Blueprints for Learning: How does Healthcare System advance the science of its data?

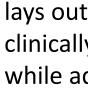
Abstract

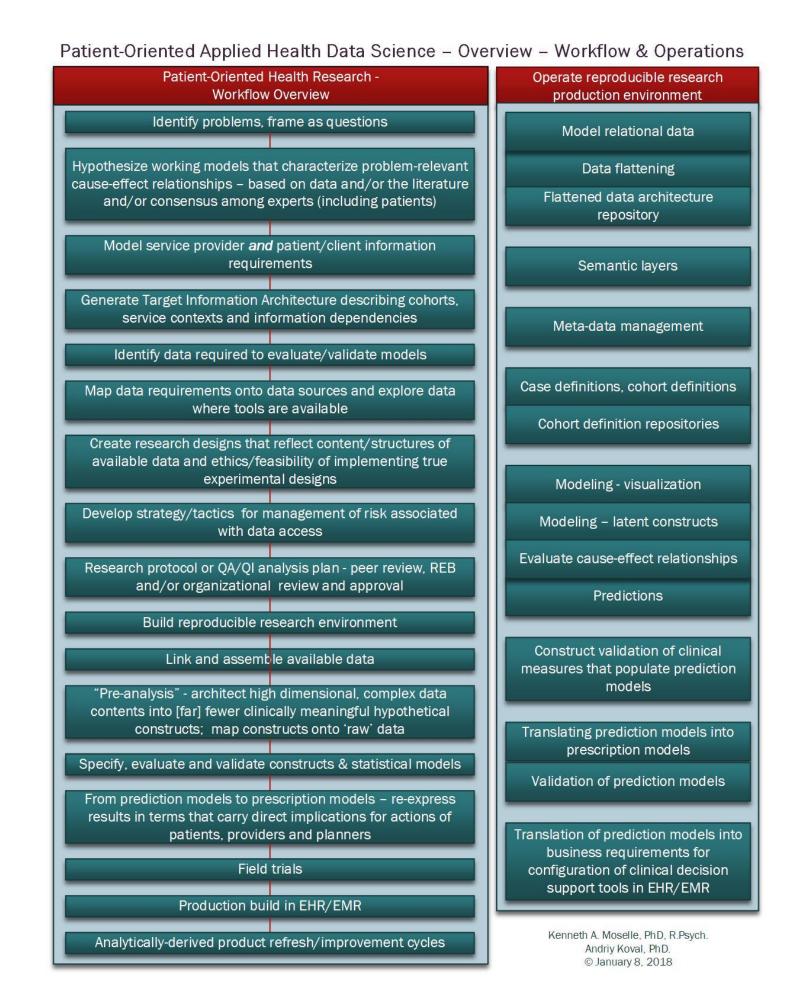
In this poster we present a framework for planning and implementing research projects that rely on skills and techniques of "data science" to generate actionable knowledge from linked, full-cross-continuum health data in the context of learning healthcare system.

First, we lay out the elements of the general framework for applied health data science (AHDS), exemplifying a generic workflow process. Then we delineate critical features of the environments for data access and data analysis that are critical to ensuring *practical reproducibility* - a paramount consideration for building a healthcare system that *learns*.

Using an ongoing research program at the Stroke Rapid Assessment Unit at VIHA, we proceed to demonstrate how a specific implementation of this framework transmutes into the research/analytical core of the Cognitive Health Initiative (CHI), which pursues a combination of computerized cognitive assessments and provider-generated clinical records to advance the accuracy of diagnosing and to improve patient care. Data visualizations of personlevel and cohort-level are provided.

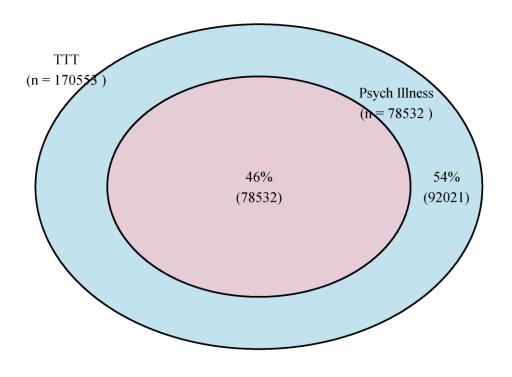
We conclude by demonstrating how this framework could be instantiated to support two projects of the current HSI fellow. The first project, explores the predictive capacity of clinical transactions (i.e. how healthcare system was engaged by the patient) to anticipate catastrophic medical events, such as opioid overdose (OO) or a death from an OO. The second project aims to leverage directly off of transactional records generated at a full continuum of services to enhance the surveillance of MHSU conditions, which are notoriously prone to be misrepresented by administrative sources of data.





