

### The Open-Source EMERSE (Electronic Medical Record Search Engine) Tool

Improving Workflow: Informatics Tools No Researcher Should Be Without S36

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# **Disclosure**



We have no relevant relationships with commercial interests to disclose.

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- Cleveland Institute for Computational Biology internal funding (Case Western Reserve University and University Hospitals Health System of Cleveland)



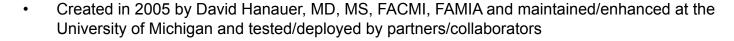
### After participating in this session, the learner should be better able to:

- Understand where EMERSE fits in the informatics toolbox and how it unlocks the critical health information contained in clinical notes
- Understand how EMERSE is not NLP, nor a substitute for NLP, because it is not competing with NLP it is intended as a self-service tool not requiring technical expertise
- Discover how EMERSE can benefit multi-disciplinary teams trying to capture the true picture of what is happening within patient populations by being able to rapidly search and review narratives written by thousands of unique individuals
- Understand that EMERSE is an extremely powerful and game-changing tool for research that requires a disciplined approach to ensure success

# **EMERSE – What is it?**



A human-augmented search engine for anything contained in medical notes – not NLP, but another tool in the informatics toolbox



- Used to perform rapid searches against the 80% of clinical data stored in notes for an entire patient population, defined lists of patients, and at the individual patient level
- All source notes are indexed and stored in a document repository EHR never touched directly
- Powered by a collection of over 1.5 million clinically curated terms and phrases
- Searches can be done on 100's of terms simultaneously
- Live at 6 academic medical centers covering ~10 million patients and > 442 million documents







- Easy to understand user-interface with a ~30-minute learning curve A "system for the people"
- Software is free from the University of Michigan, however, there is an initial cost to implement
- Relatively low maintenance requirements (0.15 FTE) no ongoing vendor fees
- Rapid querying compared to EMR e.g., gray platelet syndrome: 14,940 seconds vs. 2 seconds
- EMERSE excels at finding diagnoses that do not have a specific ICD-10 code e.g., leiomyosarcoma

Michigan Case Study - Cutaneous Leiomyosarcoma (cLMS) – Incidence of 0.2 per 100,000 per year – Cancer Registry found 101 patients, EMERSE found 311 potential that was narrowed down to 128 positive after manual chart review= 21% additional patients; 183 false positives due to standardized language in genetics consultation notes stating risk for "cutaneous leiomyosarcoma"\*

\*Oral presentation at Association of Academic Surgeons Annual Meeting 2020, Battacharya, A. et al.

#### The Open-Source EMERSE (Electronic Medical Record Search Engine) Tool



- Used for research and clinical operations (billing/coding, quality, infection control)
- University of Michigan is tracking research where EMERSE has been referenced:

EMERSE has supported a wide variety of clinical and translational research studies, listed below:

Papers (463)	Abstracts (84)	More (14)
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This lists below contain publications and other works that have used EMERSE to support clinical and translational research. The lists do not include informatics-themed papers that reference EMERSE in the context of being an information retrieval system for clinical data.

\* Papers and abstracts marked with an asterisk are part of multi-site collaborative studies, where EMERSE was used at a single site; data for the overall study came from multiple sites.

#### Papers

- Nadel JL, Ziats C, Mossner JM, Starr JB, Smith BW, Kelly MP, Muraszko KM, Farley FA, Maher CO, Garton HJL, Strahle JM. Superficial abdominal reflex in syringomyelia: Associations with Chiari I malformation, Journal of Clinical Neuroscience, Volume 98, 2022, Pages 1-5, ISSN 0967-5868, https://doi.org /10.1016/j.jocn.2021.12.037. PMID: Pending.
- Richman EL, Lombardi BM, de Saxe Zerden L, Forte AB. What Do EHRs Tell Us about How We Deploy Health Professionals to Address the Social Determinants of Health. Soc Work Public Health. 2021 Dec 7:1-10. doi: 10.1080/19371918.2021.2001406. Epub ahead of print. PMID: 34874813

#### https://project-emerse.org/publications.html

## **Cleveland Institute for Computational Biology**



- University Hospitals Health System of Cleveland, Ohio, ~ 2 million patients
- Case Western Reserve University, Cleveland, Ohio, Jonathan L. Haines, PhD, Director

Translating big data to better understand disease mechanism, improve clinical care, and inform population health

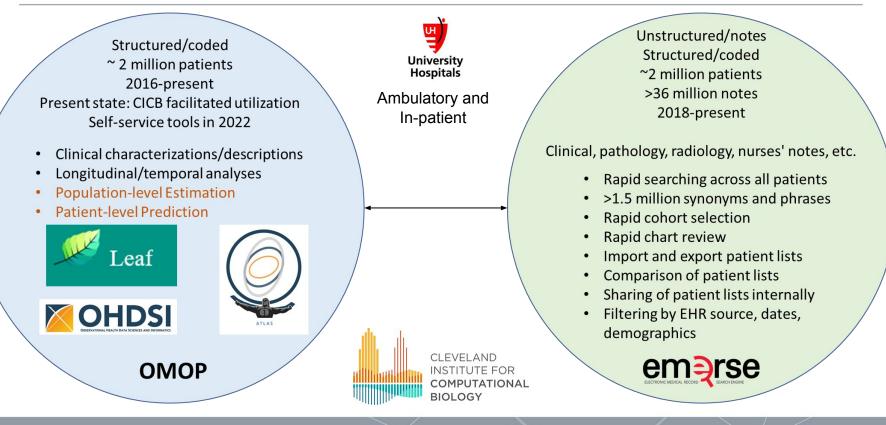






# **CICB Informatics Infrastructure**





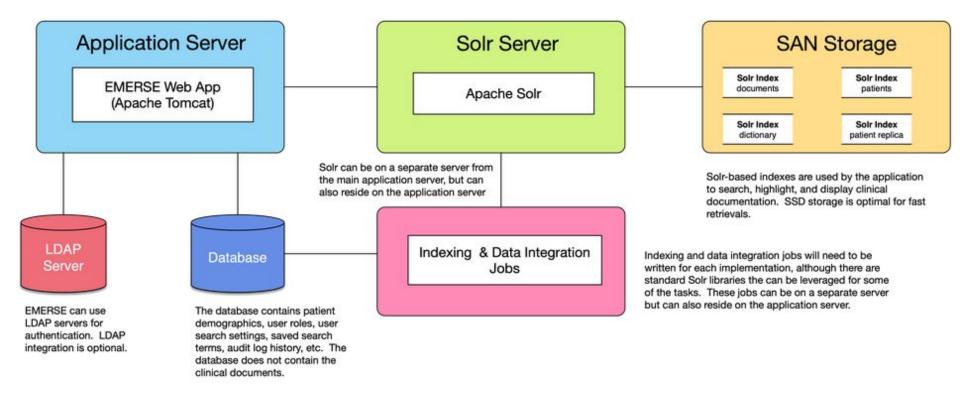
### **CICB EMERSE Implementation Timeline and Experience So Far**



