

Analyzing Healthcare Data with MAV-clic: Example Case Studies

Supplementary Material: “MAV-clic: Management, Analysis and Visualization of Clinical Data”

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Analyzing Healthcare Data with MAV-clic: Example Case Studies

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Abstract

Healthcare data includes information about patient life style, medical history, visits to the practice, lab tests, imaging test, diagnoses, medications, surgical procedures, genomics profile, consulted providers and claims. Adequate and analytic access to the health care data has potential to revolutionize the field of medicine by improving the quality and transition of care, and developing better understanding of biological mechanisms and modelling complex biological interactions by integrating and analyzing knowledge in a holistic manner. To fulfill the growing interests in implementing the health information system, MAV-clic is developed to satisfy the requirements of data owners as well as data users in the healthcare system. As the multi-database management system, it can benefit for the data owners to manage huge database from multiple sources in a centralized manner. The data having different contents, formats, styles, sizes, structures can be extracted and transformed into the normalized format and stored into the MAV-clic system with High performance computing technology. The well-organized data management features allow for data users to analyze the complex, disparate healthcare data. Analytics process in MAV-clic can help building the cohort in terms of demographic information, and time information as well as generating evidence using analytics of the patient's information along with diagnoses, medications, laboratory results. MAV-clic also offers the customized functions, which can explore the quality measures of the hospital using the EHR database, visualize the patterns of the analyzed results, and report the summary in an automated and timely manner. In this manuscript we describe the potential of MAV-clic by analyzing healthcare data and explaining with some example case studies.

Here, we present an example to calculate measure “Diabetes Poor Control (CMS 122)”. It consists of 11 events based steps. Measure criteria consists of following elements:

72 • ICD Codes: E13 & E11 & E10 & O24 (and all available relevant to these)

74 Numerator:

- HbA1c Laboratory Tests > 9

76 Time interval:

- 7 days interval

E13 && E11 && E10 && O24

79

80

Step 2: Diabetes Poor Control (CMS 122)

Age: 18~ 74

MAV-Click Measurement Analyzer || Feb 20, 2018 4:25:16 PM

Clinical Data Analysis | Measurement Analysis | Report Generation

☒ Auto ETL ☐ Click ☐ Practice ☐ Refresh ☒ Disconnect

Date: ☐ 24 Hr ☐ 7 Days ☐ 30 Days ☐ 365 Days ☒ Customize Job 11, 2018 Job 17, 2018 Patients New All

☒ Age 17 75 ☐ Marital Status ☐ Single ☐ Married ☐ Divorced ☒ All Gender ☐ Male ☐ Female ☒ All Veteran ☐ Veteran ☐ Non ☒ All

Region: Street: City: County: State: Country: Zip:

☐ Language: English ☐ Race: American Indian or Alaska Native ☐ Religion: African Meth Episcopal Zion ☐ Smoker: ☐ Smoker ☐ Non ☒ All

Summary Results Population Patients Visits Diagnosis Medications Diagnoses-Codes Providers Practices Enterprises

Diagnoses: 326

diagnosis	diagnosis	icd9cm_co	description	alt_diag_co	alt_diag_co	recall_letter	auto_recall	legacy_dia	delete_ind	note	created_by	modified_by	create_tm	modify_tm	row_tmst	user_des
7193C8FC...	E13.00	E13.00	Oth diab ...						N	20	20	20	2015-07-1...	2015-07-1...		[B@1d4fb...
7193C8FC...	E13.01	E13.01	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@1d83...
7193C8FC...	E13.10	E13.10	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@7b0da...
7193C8FC...	E13.11	E13.11	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@232eb...
7193C8FC...	E13.21	E13.21	Other spe...						N	20	20	20	2015-07-1...	2015-07-1...		[B@43401...
7193C8FC...	E13.22	E13.22	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@63f19...
7193C8FC...	E13.29	E13.29	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@62933...
7193C8FC...	E13.311	E13.311	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@34ebc...
7193C8FC...	E13.319	E13.319	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@773b9...
7193C8FC...	E13.321	E13.321	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@187d0...
7193C8FC...	E13.3211	E13.3211	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@63235...
7193C8FC...	E13.3212	E13.3212	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@9c9afdc
7193C8FC...	E13.3213	E13.3213	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@228b4...
7193C8FC...	E13.3219	E13.3219	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@3cb62...
7193C8FC...	E13.329	E13.329	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@45193...
7193C8FC...	E13.3291	E13.3291	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@1eacdc
7193C8FC...	E13.3292	E13.3292	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@7948...
7193C8FC...	E13.3293	E13.3293	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@748db...
7193C8FC...	E13.3299	E13.3299	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@78e58...
7193C8FC...	E13.331	E13.331	Oth diab ...						N	20	20	20	2015-07-1...	2015-07-1...		[B@2f24a...
7193C8FC...	E13.3311	E13.3311	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@72e8e...
7193C8FC...	E13.3312	E13.3312	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@6bcb4b...
7193C8FC...	E13.3313	E13.3313	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@3f628...
7193C8FC...	E13.3319	E13.3319	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@356a8...

Measure: 1:Diabetes Version: Save Diagnoses Codes Get Diagnoses Codes

Prepared, designed and developed by Asst. Prof. Dr. Zouheir AHMED at the University of Connecticut Health Center (UConn Health), USA.

