

New interfaces to established methods for exploration and analysis of longitudinal healthcare data

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Introduction

Large healthcare databases are becoming available, but there is a paucity of tools to allow exploration and analysis without extensive programming. Our goal was to develop a tool to facilitate the interactive exploration and analysis of longitudinal healthcare data. The tool called Empirica Healthcare is able to work with a variety of data models, including the OMOP CDM and data from OSIM2, and provides facilities to visually explore data and perform risk-outcome analysis using established models.

Exploration and Analysis Options

- Data browser enables quick retrieval of patients matching specified criteria and the creation of patient cohorts for analysis.
- Descriptive analysis types include:
 - drug utilization
 - outcome characterization
 - risk-outcome analysis
- Evaluative analysis (model fitting) include:
 - Poisson regression
 - Cox proportional hazards
 - Logistic regression
 - High-dimensional propensity scores

Case Study: Risk-Outcome Analysis based on OSIM2 Simulated Data

OSIM2 was used to generate simulated data for 10 million patients. Two signals were “injected” for the drug Ciprofloxacin and the outcomes: acute myocardial infarction, and cardiac arrhythmia (known associations). Patients exposed to ciprofloxacin prior to signal injection were used as a comparator. The two associations were analyzed using Poisson regression, Cox proportional hazards, Logistic regression, and Propensity scores.

Cohort selection

DEMOG Criteria

Age group: 00-04, 05-17, 18-24, 25-34, 35-44, 45-54, 55-64, >65

Gender: F, M

Total patients: --

DIAGNOSIS Criteria

Condition name: Acute myocardial infarction (56,180)

Total patients: 56,180

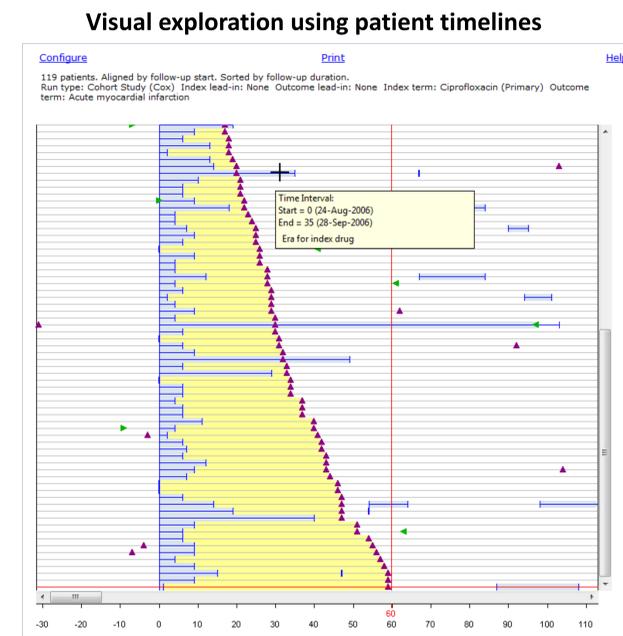
DRUG Criteria

Generic name: Ciprofloxacin (724,370)

Total patients: 724,370

Patients meeting all criteria: 12,028

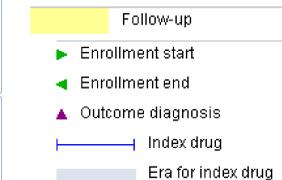
~700K patients exposed to ciprofloxacin, ~56k patients experienced MI, ~12K patients with drug and event



Interactive multi-patient timeline. Here showing time to onset.

OSIM2 signal generation parameters

DRUG_CONCEPT_ID	1797513 (ciprofloxacin)
CONDITION_CONCEPT_ID	312327 (Acute MI)
RELATIVE_RISK	316999 (Cardiac arrhythmia) 2
OUTCOME_RISK_TYPE	first exposure
OUTCOME_ONSET_DAYS_MIN	0
OUTCOME_ONSET_DAYS_MAX	60
OUTCOME_ONSET_DAYS_MAX_TYPE	start
ACCUMULATIVE_RISK_ALPHA	NULL
OUTCOME_DELAY_DAYS_MIN	0
OUTCOME_DELAY_DAYS_MAX	0



Cox proportional hazards model coefficients for the ciprofloxacin-MI association

Model with Main Effects Only

Estimated relative risk close to simulation parameter (RR=2)
RR by age shows that risk increases with age

