 Sep 2018 | KAREEMA SNOWDEN MSN RN | Radiology - Diagnostic  
 20 Jan 2018 | TIMOTHY WATERMAN MD | General Practice

**Radiology**  
 9/9/20/2018 | MRI of Lumbar Spine & Hip | Pg. 35  
 9/9/20/2018 | MRI of Abdomen | Pg. 38  
 9/9/20/2018 | X-Ray Lumbar Spine | Pg. 37

**Navigation:** Home, Print, Export, User Guide, Telegenesis

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## Classical Medical Events Lists Ordered By Time

We found the easiest way to incorporate navigation elements, is to present our medical database as a user spreadsheet. This allows users to sort events, diseases, drugs, and specialized custom deep probes in any way. Linking from all toolsets to the medical record pages was vital so we developed external linking modules. We added enough information so users can trim what they do not require to create client reports.

Such indexes should be ordered by timestamps rather than date stamps so the chronologies are accurate. Tiered attribution must be followed to fully document when a nurse writes on behalf of the doctor. Similarly, accuracy and microscopic resolution of events are fundamental to the mission of accurate chronologies.

[Our version of this report - Click Here](#)

### What Provider Indexes can tell you?

The most complete database of medical providers lists over 5 million providers along with their specialties (taxonomy) and contact information. This database is the National Plan & Provider Enumeration System maintained by US Department of Health And Human Services.

When you examine medical events based on specialties you get a clear view of who the patient sees most often. Consider what it says if the most frequent providers are related to hospice along with oncologists. When presented correctly, this data is not only enlightening but necessary to get a complete view of the patient.

For legal use cases, it is important to know if the person offering the opinion does indeed have qualifications in the area that the opinion is offered.

[For our version of Provider Type and Provider Indexes click here.](#)

### Significance of Event Type References

When a list of surgeries is important or time-lined biopsy results are required, event types provide the solution. Ambulance and Triage reports provide a time-ordered view of incidents. Event type references provide a new dimension to medical information that not only provides information inside an event but the pattern of events leading up to an incident or the current state of the patient.

[For our version of event type indexes click here.](#)

### ICD10 & 9 Disease Indexes

The chronological view of events is important, yet disease indexes are vital to understanding disease progression and related conditions over time. Without disease indexes, a user must examine each record and depend on the memory of each previous event reviewed to form an opinion. Disease indexes allow a user to travel through the timeline as the disease progressed and codependent conditions began to appear.

## **ICD10 & 9 Disease Chronology (Contd.)**

This is not only vital to treatment but also to the development of notes which often accompany medical indexes.

[For our version of disease indexes, click here.](#)

## **Using Drug Indexes**

Drug indexes offer a timeline of drugs being used to treat the patient. Date range display when the drug was first prescribed and changes in prescribed dosage over time. This information is important in medication-related injury claims, in the analysis for pharma drug development and in understanding drug interactions during treatment.

[For our version of drug indexes click here.](#)

## **Deep Custom Probes**

Perhaps the strongest capability of chronological presentation is in custom probes. We have built special phrases for birth neurological disorders, insurance risk factors, life settlement ratable conditions, and co-morbidity assessments, personal injury terms, and many other use cases. In each case, these deep probe chronologies provide a rapid understanding of the medical data from the perspective of the specific use case.

[For examples of such deep-probe reports click here](#)

## **Some special Use Case indexes we generate**

Legal Cases  
Life Settlement  
Life Insurance  
Healthcare  
Pharmaceutical Industry  
Genomics

# CONCLUSION

Medical record reviews and medical data presentations can be substantially improved by responding to the needs of users. Medical databases facilitate multiple views and a more granular presentation allowing a user to move rapidly through the data to gain the information required for their needs. Hyperlinks, custom views and overviews are necessary components of modern medical record indexing because they improve the efficiency and comprehension of a medical record presentation.

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