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Step 3: Diabetes Poor Control (CMS 122)

Date 02-11-2018 to 02-17-2018

MAV-Click Measurement Analyzer || Feb 20, 2018 4:25:16 PM

Clinical Data Analysis | Measurement Analysis | Report Generation

☒ Auto ETL ☐ Click ☐ Practice ☐ Refresh ☒ Disconnect

Date: ☐ 24 Hr ☐ 7 Days ☐ 30 Days ☐ 365 Days ☒ Customize Job 11, 2018 Job 17, 2018 Patients New All

☒ Age 17 75 ☐ Marital Status ☐ Single ☐ Married ☐ Divorced ☒ All Gender ☐ Male ☐ Female ☒ All Veteran ☐ Veteran ☐ Non ☒ All

Region: Street: City: County: State: Country: Zip:

☐ Language: English ☐ Race: American Indian or Alaska Native ☐ Religion: African Meth Episcopal Zion ☐ Smoker: ☐ Smoker ☐ Non ☒ All

Summary Results Population Patients Visits Diagnosis Medications Diagnoses-Codes Providers Practices Enterprises

Diagnoses: 326

diagnosis	diagnosis	icd9cm_co	description	alt_diag_co	alt_diag_co	recall_letter	auto_recall	legacy_dia	delete_ind	note	created_by	modified_by	create_tm	modify_tm	row_tmst	user_des
7193C8FC...	E13.00	E13.00	Oth diab ...						N	20	20	20	2015-07-1...	2015-07-1...		[B@1d4fb...
7193C8FC...	E13.01	E13.01	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@1d83...
7193C8FC...	E13.10	E13.10	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@7b0da...
7193C8FC...	E13.11	E13.11	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@232eb...
7193C8FC...	E13.21	E13.21	Other spe...						N	20	20	20	2015-07-1...	2015-07-1...		[B@43401...
7193C8FC...	E13.22	E13.22	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@63f19...
7193C8FC...	E13.29	E13.29	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@62933...
7193C8FC...	E13.311	E13.311	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@34ebc...
7193C8FC...	E13.319	E13.319	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@773b9...
7193C8FC...	E13.321	E13.321	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@187d0...
7193C8FC...	E13.3211	E13.3211	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@63235...
7193C8FC...	E13.3212	E13.3212	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@9c9afdc
7193C8FC...	E13.3213	E13.3213	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@228b4...
7193C8FC...	E13.3219	E13.3219	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@3cb62...
7193C8FC...	E13.329	E13.329	Oth diab...						N	20	20	20	2015-07-1...	2015-07-1...		[B@45193...
7193C8FC...	E13.3291	E13.3291	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@1eacdc
7193C8FC...	E13.3292	E13.3292	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@7948...
7193C8FC...	E13.3293	E13.3293	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@748db...
7193C8FC...	E13.3299	E13.3299	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@78e58...
7193C8FC...	E13.331	E13.331	Oth diab ...						N	20	20	20	2015-07-1...	2015-07-1...		[B@2f24a...
7193C8FC...	E13.3311	E13.3311	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@72e8e...
7193C8FC...	E13.3312	E13.3312	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@6bcb4b...
7193C8FC...	E13.3313	E13.3313	Oth diab...						N	341	341	341	2016-09-2...	2016-09-2...		[B@3f628...
7193C8FC...	E13.3319	E13.3319	Oth diab ...						N	341	341	341	2016-09-2...	2016-09-2...		[B@356a8...

Measure: 1:Diabetes Version: Save Diagnoses Codes Get Diagnoses Codes

Prepared, designed and developed by Asst. Prof. Dr. Zouheir AHMED at the University of Connecticut Health Center (UConn Health), USA.

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Step 4: Diabetes Poor Control (CMS 122)

Find patients

MAV-Clc Measurement Analyzer || Feb 20, 2018 4:25:16 PM

Clinical Data Analysis | Measurement Analysis | Report Generation

☒ Auto ETL ☐ Click ☐ Practice ☒ Disconnect

Date: ☐ 24 Hr ☐ 7 Days ☐ 30 Days ☐ 365 Days ☒ Custom ☒ All

☒ Age ☐ Marital Status ☐ Single ☐ Married ☐ Divorced ☒ All ☐ Gender ☐ Male ☐ Female ☒ All ☐ Veteran ☐ Veteran ☐ Non ☒ All

Region: Street: City: County: State: Country: Zip:

☐ Language: ☐ Race: ☐ Religion: ☐ Smoker ☐ Smoker ☐ Non ☒ All

Summary | Results | Population | Patients | Visits | Diagnosis | Medications | Diagnoses-Codes | Providers | Practices | Enterprises

Diagnoses: 326

diagnosis_id	diagnosis	icd9cm_co	description	alt_diag_co	alt_diag_co	recall_letter	auto_recall	legacy_dia	delete_ind	note	created_by	modified_by	create_tm	modify_tm	row_timestamp	user_des
7193C8FC...	E13.00	E13.00	Oth diab ...						N		20	20	2015-07-1...	2015-07-1...		@0144fb...
7193C8FC...	E13.01	E13.01	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@061d83...
7193C8FC...	E13.10	E13.10	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@0790da...
7193C8FC...	E13.11	E13.11	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@0232ab...
7193C8FC...	E13.21	E13.21	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@043401...
7193C8FC...	E13.22	E13.22	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@063f19...
7193C8FC...	E13.29	E13.29	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@062933...
7193C8FC...	E13.311	E13.311	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@034abc...
7193C8FC...	E13.319	E13.319	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@0773b9...
7193C8FC...	E13.321	E13.321	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@01870d...
7193C8FC...	E13.3211	E13.3211	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@063235...
7193C8FC...	E13.3212	E13.3212	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@09c8afdc
7193C8FC...	E13.3213	E13.3213	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@0228b4...
7193C8FC...	E13.3219	E13.3219	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@03c362...
7193C8FC...	E13.329	E13.329	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@045193...
7193C8FC...	E13.3291	E13.3291	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@01eac8c
7193C8FC...	E13.3292	E13.3292	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@0799ab...
7193C8FC...	E13.3293	E13.3293	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@0748db...
7193C8FC...	E13.3299	E13.3299	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@078e58...
7193C8FC...	E13.331	E13.331	Oth diab...						N		20	20	2015-07-1...	2015-07-1...		@02f24a...
7193C8FC...	E13.3311	E13.3311	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@0728e6...
7193C8FC...	E13.3312	E13.3312	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@06b6cb...
7193C8FC...	E13.3313	E13.3313	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@03fe28...
7193C8FC...	E13.3319	E13.3319	Oth diab...						N		341	341	2016-09-2...	2016-09-2...		@0356a8...

