REDUCING DIAGNOSTIC ERROR

THROUGH A SYNOPTICALLY BASED ELECTRONIC HEALTH RECORD

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1. Describe how predefined synoptic organization of clinical data aids in diagnostic interpretation 2. Recognize the theoretical basis for synoptically organized clinical elements as the means of attaining a more accurate diagnosis
3. Explain how linking configurable standardized clinical values to each Synoptic Clinical Element eases capture of critical diagnostic information

SITUATION

Safe affordable health care requires accurate and timely diagnosis. Effective diagnosis requires building a knowledge structure that provides a means for establishing an hypothesis [Differential Diagnosis] and to test the hypothesis to arrive at the one or more likely causes of the patient's illness. Unfortunately, today's **eHR**'s recapitulate conventional paper-based charts providing a limited, chronologic view of clinical data by type such as progress notes, laboratory results, and radiologic studies unrelated to epidemiologic data and reliable Medical Decision Points [**MDP**'s].

The result?

Ineffective, incomplete, and untimely correlation of clinical information towards the rendering of one or more accurate diagnoses.

PROBLEM

How do we integrate general medical knowledge and patient clinical data most effectively to:

RISK: → **Maintain patient safety**
QUALITY: → **Minimize pain and discomfort**
UTILITY: → **Maximize efficiency and minimize cost**

Through accurate, timely diagnosis?

SOLUTION

If properly designed and automated, the capabilities provided by advanced relational database management systems [**RDMS**] would allow the clinician to avoid many diagnostic errors related to:

➡ Incomplete clinical information
➡ Disorganized test and procedural results unconnected to patient problems
➡ Nonstandard qualitative and quantitative representation of critical diagnostic data

All of which create a barrier to application of appropriate clinical knowledge, prior probability, and logical deduction in arriving at the correct diagnosis.

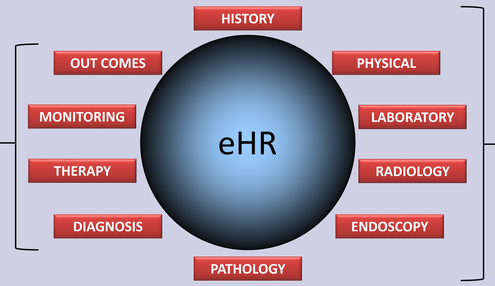
IMPLEMENTATION

My company is in the process of developing and testing a **Clinical Tracking System** [**CTS**] utilizing a Relational Database Management System implementing a completely synoptic approach to structuring all clinical data and allowing for associative linking.

This approach has resulted in a model tracking system utilizing a set of predefined, **Synoptic Clinical Elements** [**SCE**] that optimizes data entry, retrieval, and presentation while providing an optimal means for the application of analytical methods to reduce errors in diagnosis. This model system can be scaled up for application as a full fledged **eHR** with the option to include process management features, diagnostic criteria, and standards of practice through configuration management. Displayed on the right is a simplified data structure showing a single clinical encounter to illustrate the basic concept.

SIMPLIFIED OVER VIEW OF SYNOPTIC STRUCTURE AND FUNCTION

The eHR must integrate a large volume of disparate information to allow the clinician to apply diagnostic criteria effectively



At the same time the eHR must provide the means of applying The Scientific Method to assure the diagnosis is accurate

All **Synoptic Headings** and their attached Clinical Elements generating during the workup of the **CLINICAL PROBLEM** can subsequently be linked to the **DIAGNOSIS LIST** and then linked back to Therapeutic Elements for follow up check that the diagnosis is accurate and treatment effective.

CLINICAL PROBLEM LIST

#	PROBLEM	TYPE	STATUS
1	Sore Throat	ACUTE	CLOSED
2	Leg Injury	ACUTE	CLOSED
3	Acute Abdomen	ACUTE	CLOSED
4			
5			

eHR SECTIONS & SYNOPTICS

DIAGNOSIS LIST

#	DIAGNOSIS	TYPE	STATUS
1	Strep Throat	DX	CLOSED
2	Leg Fracture	DX	CLOSED
3	Acute Appendicitis	DX	CLOSED
4			
5			

1 HISTORY– ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
1.1	Chief Complaint	QD	Onset of abdominal pain x 24 hours
1.2	History of Complaint	QT	See Attached Text
1.3	Review of Systems	QT	See Systems Sub-synoptic
1.4	Family History	QT	Non-contributive
1.5	Risk Factors	QT	Smoking

PREDEFINED HEADINGS FOR PHYSICAL SECTION

2 PHYSICAL : PREDEFINED HEADINGS

#	ELEMENT	TYPE	DEFAULT VALUE/STATE
1.1	Head & Neck	QD	
1.2	Thorax	QD	
1.3	Abdomen	QD	
1.4	Groin	QD	
1.5	Etc…	QD	

2 PHYSICAL – ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
2.1	Head & Neck	QT	Unremarkable
2.2	Thorax	QT	Unremarkable cardiac and pulmonary examination
2.3	Abdomen – RLQ	QT	1.3.1 Point 1.3.5 Rebound
2.4	Groin	QT	Unremarkable

PREDEFINED SYNOPTIC ELEMENTS -ABDOMEN HEADING

2 PHYSICAL : PREDEFINED SYNOPTIC CLINICAL ELEMENTS

#	ELEMENT	TYPE	DEFAULT VALUE/STATE
1.3.1	Pain	QD	Point
1.3.2	Pain	QD	Diffuse
1.3.3	Pain	QD	Stabbing
1.3.4	Pain	QD	Radiating
1.3.5	Pain	QD	Rebound

A global set of predefined **Synoptic Headings for each section of the eHR** can be defined and assembled into a collection of predefined Synoptic Headings specific to each clinical situation . This provides a means of establishing a prioritized set of tasks related to the presenting complaint or condition of the patient.