- NIH/NCI 5-year grant starts (Jill Barnholtz-Sloan, PhD, and now Satya Sahoo, PhD, local PIs)
- 18 months spent obtaining institutional buy-in
  - Meetings with researchers many
  - Meetings with C-suite hospital representatives
  - Meetings with CQOs and system CMIO, leading to capital funding from the president of University Hospitals Cleveland Medical Center, Daniel Simon, MD
- Implementation started at the beginning of COVID all remote work (2/2020-11/30/2020)
- Pilot phase in late 2020 through October 2021 Validation of EMERSE via source systems
- Official launch in November 2021
- Currently over 175 EMERSE user accounts (research and ops), > 50 IRB protocols
- With COVID surge having waned, now picking up new users every week

## **EMERSE Architecture – Deployment View**







- Open-source enterprise search platform built on Apache Lucene
- Highly reliable, scalable, fault tolerant
- Distributed indexing, replication, and load-balanced querying

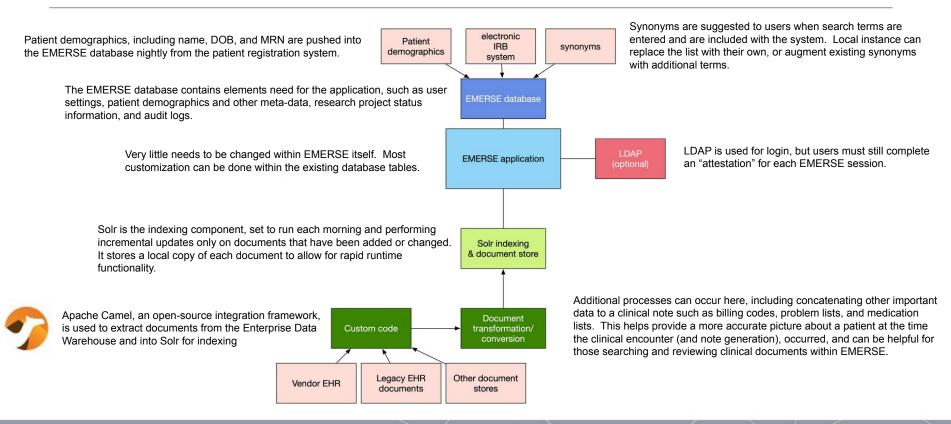
Solr powers some of the most heavily-trafficked websites and applications in the world. Here are some examples (alphabetical order):

	Adobe	AOL	AT&T
	Bestbuy	Bloomberg	Buy.com
	Chegg	Comcast	Disney
	DuckDuckGo	eBay	eharmony
	Instagram	Internet Archive	Magento
APACHE	MTV Networks	Netflix	Salesforce
LUCENE	SAP Hybris	StubHub	Ticketmaster
and all and the	Travelocity	Zappos	



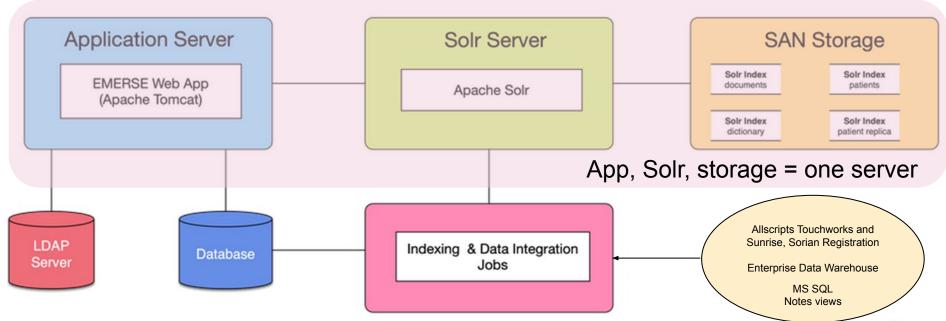
## **EMERSE Architecture – Process View**





## **University Hospitals EMERSE Implementation**





- New notes added from prior day at 6 a.m. for near real-time updates
- Emergent MRN errors corrected from the prior day via Health Identity Management

University Hospitals **EMERSE Demonstration Simulation – Why?** 



- "Live Demos" = Extra stress of a technical issue arising
- Demo system is limited to 10,000 synthetic patients; live =  $\sim$  2 million
- Live system contains full PHI and we need to redact
- Allows us to look at real use cases/scenarios
- Allows us to look at performance across ~ 2 million patients and >36 million documents
- However, return counts will also be obfuscated

## **Accessed via Chrome Browser**



EMERSE		× +		
→ C ∆				
Emerse Login 🍳	EMERSE Test	REDCap	SailPoint Identity	III Emerse Dashboard
Welcom	e to			
EMER	SE			
This is a logi	n hint			
mark.beno@	uhhospitals.c	org		
Password			Ø	
		SUBMIT		
3		<b>SODMIT</b>		

### **EMERSE – Attestation Screen**



#### Attestation

SUBMIT

Please select the reason you are using EMERSE from the list below

	Reason	Туре
)	Other Reason	Free Text (new)
	Testing by CICB	Free Text (prior)
)	Education/Training	Common Use Case
)	STUDY20210332 UWL (Rao, Goutham)	Free Text (prior)
)	PREP TO RESEARCH (FernandezBacaVaca)	Free Text (prior)
)	PREP TO RESEARCH (Rajagopalan)	Free Text (prior)
)	Quality Improvement	Common Use Case
)	Patient Safety	Common Use Case
)	Infection Control	Common Use Case
)	Clinical Care	Common Use Case
	Cancer Registry	Common Use Case
)	Billing & Coding	Common Use Case

- Records why are you using EMERSE for each session
- Some categories are for operations (e.g, Quality Improvement, Patient Safety, Billing and Coding)
- Research identified as either PREP or by the IRB number
- All activity is logged for the session



		Mark Beno ^
Patients		
Filters		
Terms		
Results HIGHLIGHT DOCUMENTS	FIND PATIENTS	
Temporary Terms Saved Terms Ad	vanced Terms	
Temporary Terms Name/Description Manage Terms View Terms Sharing Clear/Delete	Terms to include Please add terms or multi-word phrases, one at a time using the field below.  ① You need at least one term in your query  Add term  MDD	UPLOAD TERMS       SAVE TERMS         Phrases to exclude       Please add phrases to exclude one at a time using the field below.         Add Phrase
	Included terms None	None