Measure: Version:

Report generated and developed by Asst. Prof. Dr. Shashank JAIN at the University of Connecticut Health Center (UConn Health), USA.

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Step 5: Diabetes Poor Control (CMS 122)

Patients

MAV-Clc Measurement Analyzer || Feb 20, 2018 4:35:20 PM

Clinical Data Analysis | Measurement Analysis | Report Generation

☒ Auto ETL ☐ Click ☐ Practice ☒ Disconnect

Date: ☐ 24 Hr ☐ 7 Days ☐ 30 Days ☐ 365 Days ☒ Custom ☒ All

☒ Age ☐ Marital Status ☐ Single ☐ Married ☐ Divorced ☒ All ☐ Gender ☐ Male ☐ Female ☒ All ☐ Veteran ☐ Veteran ☐ Non ☒ All

Region: Street: City: County: State: Country: Zip:

☐ Language: ☐ Race: ☐ Religion: ☐ Smoker ☐ Smoker ☐ Non ☒ All

Summary | Results | Population | Patients | Visits | Diagnosis | Medications | Diagnoses-Codes | Providers | Practices | Enterprises

Patients: 392

first_office	last_office	next_office	pharmacy	pharmacy	default_loc	privacy_level	suppress	preferred_p	financial_d	site_id	guar_hy
20120502	20180214		EB10DE02...			N				000	P
20100701	20180212		78888E03...			N				000	P
20180212			8C0D0A41...			N				000	P
20180214			PCECC087...			N				000	P
20180215			61DPEC50...	4EC06851...		N				000	P
20180214			0711401F...			N				000	P
20180131			E8050A8B...			N				000	P
20180216			8A4515C6...	4EC06851...		N				000	P
20110811	20180214		4EC06851...	09E3F49F...		N				000	P
20180216			E5E0A30F...			N				000	P
20170130			9408F802...			N				000	P
20120711	20180215		89D0847D...			N				000	P
20101022	20180205		FEB3EAD8...			N				000	P
20130523	20180214		70B20D00...			N				000	P
20100930	20180214		9FD442F4...			N				000	P
20110402	20180201		2A2F8537...			N				000	P
20120927	20180216		9388C820...			N				000	P
20180214			88D8C7FD...			N				000	P
20110405	20180216		E5E0A30F...			N				000	P
20101214	20180215		609C4A86...			N				000	P
20180215			5898793F...			N				000	P
20180215			C0419862...			N				000	P
20121214	20180213		83AEAF4...			N				000	P
20180212			ASCAE6C...			N				000	P
20180214			24160C80...			N				000	P
20120327	20180212		721370D4...			N				000	P
20100309	20180214		721370D4...	8C65FDB8...		N				000	P

Report generated and developed by Asst. Prof. Dr. Shashank JAIN at the University of Connecticut Health Center (UConn Health), USA.

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Step 7: Diabetes Poor Control (CMS 122)

Get patients checked for Hb A1c > 9

MAV-Clic Measurement Analyzer ||| Feb 20, 2018 4:41:49 PM

Tab: **Report Generation**

☐ Adult - Sinusitis Medicine prescribed within last days >= 10 ☐ Show all medications

☐ High Risk Elderly Patients Prescribed medicine quantity >= 2

☒ Diabetes - Hemoglobin A1c ☒ Hemoglobin level >= 9

☐ Lab test ☐ Range >= 0 ☐ Range <= 0

Count: 12

msg_conf	seg_id	obr_seq_n	obr_value_type	obs_id
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10

Count: 72

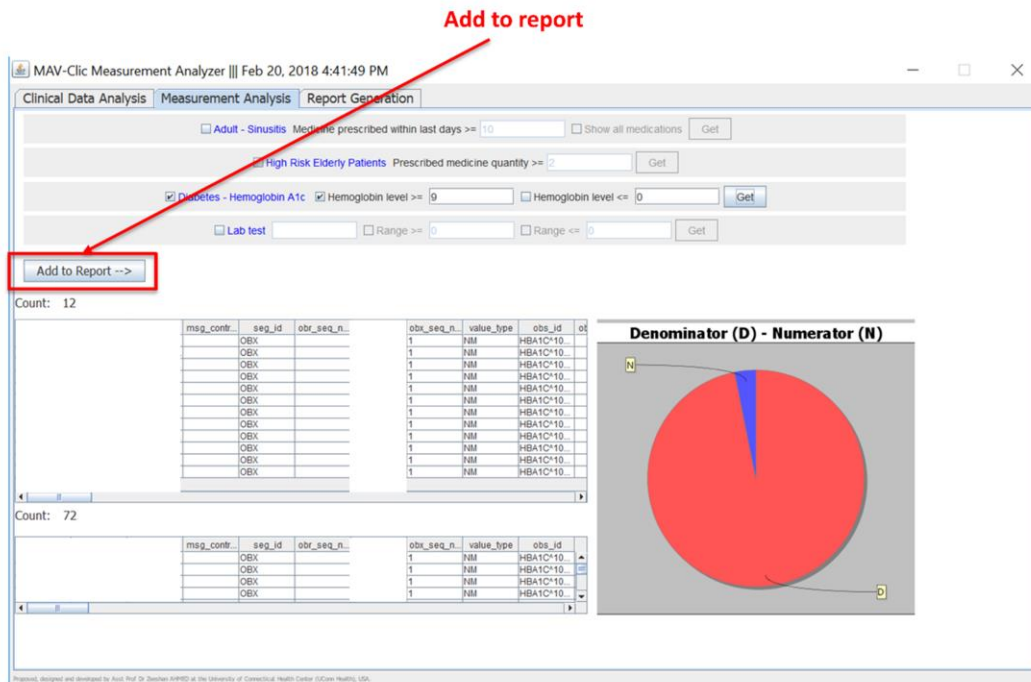
msg_conf	seg_id	obr_seq_n	obr_value_type	obs_id
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10
OBX			NM	HBATC*10

Denominator (D) - Numerator (N)

The pie chart shows a large red slice (D) and a small blue slice (N). The red slice represents the denominator (D) and the blue slice represents the numerator (N).

