

ClinicalPath: a Visualization tool to Improve the Evaluation of Electronic Health Records in Clinical Decision-Making – Supplemental Material

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Abstract— This document contains supplemental material for the article “ClinicalPath: a Visualization tool to Improve the Evaluation of Electronic Health Records in Clinical Decision-Making”.

1 DATA REQUIREMENTS

To explore the ClinicalPath system, the data must contain a set of requirements to fulfill the proposed visualization. The most important are:

- A list of tests containing the collection date, name of test, acronym, test result, and the patient identification;
- A list of reference values for each test, to create the normal, low/high, and very low/high categorization;
- A list of meta-information for each patient, such as sex and age;
- A list containing the category or type of test to create the test ordering process.

2 TABLES OF TEST LISTS

Table 1. Test list part I.

Acronyms	Description
covid_iga	detection of SARS-CoV2 by IgA, = 1 if true else 0
covid_igm	detection of SARS-CoV2 by IgM, = 1 if true else 0
covid_igg	detection of SARS-CoV2 by IgG, = 1 if true else 0
covid_per	detection of SARS-CoV2 by PCR, = 1 if true else 0
covid_soro	detection of SARS-CoV2 by ECL, = 1 if true else 0
covid_iga_num	SARS-CoV2 IgA antibodies (AU/mL)
covid_igm_num	SARS-CoV2 IgM antibodies (AU/mL)
covid_igg_num	SARS-CoV2 IgG antibodies (AU/mL)
covid_soro_num	SARS-CoV2 ECL immunoassay index (AU/mL)

Table 2. Test list part II.

Acronyms	Description
aPTT	activated partial thromboplastin time (s)
AT	antithrombin activity (%)
eGFR	estimated glomerular filtration rate (mL/min/1.73m ²)
ESR	erythrocyte sedimentation rate (mm/h)
HCT	hematocrit [erythrocytes i.e. red blood cells] (%)
MCH	mean corpuscular [erythrocyte] hemoglobin (pg)
MCHC	mean corpuscular hemoglobin concentration (g/dL)
MCV	mean corpuscular volume (fL)
MPV	mean platelet volume (fL)
PLT	platelet count (/mm ³)
PT	prothrombin time (s)
PT%	normalized prothrombin time (PT/INR)
RBC	erythrocyte [red blood cell] count ($\times 10^6/\text{mm}^3$)
RDW	erythrocyte size distribution width (%)
TT	thrombin time (s)
WBC	leucocyte [white bool cell] count (/mm ³)
basophil#	basophil count (/mm ³)
basophil%	percentage of basophils (%)
eos#	eosinophil count (/mm ³)
eos%	percentage of eosinophils (%)
lymphocyte#	lymphocyte count (/mm ³)
lymphocyte%	percentage of lymphocytes (%)
monocyte#	monocyte count (/mm ³)
monocyte%	percentage of monocytes (%)
neutrophil#	neutrophil count (/mm ³)
neutrophil%	percentage of neutrophils (%)

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Table 3. Test list part III.

Acronyms	Description
ALP	alkaline phosphatase (U/L)
ALT	alanine [glutamic-pyruvic] transaminase (U/L)
AST	aspartate [glutamic-oxaloacetic] transaminase (U/L)
BILC	conjugated bilirubin (mg/dL)
BILU	unconjugated bilirubin (mg/dL)
Ca	calcium (mmol/L)
Ca⁺⁺	ionized calcium (mmol/L)
Ca⁺⁺F	post-filter ionized calcium (mmol/L)
Cl⁻	serum chloride (mEq/L)
CRP	C-reactive protein (mg/dL)
cTnI	cardiac troponin I (ng/mL)
D-D	D dimer (ng/mL)
GGT	gamma-glutamyl transferase (U/L)
Hb	serum hemoglobin (g/dL)
HbA1c	Hemoglobin A1C (mmol/mol)
HCO₃⁻	serum bicarbonate (mmol/L)
hs-cTnT	high-sensitivity cardiac troponin T (ng/mL)
IL-6	interleukin 6 (pg/mL)
IL-10	interleukin 10 (pg/mL)
K⁺	serum potassium (mEq/L)
LDH	lactate dehydrogenase (U/L)
Na⁺	serum sodium (mEq/L)
NT-proBNP	N-terminal brain natriuretic peptide precursor (pg/mL)
PCT	procalcitonin (ng/mL)
pH	venous blood pH
PTH	parathyroid hormone (pg/mL)
TBIL	total bilirubin (mg/dL)
TNF	tumor necrosis factor alpha (pg/mL)
TSH	thyroid-stimulating hormone (μU/L)
albumin	albumin (g/dL)
cholesterol	total cholesterol (mg/dL)
creatinine	creatinine (mg/dL)
ferritin	ferritin (μg/L)
fibrinogen	fibrinogen (mg/dL)
globulin	globulin (g/dL)
glucose	glucose (mg/dL)
protein	total protein (g/dL)
urea	serum urea (mg/dL)