		Mark Beno ^
Patients		
Filters Terms		
Results         HIGHLIGHT DOCUMENTS           Temporary Terms         Saved Terms         Adv		
Temporary Terms		UPLOAD TERMS
Manage Terms	Terms to include	Phrases to exclude
View Terms	Please add terms or multi-word phrases, one at a time using the field below.	Please add phrases to exclude one at a time using the field below.
Sharing Clear/Delete	() You need at least one term in your query	Add Phrase
	Add term	ADD
	ADD	Excluded phrases None
	Included terms None	



<b>Ə</b> EMERSE		Mark Beno ^
Patients Filters Terms Results HIGHLIGHT DOCUMENTS	FIND PATIENTS	
Temporary Terms Saved Terms Adva	anced Terms	
Temporary Terms Name/Description Manage Terms	Terms to include	UPLOAD TERMS SAVE TERMS Phrases to exclude
View Terms Sharing Clear/Delete	Please add terms or multi-word phrases, one at a time using the field below.   You need at least one term in your query  Add term  ADD	Please add phrases to exclude one at a time using the field below.   Add Phrase   ADD   Excluded phrases News
	Included terms None	None

## **EMERSE – Filters**



			1		
FILTERS Encounter Dates Age (current) Sex Race Ethnicity	reviewing patients' charts. The date range for selection in Start Date:	een the following dates will be fo is from 07/15/2014 to 01/06/202 	22 <u>(11)</u>		
Vital Status Document Source	End Date:	MM/DD/YYYYY	<u> </u>	FILTERS Encounter Dates Age (current) Sex Race Ethnicity	Only documents with the following criteria will be found in search and when revie patients' charts. (Checking all options is equivalent to unchecking all options. No filter will be appli American Indian and Alaska Native Black or African American Patient Refused Middle Eastern
				Vital Status Document Source	<ul> <li>Middle Eastern</li> <li>Other</li> <li>Hispanic</li> <li>Bi/Multi Racial</li> <li>Asian</li> <li>Native Hawaiian and Other Pacific Islander</li> <li>Unknown</li> <li>White or Caucasian</li> </ul>



		Mark Beno ^
Patients Filters Terms Rcsolido	FIND PATIENTS	
Temporary Terms Saved Terms Temporary Terms	Advanced Terms	UPLOAD TERMS SAVE TERMS
Name/Description Manage Terms View Terms Sharing Clear/Delete	Terms to include Please add terms or multi-word phrases, one at a time using the field below.   You need at least one term in your query  Add term	Phrases to exclude Please add phrases to exclude one at a time using the field below.  Add Phrase
	Add term	Excluded phrases None

# **EMERSE – Simple search**



erms to inclu	de				
lease add terms	or multi-word ph	rases, one at a t	ime using the fiel	d below.	
() You need at I	east one term in y	our query			
Add term					
Enbre					•
ADD					

# **EMERSE – Simple Search**



	-					
	E					
Patients						
Filters				Results returned		
Terms	enbrel			in less than 1 second		
Results	HIGHLIGHT DOCUMEN	TS FIND PATIENTS	]			
Summaries	Demographics Tree	nds				
	atients matched ese patients in more deta			en click the Highlight Docume	ents button.	
Top 100 M	1atching Documents					
(Touchv	vorks)				09/07/2021	

# **EMERSE – Simple Search**



#### (Touchworks)

#### 07/06/2020

...instructions on how to inject Enbrel. please call her at 216...

...instructions on how to inject Enbrel SureClick (did not receive medication...

...7bf4e9f373e1FormStart GroupHeading8Start Specialty Pharmacy: Medication: Enbrel Dose: 50mg SQ once weekly...

...Clinical Intervention: Medication education/counseling: Enbrel New start education. Patient Education...

...Monitoring Note: TNF Inhibitors Medication: Enbrel (Etanercept) 50mg every week Indication...

...storage, administration, and disposal of Enbrel. Patient educated to pull Enbrel from refrigerator approximately 30 minutes...

...again. Patient not to leave Enbrel at room temperature for more...

...hours. Patient instructed to inject Enbrel subcutaneously, and ensure the full...

...manufacture web site to view enbrel SureClick injection video before injecting...

# **EMERSE – Adding synonyms**



ease add terms or m	ulti-word phrase	es, one at a ti	ime using the	field below.		
Add term						
						<b>\$</b>
ADD						
cluded terms						
🤌 enbrel					C e VI	NONYMS

# **EMERSE – Adding synonyms**

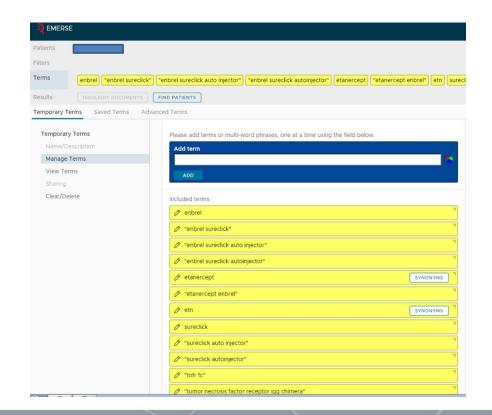


Synonyms for "enbrel"	×
Click individual terms to highlight or de-highlight.	
Synonyms (11) HIGHLIGHT ALL HIGHLIGHT NON	E
enbrel sureclick enbrel sureclick auto injector enbrel sureclick autoinjector etanercept etanercept enbrel eta	n
sureclick sureclick auto injector sureclick autoinjector tnfr fc tumor necrosis factor receptor igg chimera	
Spelling Alternatives (48) HIGHLIGHT ALL HIGHLIGHT NON	E
ambril eanbrel ebbrel ebrel eenbrel embrel embril enabrel enbbrel enbel enberl enberl	
enbiel enbre enbreal enbree enbrek enbrel4 enbrel8 enbrela enbrele enbrell enbrels enbreo	
enbrex enbril enbrle enbrol enbryl encrel endbrel endrel engrel enlbrel enmbrel enprel enrbe	el 🛛
enrel enrel entrel envrel erbrel eubrel ewnbrel ienbrel inbrel nbrel renbrel	
ADD HIGHLIGHTED TERMS (59) CANCE	L

.