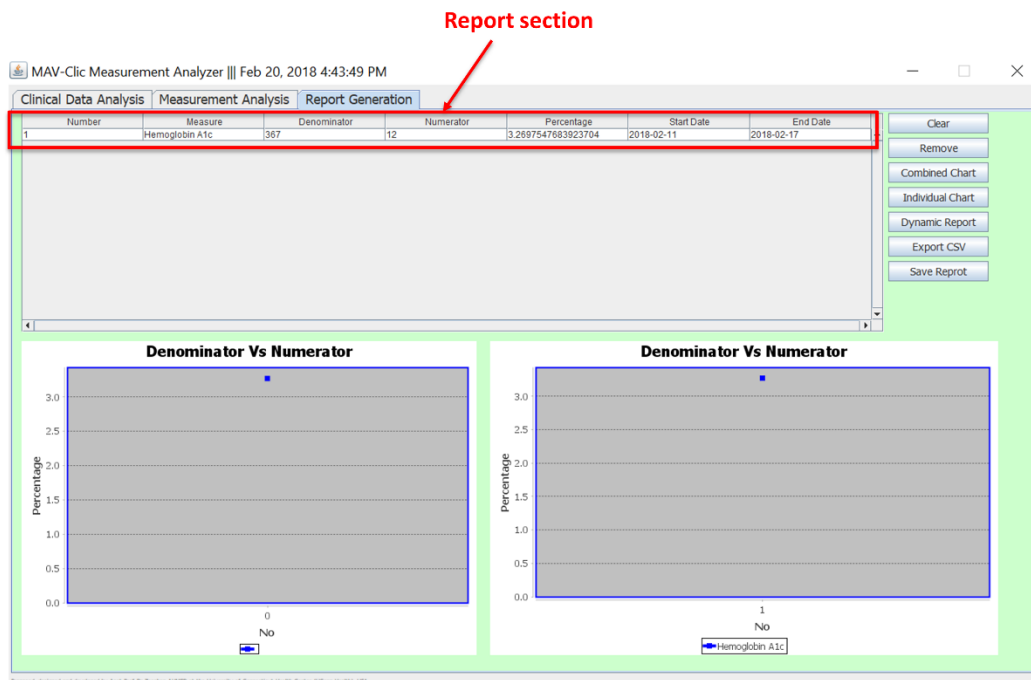
86

Step 8: Diabetes Poor Control (CMS 122)



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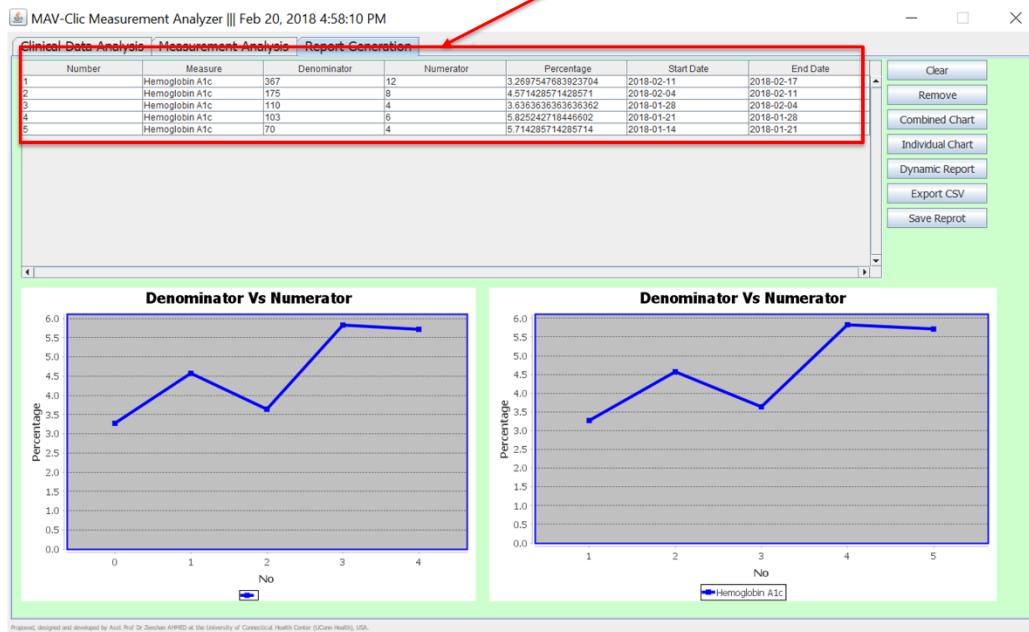
Step 9: Diabetes Poor Control (CMS 122)



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Step 10: Diabetes Poor Control (CMS 122)