3 TEST CATEGORIZATION

Table 4. Test categorization and the acronyms of the test – Part I

Test Category	Acronyms
Red Series Hemogram	RBC
Red Series Hemogram	Hb
Red Series Hemogram	HCT
Red Series Hemogram	MCV
Red Series Hemogram	VCM
Red Series Hemogram	MCH
Red Series Hemogram	MCHC
Red Series Hemogram	RDW
White Series Hemogram	WBC
White Series Hemogram	basophil#
White Series Hemogram	basophil%
White Series Hemogram	eos#
White Series Hemogram	eos%
White Series Hemogram	lymphocyte#
White Series Hemogram	lymphocyte%
White Series Hemogram	monocyte#
White Series Hemogram	monocyte%
White Series Hemogram	neutrophil#
White Series Hemogram	neutrophil%
Hemogram - Platelets	PLT
Medium Platelet Volume	MPV
Liver Function / Coagulation Factors	aPTT
Liver Function / Coagulation Factors	AT
Liver Function / Coagulation Factors	PT
Liver Function / Coagulation Factors	TT
Liver Function / Coagulation Factors	ALP
Liver Function / Coagulation Factors	ALT
Liver Function / Coagulation Factors	AST
Liver Function / Coagulation Factors	BILC
Liver Function / Coagulation Factors	BILU
Liver Function / Coagulation Factors	PT%
Liver Function / Coagulation Factors	D-D
Liver Function / Coagulation Factors	fibrinogen
Liver Function / Coagulation Factors	GGT
Liver Function / Coagulation Factors	TBIL
Liver Function / Coagulation Factors	albumin
Liver Function	eGFR
Liver Function	creatinine
Liver Function	urea

Table 5. Test categorization and the acronyms of the test – Part II

Test Category	Acronyms
Ion Evaluation	Ca
Ion Evaluation	Ca++
Ion Evaluation	Ca++F
Ion Evaluation	Cl-
Ion Evaluation	HCO3-
Ion Evaluation	K+
Ion Evaluation	Na+
Ion Evaluation	pH
Cardio Evaluation	cTnI
Cardio Evaluation	cTnT
Cardio Evaluation	NT-proBNP
Inflammatory Evaluation	CRP
Inflammatory Evaluation	PCT
Inflammatory Evaluation	ESR
Inflammatory Evaluation	globulin
Inflammatory Evaluation	IL-6
Inflammatory Evaluation	IL-10
Inflammatory Evaluation	TNFa
Inflammatory Evaluation	LDH
Endocrine Evaluation	glucose
Endocrine Evaluation	HbA1c
Endocrine Evaluation	TSH
Endocrine Evaluation	PTH
General Evaluation	cholesterol
General Evaluation	ferritin
General Evaluation	protein
COVID	covid_pcr
COVID	covid_iga
COVID	covid_soro
COVID	covid_igg
COVID	covid_igm

4 QUESTIONNAIRE FROM USER EVALUATION

Table 6. Background and experience questions.

Acronyms	Background and experience questions
BQ1	How old are you?
BQ2	What is your gender?
BQ3	How many years of experience do you have in the field of medicine in general?
BQ4	Do you have any medical specialization? If yes, which one?

Table 7. Three basic questions not requiring medical knowledge. Correct answers are marked in bold.