# **EMERSE – Adding synonyms**





# **EMERSE – Adding synonyms to search**



	Results returned
Patients	in less than 4 seconds
Filters	Seconds
Terms	enbrel "enbrel sureclick" "enbrel sureclick auto injector" "enbrel sureclick autoinjector" etanercept "etan
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS
Summaries	Demographics Trends
1.63% 0.53	inste matched the coarch criteria
	ients matched the search criteria
	e patients in more detail, move to a Temporary Patient List and then click the Highlight Documents button.
Top 100 Ma	tching Documents

# **EMERSE – Synonyms discussion**



#### Synonyms and phrases collection

- >1.5 million built into EMERSE and are updated through U. of Michigan
- Allows rapid searching across 100s of terms simultaneously
- Drugs and brand names, diagnoses and procedures, non-clinical words, etc.
- Common phrases in written notes
- Users can supplement with additional search terms

Think about the variety of styles used in writing medical notes – all of this can be searched as well as combined in a single search

Category*	Examples	
	• ALL, acute lymphoblastic leukemia	
Acronyms	<ul> <li>ESRD, end stage renal disease</li> </ul>	
	• CXR, chest x-ray	
	• chemotherapy, chemo	
Abbreviations	<ul> <li>ventilator, vent</li> </ul>	
	• shoulder pain, shld pain	
	<ul> <li>myocardial infarction, heart attack</li> </ul>	
Professional and consumer terms	<ul> <li>alopecia, hair loss</li> </ul>	
	• emesis, puking	
	• ventilator, ventilater ventalator	
Misspellings	• pneumoina, pneuomnia, pneuomonia	
	• diarriea, diahhrea, diarhea	
	• anesthesia, anaesthesia	
American English &	• anemic, anaemic	
British English spelling	• virilization, virilisation	
	• Tylenol, acetaminophen	
Trade and generic drug names	• Prilosec, omeprazole	
na estar senar anna en 😑 contransference en estar en 🖓 (1997-1997-1999)	<ul> <li>Zoloft, sertraline</li> </ul>	

# **EMERSE – Synonyms for common phrases**



Included terms	
🖉 "feels tired"	SYNONYMS

Synonyms for "feels tired"	×
Click individual terms to highlight or de-highlight.	
Synonyms (22) HIGHLIGHT A	LL HIGHLIGHT NONE
bushed bushed after bushed following completely bushed completely exhausted com	npletely tired
feel bushed feel exhausted feel tired feeling bushed feeling exhausted feeling tired	feels bushed
feels exhausted felt bushed felt exhausted felt tired really bushed really exhausted	really tired
tired after tired out	
ADD HIGHLIGHTED TER	CANCEL

# **EMERSE – Synonyms for common phrases**



1911	nrise
130	111130

...Pt greeted MT and stated feeling ""tired"" after working with PT/OT...

#### (Sunrise)

...Topic Details S: Feeling exhausted. Denies HA, visual changes, chest... (PGY-2) S: Feeling exhausted. Denies HA, visual changes, chest...

#### (Touchworks)

...FOR CO VID. PATEINT STILL REALLY TIRED AFTER DOING ANYTHING. PLEASE ADVISE

#### (Sunrise)

...warmly upon arrival, stated feeling ""really tired"" after a ""very busy"" morning...

#### (Touchworks)

...Sleep disturbance with snoring: -He feels tired during the day, does not...

# **EMERSE – Searching with synonyms**



#### Terms to include

Please add terms or multi-word phrases, one at a time using the field below.

Add term	
	5
ADD	
Included terms	
🖉 arthritis	SYNONYMS
🧷 "rheumatoid arthritis"	SYNONYMS
🧷 "rheumatoid arthritides"	SYNONYMS
🖉 enbrel	.H.
🖉 "enbrel sureclick"	ų
🖉 "enbrel sureclick auto injector"	.h
🧷 "enbrel sureclick autoinjector"	ų
🔗 etanercept	SYNONYMS

### **EMERSE – Searching for any blue AND any yellow within the same note**



न् EMERSE	E Results returned
Patients	in less than 3 seconds
Filters	
Terms	arthritis "rheumatoid arthritis" "rheumatoid arthritides" enbrel "enbrel sureclick" "enbrel sureclick
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS
Summaries	Demographics Trends
To review the	tients matched the search criteria ese patients in more detail, move to a Temporary Patient List and then click the Highlight Documents button.

### **EMERSE – Moving discovered cohort to a temporary list**



MRN	Patient Name	Age	DOB	Action

### **EMERSE – Selecting highlight documents numeric view**



MRN Name	Touchworks	Sunrise
	1 of 46	343 of 4289
	100 of 141	109 of 386
	63 of 89	140 of 256

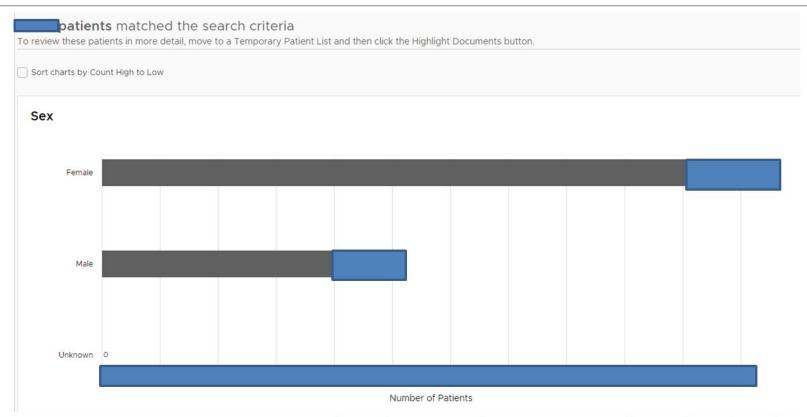
### **EMERSE – Switching to mosaic view for highlighting**





# **EMERSE – Temporary list demographics**





# **EMERSE – Saving patients to a permanent list**



CREATE

 $\times$ 

### **Patient lists** Create Patient List Created using EMERSE searches Name Enbrel and arthritis Entered manually Description Example Imported from an Excel file Shared with other EMERSE users Can be compared to other patient lists

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CANCEL

# **EMERSE – Saving patients to a permanent list**



### Patient lists

- Created using EMERSE searches
- Entered manually
- Imported from an Excel file
- Shared with other EMERSE users
- Can be compared to other patient lists

Number of patients that can be added to the list:	
Add Patients	Add by Bulk Upload
Medical Record Numbers	Uploading will append patients to th
	Choose File No file chosen

### **EMERSE – Tagging, annotating, and exporting patient lists**



Temporary Patient List	Saved Patient List	s All Local Patients	Network
Add/Upload Patient	Add a pass	sword to protect the Exce	el file
Patient Demograph	ics Enter pass	word enter pass	word 💿
Sharing		A strong pass	sword is required
Clear/Delete	Re-enter p	assword re-enter pa	assword 💿
Export	· · · · ·		
	- DOWNLO	CLEAR	

Temporary Patient List	Saved	Patient Lists	All Local Patients	Network					
colorectal AND carcino	*								
Name/Description	·	MRN	Patient Name	Age	DOB	Comment	Tag	Action	-
Add/Upload Patients				. Cinidanaa		need to review		Remove	
View Patients						14	/ 255		
Patient Demographic	s								
Sharing						Patients per page 50 ~	69 Patients	< < 1 / 2 >	>