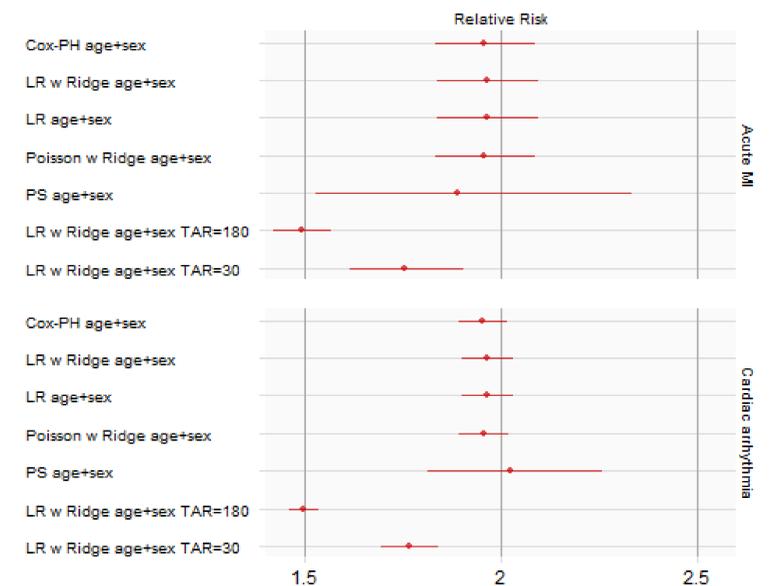
Response	Predictor	Coeff	SE	Z Score	P Value	RR	RR_025	RR_975
Acute myocardial infarction	Ciprofloxacin (Primary)	0.672296	0.033101	20.310499	0	1.95873	1.835688	2.090018
Acute myocardial infarction	AGEGRP(Custom):0-9	-0.563237	0.032052	-17.572876	0	0.569363	0.534696	0.606277
Acute myocardial infarction	AGEGRP(Custom):10-19	-0.387482	0.035096	-11.040569	0	0.678764	0.633643	0.727097
Acute myocardial infarction	AGEGRP(Custom):20-29	-0.242881	0.033661	-7.215504	0	0.784365	0.734287	0.837858
Acute myocardial infarction	AGEGRP(Custom):65+	0.737262	0.028053	26.281375	0	2.090205	1.978383	2.208347
Acute myocardial infarction	SOURCE_GENDER_CODE:M	0.203277	0.026918	7.551624	0	1.225412	1.162436	1.291799

Interaction model finds smaller effects of Cipro for oldest age group

Model with Main Effects Plus Interactions with Primary Index Term

Response	Predictor	Coeff	SE	Z Score	P Value	RR	RR_025	RR_975
Acute myocardial infarction	AGEGRP(Custom):65+	1.030045	0.044534	23.129305	0	2.801191	2.567055	3.056682
Acute myocardial infarction	Ciprofloxacin (Primary)*AGEGRP(Custom):10-9	0.14191	0.067444	2.104117	0.035368	1.152473	1.00977	1.315344
Acute myocardial infarction	Ciprofloxacin (Primary)*AGEGRP(Custom):10-19	-0.051605	0.073993	-0.697431	0.485533	0.949704	0.821496	1.097921
Acute myocardial infarction	Ciprofloxacin (Primary)*AGEGRP(Custom):20-29	-0.031813	0.06926	-0.459325	0.646001	0.968688	0.845726	1.109528
Acute myocardial infarction	Ciprofloxacin (Primary)*AGEGRP(Custom):65+	-0.272467	0.054882	-4.964615	0.000001	0.761498	0.683839	0.847978
Acute myocardial infarction	Ciprofloxacin (Primary)*SOURCE_GENDER_CODE:M	0.006012	0.053913	0.11151	0.911212	1.00603	0.905149	1.118154
Acute myocardial infarction	SOURCE_GENDER_CODE:M	0.326546	0.044142	7.397639	0	1.386172	1.271286	1.511439

Model comparison for ciprofloxacin-MI/cardiac arrhythmia



Cox-PH, LR, and the Poisson models produce similar estimates. HDPS results in wider CIs. Time at risk (TAR=30/60/180) appears to be the most influential parameter

Perform cohort study using the following model:

Poisson regression
 Logistic regression Use high-dimensional propensity scores
 Cox proportional hazards

Use ridge regression

Configuration: OMOPDEMO1_ALL [Browse](#)

Specify primary cohort:
 Select patient group: Ciprofloxacin Patients [Browse](#)

Specify comparison cohort:
 Restrict to patient group: Ciprofloxacin Comparator Patients [Browse](#)

Start of analysis period (mm/dd/yyyy): 12/31/2001

End of analysis period (mm/dd/yyyy): 12/31/2007