Acronyms	Question description
SQD	Open the ClinicalPath system and choose patient 268138 to view the Clinical path. In the red series blood count category, select the Serum Hemoglobin (HB) test and answer the following questions:
SQ1	On 11/13/2019, what was the result of this test? Choices: 13,1; 10,6 ; 18,1; 19; 9,3.
SQ2	On 01/02/2020, in which value range was the result of this test in agreement with the visualization? Choices: Very low; low; normal ; high; very high.
SQ3	Deselect the HB test and select the HCM test. According to this patient's entire history, the result of this test was always: Choices: Normal ; abnormal; changes over time; this patient did not perform this test.

Table 8. Five advanced questions containing a fictional patient's medical history (four multiple-choice and one open question). The possible answers for AQ1 – AQ4 are: Yes; no; I don't know. The correct answers were Yes, Yes, No, Yes for AQ1, AQ2, AQ3, and AQ4 respectively.

Acronyms	Question description
AQD	In the ClinicalPath system, go to "Open" in the upper left corner and select patient 1591522 and read the clinical history. <i>Clinical history of the patient:</i> Patient MRS, 36 years old, puerperal, in the 15th Postoperative after cesarean, at the present date (10/01/2020) comes to the emergency room with complaints of fatigue, feelings of fainting or pressure drop, reporting skin sensation hot, and have observed slight red vaginal bleeding. On physical examination: eupneic in Ambient Air, blood pressure: 85x60, respiratory frequency: 26, heart rate: 110, St O2: 94%, axillary temperature: 99.5 fahrenheit. Abdomen: flaccid, slightly painful on palpation, especially in the lower quadrants, surgical wound reddened at the edges, with a small area of drainage of seropurulent secretion. Without too many particularities. Read only the tests requested in the questions to solve them. Based on the the history presented, review the tests requested in the system, and answer:
AQ1	When evaluating the blood counts from 10/01/2020 to 10/05/2020, is it possible to infer that there is a possibility of late puerperal hemorrhage, with significant drops in Hb and Ht? (late puerperium: 11th day to 42nd day postpartum)
AQ2	Analyzing the white blood cell count (WBC), do you believe it is possible to be facing an infection resulting from the assistance offered in a hospital environment?
AQ3	Evaluate the results of PLT, aPTT, and PT% in the mentioned period, do you agree that, in case there is active bleeding or important inflammatory disorder, these did not impact the clotting mechanisms of this patient?
AQ4	Analyzing the results of Urea and Creatinine in the period from 10/01/2020 to 11/24/2020, knowing that antibiotic therapy was used, is it plausible to say that there was an acute renal failure and that it was solved?
AQ5	Based on the tests and the history presented, do you think it is possible to create other diagnostic hypotheses or identify relevant changes for this patient that are not included in the previous questions? If yes, name some that you consider relevant, and discuss how did you found them.

Table 9. Likert-scale-based questions to evaluate the user preference of the system, along with an open question to justify the choices. The five options of the 5-Likert-scale are: Strongly Disagree, Disagree, I don't know, Agree and Strongly Agree.

Acronyms	Question description
LQD	According to your opinion about the system, rate using a 5-Likert-scale according to the level of agreement of the sentence:
LQ1	The interface and usability of ClinicalPath is intuitive.
LQ2	ClinicalPath is efficient and would optimize my time.
LQ3	ClinicalPath is easy to use.
LQ4	It's easy to learn how to use ClinicalPath.
LQ5	Leave a comment on your perception of the ClinicalPath system with regard to the above items.

Table 10. A mix of multiple choices and open questions to collect the users' feedback about the system.

Acronyms	Question description
FQD	According to your opinion, answer the questions about your feedback of the system.
FQ1	Have you ever tried to do analyzes similar to those performed on the tasks described in the experiment? (Yes or No choice)
FQ2	Did you gain insights or come to new conclusions from your exploration of the system? (Yes or No choice)
FQ3	In your opinion, what are the most useful visual aids offered by ClinicalPath? (Open question)
FQ4	What other visual aids do you think could be useful if incorporated into the ClinicalPath system? (Open question)