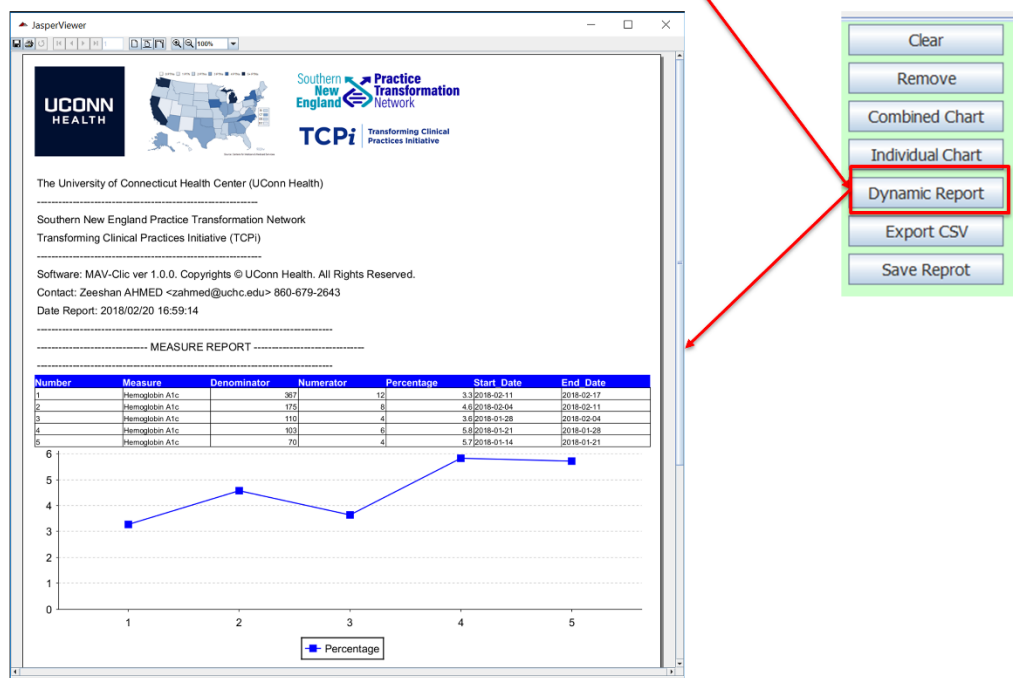
Generated report elements



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Step 11: Diabetes Poor Control (CMS 122)

Export Report



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91

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Example 2: Medication search (Medication name search)

Here, we present an example to search for the elderly patients aged 65 and over who prescribe the “Tylenol” during 7 days interval (Feb/11/2018 ~ Feb/17/2018).

It consists of 5 events based steps. The main variables under considerations in this example are represented as follows:

- Cohort Building
 - Time Interval: 7 days interval (Feb/11/2018 ~ Feb/17/2018)
 - Age > 64
- Medication Search
 - Tylenol

Step 1: Medication (Tylenol) Search

Medication Search: Tylenol

The screenshot shows the MAV-Clic Measurement Analyzer interface. The top bar indicates the date and time: Apr 4, 2018 1:53:31 PM. The main window is divided into several tabs: Clinical Data Analysis, Measurement Analysis, and Report Generation. The 'Measurement Analysis' tab is active. On the left sidebar, there are buttons for 'Auto ETL', 'Click', 'Practice', 'Disconnect', and 'Disconnect'. The 'Disconnect' button is highlighted with a red box. The main area shows a search form for 'Medication'. The 'Medication' field is set to 'Tylenol' and the 'Search' button is highlighted with a red box. A red arrow points from the text 'Medication Search: Tylenol' to the 'Search' button. The bottom of the window shows a 'Measure' dropdown set to '1Diabetes' and a 'Version' dropdown. There are also buttons for 'Save NDC Codes' and 'Get NDC Codes'.

Step 2: Medication (Tylenol) Search

MAV-Clic Measurement Analyzer ||| Apr 4, 2018 1:49:02 PM

Clinical Data Analysis | **Measurement Analysis** | **Report Generation**

☒ Auto ETL ☐ Click ☒ Disconnect

Date: ☐ 24 Hr ☐ 7 Days ☐ 30 Days ☐ 365 Days ☐ Custom Patients: ☐ New ☒ All

Age: Marital Status: ☐ Single ☐ Married ☐ Divorced ☒ All Gender: ☒ Male ☐ Female ☒ All Veteran: ☐ Veteran ☐ Non ☒ All

Region: Street: City: County: State: Country: Zip:

Language: Race: Religion: Smoker: ☐ Smoker ☐ Non ☒ All

Summary | Results | Population | Patients | Visits | **Diagnosis** | **Medications** | Diagnoses-Codes | Providers | Practices | Enterprises

Medication: 10865 ☐ Date includes patients

Measure: Version:

107

108

Step 3: Medication (Tylenol) Search

Date: 02-11-2018 to 02-17-2018

MAV-Clic Measurement Analyzer ||| Apr 4, 2018 1:49:58 PM

Clinical Data Analysis | **Measurement Analysis** | **Report Generation**

☒ Auto ETL ☐ Click ☒ Disconnect

Date: ☐ 24 Hr ☐ 7 Days ☐ 30 Days ☐ 365 Days ☒ Custom Patients: ☐ New ☒ All

Age: Marital Status: ☐ Single ☐ Married ☐ Divorced ☒ All Gender: ☒ Male ☐ Female ☒ All Veteran: ☐ Veteran ☐ Non ☒ All

Region: Street: City: County: State: Country: Zip:

Language: Race: Religion: Smoker: ☐ Smoker ☐ Non ☒ All

Summary | Results | Population | Patients | Visits | **Diagnosis** | **Medications** | Diagnoses-Codes | Providers | Practices | Enterprises

Medication: 10860 ☒ Date includes patients

file_id	auto_calc_i	prn_reason	pdm_id	formu_data	formu_sum	medid	gon	pro	medication	source_pro	create_tm	modify_tm	supervising	ineffective	ped_order	e_coupon	e_coupon
Y						476670	60113		TYLENOL PM								
Y						261893	4489		TYLENOL								
Y						261893	4489		TYLENOL								
Y						275706	4165		Tylenol-C...	EHR	0	0	00000000	N			
Y						546246	60988		Tylenol Co...	EHR	0	0	00000000	N			
Y		P0000000	Non Form...			450881	22123		Tylenol B...	EHR	0	0	00000000	N			
Y		P0000000	Non Form...			449732	3699		Tylenol P...	EHR	0	0	00000000	N			
Y						261893	4489		Tylenol 32...	EHR	0	0	00000000	N			
Y						261893	4489		Tylenol 32...	EHR	0	0	00000000	N			
Y						275706	4165		Tylenol C...	EHR	0	0	00000000	N			
Y						450958	22123		Tylenol Ar...	EHR	0	0	00000000	N			
Y						261893	4489		Tylenol 32...	EHR	0	0	00000000	N			
Y						261893	4489		Tylenol 32...	EHR	0	0	00000000	N			
Y		P0000000	On Formul...			476670	4490		Tylenol Ex...	EHR	0	0	00000000	N			
Y						275706	4165		Tylenol C...	EHR	0	0	00000000	N			
Y						261893	4489		TYLENOL								
Y						261893	4489		TYLENOL								
Y						476670	60113		TYLENOL PM								
Y						450958	22123		TYLENOL...				00000000	N			
Y						275706	4165		TYLENOL...					N			
Y						261893	4489		TYLENOL...					N			
Y						275706	4165		TYLENOL...					N			
Y						261893	4489		TYLENOL					N			
Y		P0000000	On Formul...			275706	4165		Tylenol-C...				00000000	N	0		

Measure: Version:

109

110

Check a box (Date includes patients)

Step 5: Medication (Tylenol) Search

[illegible]

Example 3: Medication search (NDC codes search)

This is an example to search for the elderly patients aged 65 and over who prescribe the Tylenol related NDC Codes “00450044406 && 00450048101 && 00450048211” during 7 days interval (Feb/11/2018 ~ Feb/17/2018).