# **EMERSE – Term collections**



### **Term collections**

- The building blocks of effective searching with EMERSE
- User-created and shared with other users
- Allows for reusable tools to use with EMERSE
- Potential to create catalogs of terms based on discipline or specialty
- Potential to create catalogs based on providers in a department by creating a term list of provider names

Patients			
Filters			
Terms			
Results	HIGHLIGHT DOCUMENTS	FIND PATIENTS	
Temporary Te	rms Saved Terms Adv	vanced Terms	
breast cancer	r	demo	
UWL terms to	exclude version 2	UWL exclude	
Location base	ed	UHCMC	
Type 1 diabet	tes E10 1-9	Type 1 diabetes E10, 1-9	
Type 1 Diabet	tes uncolded	Type 1 Diabetes uncoded	
CICB_myelop	athy	Training session	



### Term collections upload feature

- Allows common term collections to be shared with other research teams at other institutions who also have EMERSE installed
- Potential for many multi-institutional collaborative studies with the EMERSE consortium

erms			_

# **EMERSE – Sharing Terms Across Sites**



PediaTrac<sup>TM</sup> a multi-disciplinary project dedicated to creating a comprehensive, user-friendly tool for tracking infant development across key domains







	nec
IMHF: GASTRO - parenteral nutrition	"home parenteral nutrition"
	hpn
	kabiven
	parenteral
	"partial parenteral nutrition"
	"peripheral parenteral nutrition"
	pn
	ppn
	" <u>total</u> parenteral nutrition"
	tpn
	ntp
	pareneteral
	parental
	parenternal
	tpm
	trn
	ttpn
	" <u>parenteral</u> nutrition"
NAUE CASTRO D. L.	10



lational Institutes of Health Turning Discovery Into Health



# **EMERSE – Finding patients w/o coded T1D diagnosis**



### Step 1: Search for all with coded T1D in notes or other structured data source

T1D extensive coded	Please add terms or multi-word phrases, one at a time using the field below.
Name/Description	Add term
Manage Terms	
View Terms	ADD
Sharing	
Clear/Delete	Included terms
	🧭 "e10 9"
	🧭 "e10 8"
	🧭 "e10 69"
	🧭 "e10 65" "
	🧭 "e10 649".
	🧷 "e10 641"
	🧷 "e10 64"
	1 "e10 638"
	🖉 "e10 63" "4
	2 "e10 628"

# **EMERSE – Finding patients w/o coded T1D diagnosis**



Patients		
Filters	Encounter Dates	
Terms	"e10 9" "e10 8" "e10 69" "e10 65" "e10 649" "e10 641" "e10 64" "e10 6	538" "e10 63" "e10 628" "e10
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS	
Summaries	Demographics Trends	Results returned in less than 9
X pat	ients matched the search criteria	seconds

To review these patients in more detail, move to a Temporary Patient List and then click the Highlight Documents button.

### Step 2: Move these patients to a permanent list called T1D coded



### Step 3: Search for patients where T1D is mentioned in the notes, with synonyms

**Unstructured search for T1D - Assumptions** 

- Patients in this list should be in the coded list in the prior example
- We have not entered any exclusion criteria such as "do not suspect T1D"
- Resulting list would have patients who have T1D but have not been coded for it

# Step 4: Save list of found patients as permanent list called T1D uncoded

Terms	"type 1 diabete	s mellitus"	"childhood onset	diabetes"	childhood ons	et diabetes
Results	HIGHLIGHT DOC	UMENTS	FIND PATIENTS			
Summaries	Demographics	Trends				
To review th	patients matc nese patients in more Matching Docum	e detail, mo		Resu	llts returned ess than 9	<sup>1</sup> ighligh
				<i>.</i>	seconds	
(Sunrise	e)				seconds	
type 1: /	e) Additional Dx: Encep cation regimen: Hype			ype 1: Type	<mark>e 1 diabetes</mark> mellit	

...term current use of insulin: Type 1 diabetes mellitus without complication: Nonadherence to...

### **EMERSE – Finding patients w/o coded T1D diagnosis**



### Step 5: Compare coded T1D with uncoded T1D search

Temporary Patient List Saved Patient Lists All Local Patients	Network						
				[	NEW PATIENT		RE PATIENT LISTS
Name	Description		Owner	Created 4	Modified	Last Used	Patient Count
T1D coded demo 11	T1D coded		Mark Beno	10/28/2021	10/28/2021		x
TID_uncoded_demo_11	T1D uncoded		Mark Beno	10/04/2021	10/28/2021	10/28/2021	8.57x
New patient list can not have more than 100,000 patients) TID coded demo 11 TID coded REMOVE		0.01x 0.98x 7.59x		Т	T1D_uncode 11D uncoded REMOVE	PATIENT LIST FRO	MSELECTION
		Only patients in the right list not in the left	any of the	but noi T1D IC	ne of t D-10 c	hose pa codes ir	atients hav



### These patients have a coded type 2 diabetes

Patients	
Filters	Encounter Dates
Terms	e11 "e11 0" "e11 00" "e11 01" "e11 1" "e11 10" "e11 11" "e11 2" "e11 21" "e11 22" "e11 29" "e11
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS
Summaries	Demographics Trends
	patients matched the search criteria

Top 100 Matching Documents

beta blockers Name/Description

View Terms



### Who is taking specific drugs to control T2D?

- We want to visually see who in this list of T2D patients has a mention of 3 different drugs, all beta-blockers, somewhere in their notes
- When searching in a saved patient list, the search is done using logical OR

Terms to include			
nebivolol			
bystolic			
byvalson			
nadolol			
"bendroflumethiazide r	nadolol"		
corgard			
corzide			
"nadolol bendroflumet	hiazide"		
atenolol			
"apo atenolol"			
apoatenolol			
"aspirin simvastatin ate	nolol ramipril thiazide	2"	



### Highlighting documents with mosaic view

- Allows view of T2D patients who have these drugs mentioned in their notes
- Can quickly narrow down someone who might has more than one drug brand mentioned in their notes