Predefined **Clinical Elements** can be linked to one or more related **Clinical Headings**. This allows for the establishment of standardized terminology for application of diagnostic criteria as well as to allow for the collation of clinical data across many patients to validate diagnostic criteria and/or to develop new diagnostic criteria that appear to be more accurate or cost effective.

3 VITAL SIGNS/TELEMETRY – ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
3.1	Weight	MC	79.5 KG
3.2	Height	MC	178 CM
3.3	Blood Pressure	MC	115/75
3.4	Pulse	MC	100 / MIN ↑
3.5	Temperature	MC	39º C ↑

4 RADIOLOGY– ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
4.1	CT Scan Abdomen	QD	Consistent with Acute Appendicitis
4.2			
4.3			
4.4			
4.5			

5 LABORATORY – CLINICAL PATHOLOGY– ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
5.1	WBC []	MC	15,500
5.2	Neutrophils	MC	70% ↑
5.3	Bands	MC	15% ↑
5.4	Hematocrit []	MC	45%
5.5	Hemoglobin []	MC	15 GM

6 THERAPY – SURGERY– ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
6.1	Appendectomy	QT	Serosal inflammation of appendix [T]
6.2			
6.3			
6.4			
6.5			

6 LABORATORY – ANATOMIC PATHOLOGY– ASSEMBLED SYNOPTIC ELEMENTS

#	SYNOPTIC ELEMENT	TYPE	VALUE/STATE
7.1	Specimen	QD	APPENDIX, ABDOMEN, APPENDECTOMY
7.2	Gross Description	QT	Dull indurated serosal surface [T]
7.3	Microscopic Description	QT	Mucosal ulceration and neutrophils [T]
7.4	Microscopic Diagnosis	QD	Acute gangrenous appendicitis
7.5			

EXAMPLE ELEMENT TYPE LIST

CLINICAL ELEMENT TYPE LIST

#	TYPE	ABBR
1	Boolean	BL
2	Metric - Continuous	MC
3	Metric – Discrete	MD
4	Metric - Ranked	MR
5	Qualitative – Descriptive	QD
6	Qualitative – Textual	QT

Clinical Elements can be assigned a type to facilitate data extraction, statistical analysis, and application of diagnostic logic.

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COST BENEFIT ANALYSIS

The design and implementation of a brand new data structure and user interface for an **eHR** is a costly endeavor that presents us with numerous risks. However, the present breed of **eHR**'s do not afford any significant gains over paper-based systems; yet, demand a considerable cost in administrative overhead.

Therefore, in the long run, we accrue growing benefits from a properly designed **eHR** based on advanced synoptic and associative database technology that pays back all costs and then pays enormous dividends going forward to our patients benefit, our hospitals, and our society. It achieves this by dramatically reducing the cost of healthcare through efficient accurate and timely diagnostic efforts.

EXAMPLE

To the left is a simplified data model for an **eHR** with example work up of an acute abdomen that yields a diagnosis of acute appendicitis leading to confirmation on surgical removal and pathology review. This simplified model includes four core data entry tables:

➡ Table of **PROBLEMS** that link to the traditional eHR **SECTIONS**
➡ Table of **eHR SECTIONS** that link to a set of **SYNOPTIC HEADINGS**
➡ Table of **SYNOPTIC HEADINGS** linked to a set of **SYNOPTIC CLINICAL ELEMENTS**
➡ Table of **DIAGNOSES** linked back to all **SCE's** critical to the diagnostic criteria

This hierarchical organization can be easily queried using **SQL** to allow all **SCE**'s to be displayed as the clinician requires for diagnostic interpretation regardless of section or heading. This can be extended to collate across multiple problems and/or diagnoses.

To provide automation in data entry and standardization in data retrieval and diagnostic analysis there are five tables of Predefined Data Elements [**PDE**] including:

⇨ Table of predefined **PROBLEMS** that generate traditional **eHR SECTIONS**
⇨ Table of predefined **eHR SECTIONS** that generate a set of **SYNOPTIC HEADINGS**
⇨ Table of predefined **SYNOPTIC HEADINGS** linked to a set of predefined **SYNOPTIC CLINICAL ELEMENTS** that act as a pick list for completing each **HEADING** entry
⇨ Table of predefined **DIAGNOSES** linked back to all **SYNOPTIC CLINICAL ELEMENTS** critical to the diagnostic criteria that can be automatically searched and any diagnosis achieved by **SYNOPTIC CLINICAL ELEMENTS** generated returned to the clinician for examination and further workup as necessary
⇨ Table of **THERAPEUTIC ELEMENTS** that can be linked to any of the above table entries for treatment of clinical state [e.g. electrolyte imbalance] or actual causative disorder [such as CLL]

CONCLUSION

The utilization of a Linear Synoptic Database Structure [**LSDS**] throughout the **eHr** creates a highly organized system that allows for:

➡ Predefining data to be captured
➡ Predefining data entry results for automatic entry while still allowing free text
➡ A means of linking data into clusters associatively
➡ Providing a reliable means of analyzing results across patients
➡ Directing the diagnostic process to greatest advantage

This provides the means of establishing a rigorous process by which diagnostic criteria can be validated in actual clinical practice on any one or on all patients as well as identifying which physicians and/or differential diagnosis engines are most effective.