It consists of 5 steps. The main variables under considerations in this example are represented as follows:

- Cohort Building
 - Time Interval: 7 days interval (Feb/11/2018 ~ Feb/17/2018)
 - Age > 64
- NDC Code Search
 - 00450044406 && 00450048101 && 00450048211
 - Tylenol related NDC Codes

Step 1: Medication (Tylenol related NDC Codes) Search

NDC Codes Search: 00450044406 && 00450048101 && 00450048211

The screenshot displays the MAV-Clic Measurement Analyzer software interface. The title bar indicates the application name and the date/time: "MAV-Clic Measurement Analyzer ||| Apr 4, 2018 5:09:16 PM". The interface is divided into several sections. At the top, there are tabs for "Clinical Data Analysis", "Measurement Analysis", and "Report Generation". Below these, there are various filters and search options. A red box highlights the "Disconnect" button in the left sidebar. Another red box highlights the "Search" button in the "Medications" tab, which is currently selected. The "Medications" tab shows a search bar containing the NDC codes "00450048101 && 00450048211". A red arrow points from the text "NDC Codes Search: 00450044406 && 00450048101 && 00450048211" to the search bar. The interface also includes a "Measure" dropdown menu set to "Diabetes" and a "Version" dropdown menu. At the bottom, there are buttons for "Save NDC Codes" and "Get NDC Codes".

Step 3: Medication (Tylenol related NDC Codes) Search

Age > 64

MAV-Clic Measurement Analyzer ||| Apr 5, 2018 2:18:45 PM

Clinical Data Analysis Measurement Analysis Report Generation

Auto ETL Date: 24 Hr 7 Days 30 Days 365 Days Customize 10/11/2016 10/17/2016 Patients New All

Age 64 150 Marital Status Single Married Divorced All Gender State Female All Veteran Veteran Non All

Practice Region Street City County State Country Zip

Refresh Language English Race American Indian or Alaska Native Religion Other North American Zone Smoker Smoker Non All

Disconnect

Summary Results Population Patients Visits Diagnosis Medications Diagnoses-Codes Providers Practices Enterprises

Medication: 2282

Date includes patients Find Patients

pt_id	ptc_id	start_date	date_stop	arg_codes	rx_quantity	rx_refills	generic_ok	samples_ind	dispense	org_refl
186	SSCA...	20141021			0	0	Y	N		
186	871E...		20141118		0	0	Y	N	N	
146	1E36...				0	0	Y	N	N	
186	871E...		20151218		0	0	Y	N	N	
186	871E...		20141106		0	0	Y	N	N	
304	SSCA...	20140930	20140930		0	0	Y	N	N	
108	871E...		20141007		0	0	Y	N	N	
884	SSCA...	20141001	20150413		0	0	Y	N	N	
186	871E...				0	0	Y	N	N	
A2	1501...	20141023			0	0	Y	N	N	
186	871E...				0	0	Y	N	N	
884	SSCA...	20141017	20150727		0	0	Y	N	N	
308	SSCA...				0	0	Y	N	N	
C73E1960...					0	0	Y	N	N	
A2	1501...	20141030			0	0	Y	N	N	
4CD76A24...		20141022			0	0	Y	N	N	
1897871E...					0	0	Y	N	N	
1897871E...					0	0	Y	N	N	
A21E1501...		20141022			0	0	Y	N	N	
1897871E...			20160209		0	0	Y	N	N	
1897871E...					0	0	Y	N	N	
C73E1960...					0	0	Y	N	N	
4CD76A24...		20171107			0	0	Y	N	N	1
1897871E...			20160205		0	0	Y	N	N	

Measure: 1Diabetes Version: Save NDC Codes Get NDC Codes

Report generated and developed by Assoc Prof Dr Dhanraj KPRASAD at the University of Connecticut Health Center (UConn Health), USA

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Step 4: Medication (Tylenol related NDC Codes) Search

MAV-Clic Measurement Analyzer ||| Apr 5, 2018 12:03:11 PM

Clinical Data Analysis Measurement Analysis Report Generation

☒ Auto ETL ☐ Click ☐ Practice ☐ Refresh ☒ Disconnect

Date: 24 Hr 7 Days 30 Days 365 Days ☒ Custom ☐ Job 11, 2018 ☐ Job 17, 2018 ☐ Patients ☐ New ☒ All

Age: 54 150 Marital Status: Single Married Divorced ☒ All Gender: Male Female ☒ All Veteran: Veteran Non ☒ All

Region: Street City County State Country Zip

Language: English Race: American Indian or Alaska Native Religion: African Methodist Episcopal Church ☒ Smoker: Smoker Non ☒ All

Summary Results Population Patients Visits Diagnosis Medications Diagnoses-Codes Providers Practices Enterprises