# **EMERSE – Searching all patients for Dx and Rx classes**



# Who is taking different classes of drugs to control T2D?

• We want to visually see who in this list of T2D patients has a mention of 3 different drug classes mentioned in their same note

metorma metorm

Summary	Source	MR
Ltype 2, uncontrolled (250.02) (EII 65) Very poor control with of insulin (250.50,362.06) (EII 65) Very poor control with and insulin (250.50,362.06) (EII 65) Very poor control with melitus (250.50,362.07,362.04) (EII 321). Mild vitamin D deficiency diabetic smillus (250.60,357.2) (EII 42) (329). Obesity (278.00) (E66 type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus type 2, uncontrolled (250.02) (EII 65) - History of Diabetes melitus  controlled His initial doses of [fullicity] and patient agrees to give   Me pri and conso [fullicity] Metorium added to her regimen Advised   Diabetic neuropathy (250.05, 57.2) (EII 42) - History of Diabetic neuropathy (250.60,357.2) EII 40) - History of Diabetic polyneuropathy (250.60,357.2) (EII 42) - History of Diabetic colyneuropathy (250.60,357.2) (EII 42) - History of Diabetic polyneuropathy (250.60,357.2) (EII 42) - History of Diabetic polyneuropathy (250.60,357.2) (EII 42) - History of Diabetic polyneuropathy (250.60,357.2) (EII 42) - History of GERD (gastroesophageal  2 diabetes melitus (250.00) (EII 9) - History of Type 2  2 diabetes melitus (250.00) (EII 9) - PastMedicalHistory_10_twCiteListControlEnd PastMedicalHistorySectionEd   	Touchworks	02
type 2, uncontrolled (250.02) (E11.65) Very poor control with of insulin (250.50,362.06) (E11.3493). Diabetic peripheral neuropathy associated diabetes mellitus (250.60,357.2) (E11.42) Gabagentin 400 mg daily mellitus (250.50,362.07) (E11.321). Mild vitamin D deficiency	Touchworks	02

Results returned in less than 3 seconds 345 terms searched simultaneously



#### **Breast Cancer**

- This example shows visually how many patients had a mention of breast cancer and the various stages in their notes
- The search quickly shows which patients match all 5 of the search criteria in our existing list the initial search was simply "breast cancer"

s Encounter Dates	5
s "stage 4" "stag	ge iv") "stage 3" ("stage iii") "stage ii" ("stage 2") "stage i" ("stage 1") "breast cancer"
Its HIGHLIGHT DOCU	UMENTS FIND PATIENTS
oorary Terms Saved Term	ns Advanced Terms
mporary Terms	Terms to include
ame/Description	Please add terms or multi-word phrases, one at a time using the field below.
lanage Terms	Add term
/iew Terms	Add term
Sharing	ADD
lear/Delete	
	Included terms
	🖉 "stage 4" SYNONYMS
	SYNONYMS
	🖉 "stage 3" SYNONYMS
	🖉 "stage iii" SYNONYMS
	🖉 "stage ii" SYNONYMS
	🖉 "stage 2" SYNONYMS
	SYNONYMS
	SYNONYMS
	Ø "breast cancer" SYNONYMS



#### **Breast Cancer**

- We implicitly know that this patient has a mention of stages 1 through 4 mentioned in his/her notes
- Now we can look to see if it was related to cancer or some other disease
- Can add terms to exclude and do another search within this list
- We can tag matches and save as a new list



# **EMERSE – Searching with wild cards**



🖉 lispitor
Ø lititor
🖉 litpitor
🖉 liupitor
Ø livitor
🖉 llipitor
🖉 loipitor
Ø lopitor
Ø lpitor
🖉 luipitor
🖉 lupitor
🖉 lypitor
🖉 nlipitor
🖉 pipitor
🖉 hyperten*

- Using the \* character allows for the expansion of the word-stem
- In this example, hyperten is expanded

- ....A1c. He needs refills on Atorvastatin and Metformin. kp cma. GroupHeading1End...
- ...A1c: 7.1% 1/20 Statin: atorva 40 ACEi: lisinopril 20...
- ...bid Hypoglycemia events: Home BS: Hypertension, no chest pain, shortness of...
- ...272.4) (E78.5) · HTN (hypertension) (401.9) (I10) · Type 2...
- ...70\_twCiteListControlStart · Family history of hypertension (V17.49) (Z82.49) · Family history of hypertension (V17.49) (Z82.49) · Family...

TARA ANTIN ANTIN ANTINA ANTINA ANTIN'

# **EMERSE – Temporal searching**



#### Notes – Temporal searching

- Updated every morning at 6 a.m.
- Allows for near real-time searches
- Potential use for differential Dx follow-up for ED patients post-discharge
- In-patient tracking (e.g., DVT, sepsis)

4 to 10/27/2021	
2021	1
2021	

Please add terms or multi-word phrases, one at a time using the field below.

Add term	
	•
ADD	

Inclu	ded terms	
0	sepsis SYNONYMS	
0	"david thomas"	
0	"chrisopher thomas"	•
0	summers SYNONYMS	
0	stecyk	
0	roheny	•
0	"bobby paul"	
0	linz	•
0	luong	
0	kuo	
0	debs SYNONYMS	
0	chagin	

# **EMERSE – Temporal searching**



### **Clinician Names**

- The names of all signing clinicians are searchable and can become part of search strategies
- Search for both last name first name and first name last name to catch all instances of common names

Patients	All		
Filters	Encounter Dates		
Terms	sepsis "david thomas" "chrisopher thomas" summers stecyk roheny "bobby paul" linz luon		
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS		
Summaries	Demographics Trends		
	nts matched the search criteria ese patients in more detail, move to a Temporary Patient List and then click the Highlight Documents button.		
Тор Ма	tching Documents		

# **EMERSE – Enhancing notes content**



### Meta-data added to note headers is fully searchable

### **EMR Note Types**

- Over 2000 found during implementation
- Can search for many of these by name as part of a search strategy (e.g. Triage ED Peds and some condition of interest)
- Adding additional meta-data may be useful for research and ops (e.g., GIS data)

Patients		
Filters	Encounter Dates	
Terms	"triage ed peds"	
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS	
Summaries	Demographics Trends	
To review the	atients matched the search criteria ese patients in more detail, move to a Temporary Patient I Matching Documents	
(Sunrise)		
Triage - ED Peds Triage: Chart Review: CHIEF COMPLAINT		
References: 1. Data Referenced From ""Triage - ED Peds"" 03-Oct-		
53 1. Data Referenced From ""Triage - ED Peds"" 10/3/2021 11:53		



Temporary Terms Saved Terms Advanced Terms

The current settings will enable you to search using Advanced Terms.

The **Advanced Terms** feature offers precise control of searches. The search criteria are sent directly to the underlying Lucene search engine query parser. Lucene has a rich query syntax that allows for many types of searches including nested Boolean operators, proximity searches, fuzzy searches, and more. The full set of options are available on the Lucene Web Site. All searches are restricted to individual documents.

Note that with Advanced Terms, all terms will be highlighted in yellow. For more control over the colors assigned to each term, use a Term Bundle.