Patients: 43

first_office	last_office	med_office	pharmacy	pharmac	default_loc	privacy_level	suppress	preferred_p	financial_d	site_id	med_rec	guar_id	guar_type	contact_per
2018...	2018...	2018...	0786A18...	8F261F...		N				000	T01343...	SA37...	P	0
2018...	2018...	2018...	3866801...	8F261F...		N				000	T00133...	07C0...	P	0
20130321	2018...	2018...	465FF8C3...			N				000	T01098...	7C67...	P	2
2018...	2018...	2018...	73680C45...			N				000	T00817...	7122...	P	0
2018...	2018...	2018...	3FC79624...	908CAB...		N				000	T01269...	93A7...	P	0
2017...	2017...	2017...	7347CDE7...			N				000	T00990...	5480...	P	0
2017...	2017...	2017...	6EFE105G...			N				000	T01251...	FD01...	P	0
2016...	2016...	2016...	736CE75E...			N				000	T01087...	52P7...	P	0
2017...	2017...	2017...	83585964...			N				000	T01729...	838F...	P	0
2017...	2017...	2017...	59301B40...			N				000	T00708...	1A1C...	P	0
2018...	2018...	2018...	24FAC019...			N				000	T00791...	5E1C...	P	0
2017...	2017...	2017...	73200A93...			N				000	T01455...	72E2...	P	0
2017...	2017...	2017...	A02A2F80...			N				000	T00740...	490E...	P	0
20100919	2017...	2017...	6FAA5C08...			N				000	T00509...	11C9...	P	0
2018...	2018...	2018...	2931708F...			N				000	T01706...	285A...	P	0
2017...	2017...	2017...	531300F6...	F52204...		N				000	T01136...	88CA...	P	0
2018...	2018...	2018...	A4340005...			N				000	T00577...	E874...	P	0
2017...	2017...	2017...	0786A18...			N				000	T00769...	1A4D...	P	0
2017...	2017...	2017...	03A61428...			N				000	T00816...	CDAB...	P	0
2018...	2018...	2018...	96C4EF14...			N				000	T00267...	8FC8...	P	0
2018...	2018...	2018...	FF80678...			N				000	T01123...	60DA...	P	0
20101031	2017...	2017...	E1FF0238...	785BAE...		N				000	T00991...	40A8...	P	0
20130311	2017...	2017...	69834094...			N				000	T01567...	2A3F...	P	0
2017...	2017...	2017...	A003EE2E...			N				000	T01024...	CAF2...	P	0
2017...	2017...	2017...	94471F40...			N				000	T00911...	F1E8...	P	0
2017...	2017...	2017...	821E294F...			N				000	T01794...	FC82...	P	0
2018...	2018...	2018...	EDC76FE6...			N				000	T01319...	8882...	P	0

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Step 5: Medication (Tylenol related NDC Codes) Search

MAV-Clic Measurement Analyzer ||| Apr 5, 2018 12:03:38 PM

Clinical Data Analysis Measurement Analysis Report Generation

☒ Auto ETL ☐ Click ☐ Practice ☐ Refresh ☒ Disconnect

Date: 24 Hr 7 Days 30 Days 365 Days ☒ Custom ☐ Job 11, 2018 ☐ Job 17, 2018 ☐ Patients ☐ New ☒ All

Age: 54 150 Marital Status: Single Married Divorced ☒ All Gender: Male Female ☒ All Veteran: Veteran Non ☒ All

Region: Street City County State Country Zip

Language: English Race: American Indian or Alaska Native Religion: African Methodist Episcopal Church ☒ Smoker: Smoker Non ☒ All

Summary Results Population Patients Visits Diagnosis Medications Diagnoses-Codes Providers Practices Enterprises

Visits: 11

parent_enc	case_id	billable_ind	clinical_ind	optical_ind	location_id	locked_by	lock_ind	billable_tm	enc_status
00000000...	Y	Y	N	N	F4651E36...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	E897871E...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	87003875...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	E897871E...	0	N	2018-02-1...	U
00000000...	N	Y	N	N	8090957A...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	C3061485...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	E897871E...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	87003875...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	A4E20957...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	E897871E...	0	N	2018-02-1...	U
00000000...	Y	Y	N	N	E897871E...	0	N	2018-02-1...	U

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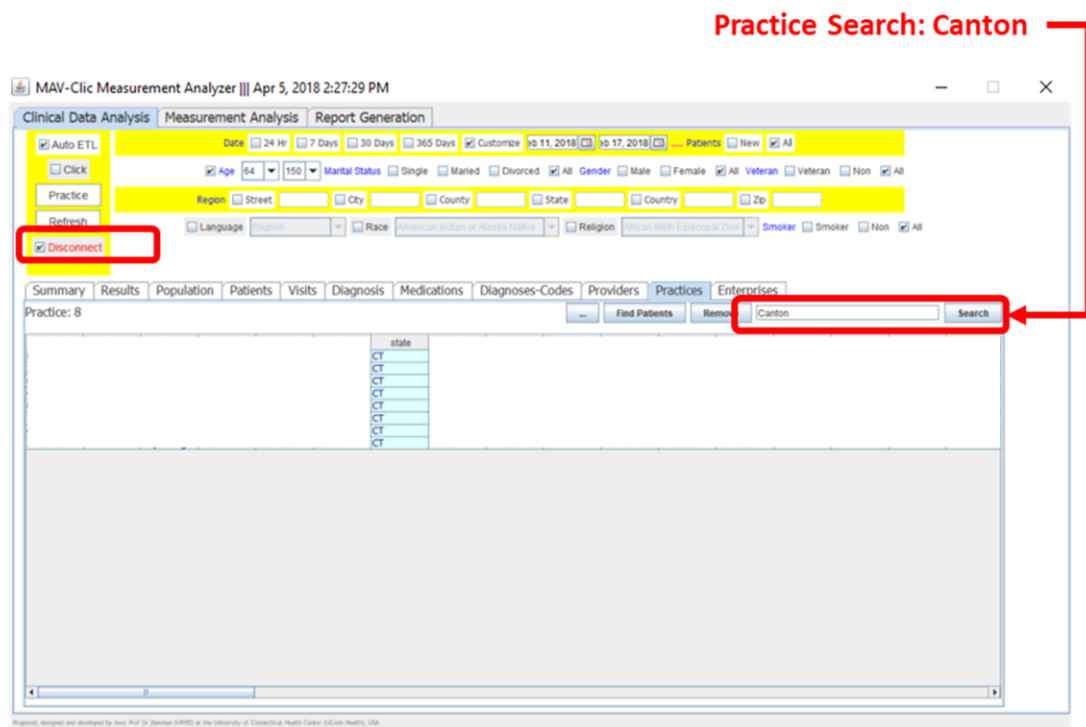
Example 4: Practice search (Practice Location Search)

Here, we present an example to search for the elderly patients aged 65 and over who visited “Canton” practice during 7 days interval (Feb/11/2018 ~ Feb/17/2018).

It consists of 6 steps. The main variables under considerations in this example are represented as follows:

- Cohort Building
 - Time Interval: 7 days interval (Feb/11/2018 ~ Feb/17/2018)
 - Age > 64
- Practice Search: Canton

Step 1: Practice (Canton Practice Location) Search



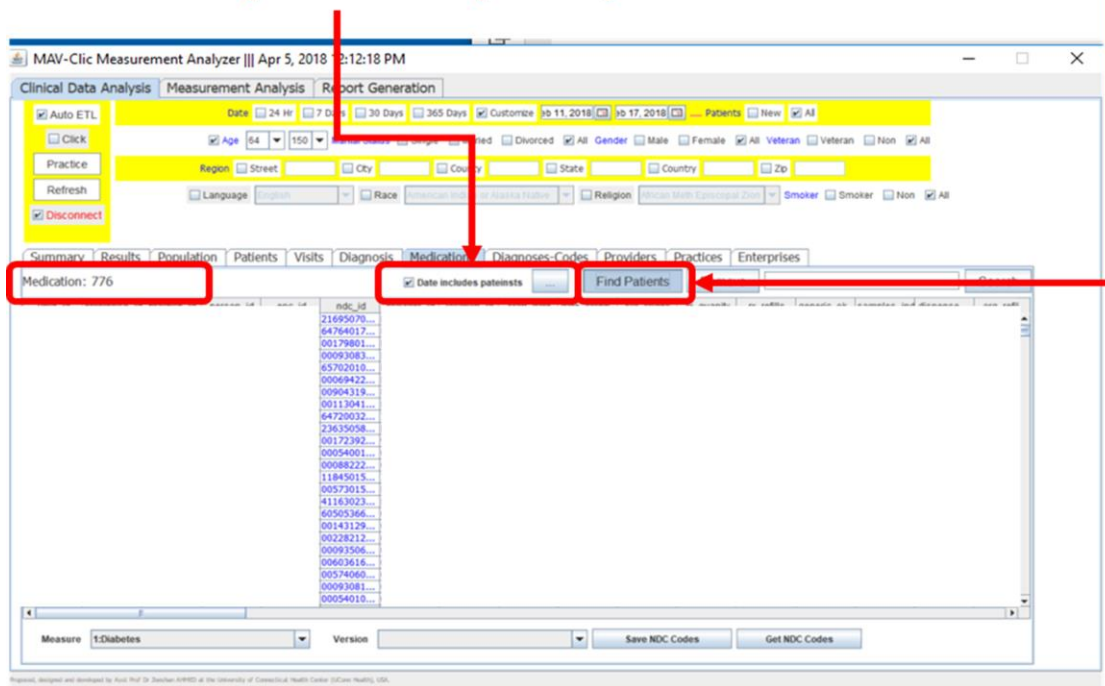
Step 3: Practice (Canton Practice Location) Search

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Step 4: Practice (Canton Practice Location) Search

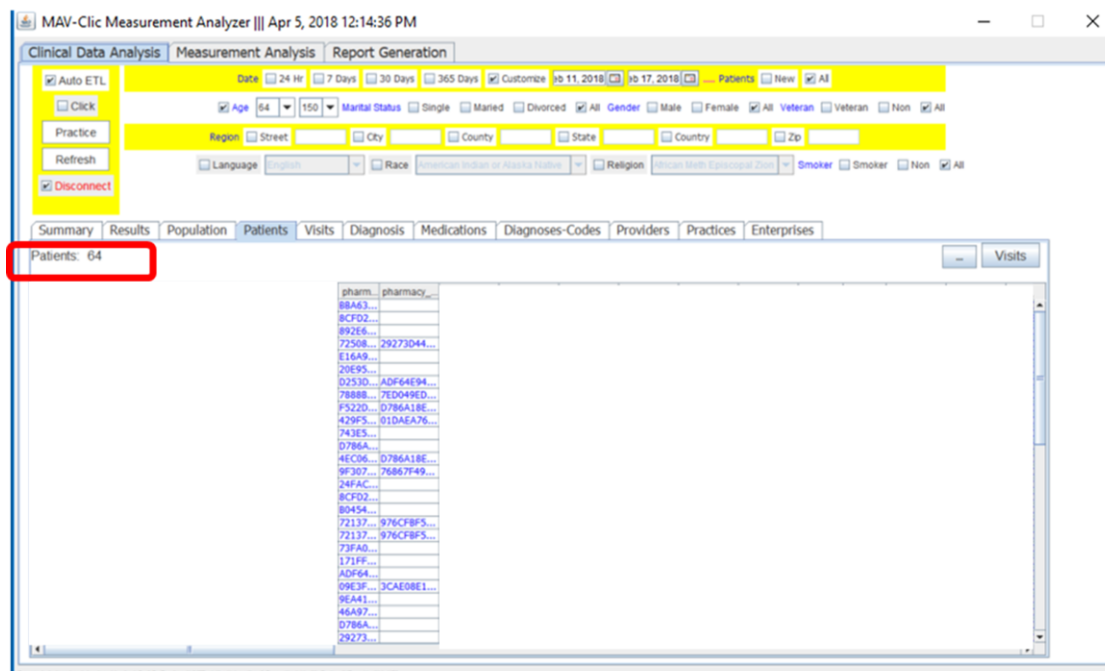
Check a box (Date includes patients)

Find Patients



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Step 5: Practice (Canton Practice Location) Search



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Authors and contributions

ZA perceived the idea and did all work on the software and infrastructure design and implementation and related aspects of MAV-clic. ZA and MK did analysis and performance evaluation of MAV-clic. BL guided study.