"hyperten\*" AND ("diabetes" OR "asthma") NOT "cancer"

SET TERMS



Patients	
Filters	
Terms	cancer AND "ct mass"~15
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS
Summaries	Demographics Trends
To review th	atients matched the search criteria ese patients in more detail, move to a Temporary Patient List and then click the Highlight Documents butto atching Documents
(Touchv	vorks) 07/10,
8132724 findings	bbaffFormFormStart FreeTextEntry1Start The patient returns to review <mark>CT</mark> for right postauricular <mark>mass</mark> . <mark>CT</mark>

# **EMERSE** – Excluding terms from a search



FIND PATIENTS

#### "ldl 116" "ldl 115" "ldl 114" "ldl 113" "ldl 112" Phrases to exclude Terms to include Results Please add phrases to exclude one at a time using the field below. Please add terms or multi-word phrases, one at a time using the field below. Add term Add Phrase Summaries Included terms Excluded phrases (Touchworks) None /> "Idl 116" 1 "Idl 115" Ø "Idl 114" Ø "Idl 113" 1 "Idl 112" 1 "Idl 111" 1 "Idl 110" Ø "Idl 109" Ø "Idl 108"

EMERSE cannot do math, but if you search for lab values, such as LDL, and include a term for each possible value of LDL, then all patients with lab results in their notes that are in that lab value "range" will be found

However, we do not want to find anything related to an "optimal" value for LDL

Demographics Trends ..goal is to get the LDL Test Name Result Flag Reference. ..borderline : totoal 220 (optimal LDL 106 (optimal ... ...borderline : totoal 220 (optimal LDL 106 (optimal ... ...borderline : totoal 220 (optimal LDL 106 (optimal ... ...borderline : totoal 220 (optimal LDL 106 (optimal ... ...borderline : totoal 220 (optimal LDL 106 (optimal ... ...borderline : totoal 220 (optimal LDL 106 (optimal ... ...borderline : totoal 220 (optima LDL 106 (optimal ... (Touchworks)

...levels are good: HDL 67 LDL 116 (down from 121 in December. ...levels are good: HDL 67 LDL 116 (down from 121 in December. ...levels are good: HDL 67 LDL 116 (down from 121 in December. ...levels are good: HDL 67 LDL 116 (down from 121 in December. ...levels are good: HDL 67 LDL 116 (down from 121 in December.

# **EMERSE – Excluding terms from a search**



#### Terms to include

Please add terms or multi-word phrases, one at a time using the field below.

Add term		
ADD		
ncluded terms		
🖉 "ldl 116"	ц.	
🖉 "ldl 115"		
🖉 "ldl 114"	я	
🖉 "ldl 113"	ų	
Ø "ldl 112"	ч	
🖉 "ldl 111"	ч	

#### Phrases to exclude

Please add phrases to exclude one

### Add Phrase

ADD

#### Excluded phrases

Ø "optimal Idl"

Excluding "optimal LDL" from the search eliminates 20 patients from the search results of this time bound search

# **EMERSE – Sampling of Current Uses**



### Epidemiological studies on eosinophilic and CMV (cytomegalovirus) colitis

Patients		
Filters		
Terms	"eosinophilic colitis"	"eosinophilic gastrointestinal disorder" ["cmv colitis"] "cytomegalovirus colitis"
Results	HIGHLIGHT DOCUMEN	ITS FIND PATIENTS
Temporary Term	s Saved Terms	Advanced Terms
Temporary Terms Name/Description Manage Terms		ADD ADD
View Terms		Included terms Excluded phrases
Sharing		
Clear/Delete	e	Cosinophilic gastrointestinal disorder"
		C "cmv colitis" SYNONYMS
		C "cytomegalovirus colitis" SYNONYMS
	_	

न् EMERS	E						
Patients							
Filters							
Terms	"eosinophilic colitis" eosinophilic gastrointestinal disorder"	"cmv colitis" "cytomegalovirus colitis"					
Results	HIGHLIGHT DOCUMENTS FIND PATIENTS						
Summaries	maries Demographics Trends						
patients matched the search criteria To review these patients in more detail, move to a Temporary Patient List and then click the Highlight Documents button.							
Top 100 Matching Documents							

### Represents just 0.0266% of local population

# Ability to rapidly review charts via EMERSE; not feasible with EHR

# **EMERSE – Sampling of Current Uses**



### Studying the prevalence of ulcerative colitis and Crohn's disease in the LGBTQ population

		Synonyms for "crohn's disease"	×			
		Click individual terms to highlight or de-highlight.				
		Synonyms (28) autoimmune disease ibradshaw cd cdai crohn croh crohn's disease activity index crohn's disease of pouch c crohn's of the pouch crohn's syndrome crohns crohns is de novo crohn's disease id e novo crohn's disease of pouch	rohn's disease of the pouch crohn's of pouch disease crohns syndrome de novo crohn's	Resulting cohort th can now be rapidly reviewed		
Synonyms for "Igbtq"	×	de novo crohn's of the pouch de novo crohn'sof pouch g	ranulomatous colitis harvey harvey bradshaw index			
Click individual terms to highlight or de-highlight.		hbi regional enteritis		emerse	Paola Saroutim	
Synonyms (21)	HIGHLIGHT ALL HIGHLIGHT NONE	Spelling Alternatives (26)	HIGHLIGHT ALL HIGHLIGHT NONE	Patients ligbtq syn		
bisexual gay insersex lesbian lesbian gay bisexual and transgender lesbia		chronn chron disease chron is corbn chron disease chron's chron's corbn's corbn's corbn's corbn's corbnes chrone's chron				
lesbian gay bisexual transgender and queer lesbian gay bisexual transgender que lesbian gay bisexual transgender que and questioning lesbian gay bisexual transgender que and que an		cronh cronhn cronhs rohn's rohns				
	sexual minority transgender			within the patient list "Igbtq syn"	TAG PATIENTS IN LIST MOVE TO TEMPORARY PATIENT LIST	
Spelling Alternatives (1)	HIGHLIGHT ALL HIGHLIGHT NONE		Search this	To review these patients in more detail, move to a Temporary Patient List and then click the Highlight Documents button. Top 100 Matching Documents		
Igtbtq		Synonyms for "ulcerative colitis"	patient list ×	(Touchworks) 10/	0/16/2018	
ADD HIGHL	IGHTED TERMS (21)	Click individual terms to highlight or de-highlight.		b54e-47cb-9df3-0036e52f60b3FormFormStart FreeTextEntryfStart Crothry - blood in stool, FreeTextEntryfEnd ChielComplaintFreeTextbolecf2d40ff presents for follow-up of CROMS disease. Initially diagnosed in 1999	1	
		Synonyms (35)	HIGHLIGHT ALL HIGHLIGHT NONE			
		active distal colitis autoimmune disease backwash ileitis				
		chronic enterocolitis colitis ucerosa distal active colitis distal actives distal disease distal active colitis distal disease				
Find LGBTQ		distal ulcerative colitis enterocolitis ileitis left colitis left				
population via notes		pan ulcerative pan ulcerative colitis panulcerative colitis pranulcerative colitis pranulcerative colitis proctosigmoid ulcerative ulcerative colitis proctosigmoid u				
		processing constructions induced and the construction of the const				
and save the list						
		Spelling Alternatives (4)	HIGHLIGHT ALL HIGHLIGHT NONE			
		popolitis ulceratice colitis ulcertaive colitis ulcertive colit	is			



ROSES Reach Out, Stay Strong, Essentials for New Moms

### Principal Investigators:





ImplementationEvaluationEric Reed, MDSarah D Ronis, MD MPH

#### Funders:

- The George Gund Foundation
- The Bruening Foundation

Goal: The primary goal of RED ROSE is to pilot ROSE, an evidence-based intervention shown to reduce the risk of developing perinatal depression in high-risk populations, within targeted patient populations at the UH Rainbow Center.

As a part of this project, we are conducting an EHR Chart Review to understand process (attendance at recommended prenatal, postpartum, and well child visits) and health (preterm birth, low birth weight, c-sections) outcomes to women who opt to obtain traditional care during pregnancy.



Cleveland Ohio 2

# **EMERSE – ROSE project used to validate EMERSE**

Title: Validation of the Electronic Medical Record Search Engine (EMERSE) to Speed and Standardize Chart Review

Section: Building the Future of D&I Science: Training, Infrastructure, and Emerging Research Areas

**Background:** EMERSE (Electronic Medical Record Search Engine) is an open-source tool developed at the University of Michigan. It is engineered to be a fast and simple way to search through electronic medical records for keywords within free text data, and has the capability to compile patient lists, create project-specific term bundles, and filter patient charts by date range. We used manually reviewed data from our ongoing study, "Reach Out, Stay Strong, Essentials for New Moms," (ROSE) to identify the strengths and weaknesses of EMERSE for chart review, as compared to manual review and EHR navigation.

Methods: We defined a patient list and term bundle (Figure 1) to search for key words in the medical charts of ROSE participants and controls. The term bundle was color-coded to visually differentiate words related to the six key areas of our review: type of ambulatory visit, nutrition status, postpartum depression screening, infant growth metrics, referrals, and scanned health questionnaires. Infant well-child visit notes were identified and reviewed using highlighted terms in EMERSE.

Findings: EMERSE quickly compiled highlighted notes for all patients within our list (n=50) from both the Touchworks ambulatory EHR and Sunrise inpatient EHR in a single search. Reviewing highlighted terms with in-note context produced nearly identical results compared to manual review. Because inpatient data, social work, and telephone call documentation were also available within the same search, EMERSE was more accurate for identifying the date and number of referrals made for each patient and could be used to gain additional information regarding patient birth history. Discrete, tabulated data (vaccinations, vital signs) was more easily reviewed directly within the EHR. EMERSE was also unable to identify or search scanned documents.

Implications: We found EMERSE to be a highly sensitive search tool. The inability to search scanned PDF documents and the lack of specificity for keywords in context necessitated some interpretation on the part of the reviewer. Overall, however, we find EMERSE to be a faster, more replicable, and more uniform way to conduct chart reviews in free-text documentation within the EHR and anticipate its utility increasing with increased study enrollment.

# Internal validation study submitted to D & I conference for 12/2021

Nora Lee, MD, Suzanne Lo, MPH, Mark Beno, MSM, Sarah Ronis, MD, MPH





EMERSE Network – ability to search across sites – exists today

Incorporation of NLP features

- negation
- uncertainty
- patient vs other
- named entity recognition/mapping to ontologies

Data extraction from templated notes

\*http://project-emerse.org/presentations.html

### **EMERSE – CICB Next Steps**

Upgrade to latest version of EMERSE

Implementation of EMERSE dashboard in Power BI to track utilization and provide functions for audit and compliance

Conduct an EMERSE end-user experience survey at all active EMERSE sites

- 1. How is EMERSE being used?
- 2. Are users sufficiently aware of how to use EMERSE?
- 3. Can learning materials be developed to enhance EMERSE?

Future de-identification of notes - done at UCSF



### Version 6.3

Also covers changes in version 6.2

#### Release date: 2021-10-04

- · The Synonyms feature is substantially more powerful now
- · Users now have the ability to choose from multiple datasets (if made available by the system administrator)
- Suggested terms can be ranked by their frequency
- · Suggested terms with no potential matches in the document can be hidden
- A network feature is now available but may not be enabled at a local site. This network feature allows a user to obtain obfuscated counts based on search terms across other EMERSE sites.

#### General SQL queries

Base Query for Login, Attestation, and Search Auditing Total number of users in the system Total number of users who logged in within the past year Username and User IDs of those who logged in within the last year Number of new users added each month Average and median number of logins per day (non-distinct users) Average and median number of logins per day (distinct users) All Attestation info for the last 7 days List of users and associated IRB numbers for research use within the past year Unique list of studies, by IRB number and principal investigator (PI) All search terms entered within the past 7 days Count of all active (not deleted) Search Term Bundles, including associated metadata such as term counts User-Specfic SQL queries Details about a specific user and studies they have been working on within EMERSE General login information about a specific user Searches done by a user from an All Patient Search, Overview Results, and Document Summary Search results from the Overview page, for a Specific User Specific Documents that were Viewed by an Individual User Patients Lists Shared with a Specific User

### **EMERSE – Lessons Learned During Roll-Out**



- Cannot simply train and go away generic examples do not translate to actual user engagement nor success
- Listening to potential end user stories is key
- Every medical specialty has unique potential uses for EMERSE and we have needed to guide each group and sometimes we need to discover what they are trying to do
- Searching effectively and getting to the information desired requires a degree of strategy that requires practice and patience this is difficult when bandwidth is limited
- Clinicians are busy and will look to their research teams to use EMERSE
- EMERSE can serve as a powerful research resource for medical fellowships, MD students, MPH students, Nursing, Social Workers pretty much anything that requires chart reviews

# **EMERSE and CICB Teams**

EMERSE Team at University of Michigan

www.project-emerse.org

David Hanauer, MD, MS

Kellen McClain. BS

Lisa Ferguson, MS

Guan Wang, MS



#### <u>CICB Team</u>

Sunah Song, PhD Harry Menegay, PhD Paola Saroufim, PharmD, MPH Devin Tian, PhD Bob Lanese, MS Veronica Sheng, MS candidate Beverly Kalasky, BS

www.icompbio.net

CICB Faculty Leadership

Jonathan Haines, PhD Daniel Simon, MD (UH) Dana Crawford, PhD William Bush, PhD Satya Sahoo, PhD Scott Williams, PhD

### CWRU and UH IT support

Mike Warfe (CWRU) Carl Langdon (UH) Cal Frye (CWRU) Brian Christian (CWRU) Ryan Jaskolka (UH) Craig Schwabl (UH)

www.case.edu/utech www.uhhospitals.com



# Thank you!

# Email me at: mark.beno@cwru.edu