Tally: Class

	location_class_description ED - Med-Surg	n_people 64156	n_encou
148	Medical Imaging	53602	2
	Lab - Island Health - General Clinical Intake - Adult MHSU	47753 46158	3
	NA Psychiatric [only] Clinic Services - Adults	28918 20858	1
16	Time-limited Ambulatory Treatment Services - Mental Health - Adults (secondary level)	20785	
	Acute Care - Med-Surg - Mixed Ages Surgery - Same Day - Mixed Ages	15253 14810	
	H&CC Services Crisis Response - Walk-in	13810 12620	
135	Med-Surg - Ambulatory Mixed Episodic - Chronic - Mixed Ages	11467	
	Endoscopy Electrodiagnostics	10794 10452	
	Surgery - Post - Acute Care Acute Care - Psychiatric - Regular - Adult (secondary level)	9082 8420	
12	Long-term Community/Clinic-based Treatment & Support - Adult (secondary level)	7551	
	Orthopedic - Ambulatory Lower Intensity Surgery - Prep - Recovery - Mixed Ages	7265	
68	Acute Care - Maternity, Perinatal	5793	
	Rehab - Phys - Cog (Therapies) Clerical Intake - Older Adults	5758 5509	
	MHSU Rehab Services - High Intensity (tertiary level???) Ambulatory Treatment Services - Psychogeriatric (secondary level)	4982 4329	
53	Residential Care - CHS - Licensed	3831	
	Ambulatory Episodic - Cardiovascular Assessment - Mixed Ages Surgery - Misc Ambulatory Services	3818 3807	
	Obstetrics - Ambulatory Clinical Intake - Addictions	3745 3511	
46	MHSU Specialist Consultation - Acute Care Multi-Service - MHSU	3476	
	Pain	3106 2899	
	Diabetes Education - Mixed Ages Acute Care - Adjunctive Therapies - Respiratory	2735 2733	
	Neurology - Diagnostic Surgery - Procedure - Mixed Ages	2661 2388	
	Morgue	2366	
	Ambulatory Treatment Services - Geriatric (secondary level) Med-Surg - Ambulatory Episodic - Mixed Ages	2155 1830	
113	Opthamology Acute Care - Med-Surg ED - Mixed Ages	1818	
149	Pharmacy	1703	
	Urological - Treatment Surgery - Anaestesia Consult - Clinic	1675 1599	
127	Ambulatory - Child & Youth Physical Disabilities Urological - Cystoscopy	1569 1566	
	Orthopedic - Ambulatory High Intensity	1566	
	Neurology - Ambulatory Episodic Respiratory - Mixed Ages - Moderate Intensity	1540 1521	
70	Acute Care - Children, Adolescents Acute Care - Intensive - Mixed Ages	1486	
95	Colposcopy	1428	
	Acute Care - Adjunctive Therapies - Nutrition Ambulatory Episodic - Urgent Assessment	1357 1353	
	Psychology - Adults	1325	
	Neurology - Urgent Follow-Up NA	1234 1191	
	MHSU Rehab services - Moderate Intensity (secondary level) Psychiatric [only] Clinic Services - Child & Youth	1160 1104	
	Residential Care - MHSU - Rental Supplements Clinical Intake - Older Adults	1087	
	Clinical Intake - Older Adults Med-Surg - Ambulatory Mixed Episodic - Chronic - Child & Youth	946	
	Perinatal Mental Health Residential Care - MHSU - Daily support - Unlicensed Moderate	915 894	
45	Support (secondary level) Early Psychosis Intervention (EPI)	836	
	Acute Care - Rehab-Phys/Cog (Therapies) Oncology - Ambulatory - Adults	834	
8	Acute Care - Psychogeriatric - Regular (secondary level)	661	
	Acute Care - Psychiatric - Regular - Child & Youth (secondary level) Primary Care - Island Health	655 618	
	Acute Care - Psychiatric Intensive care - Adult Residential Care - CHS - Assisted Living	595 587	
	Time-limited Ambulatory Treatment Services - Mental Health - Child & Youth (secondary level)	583	
	Ambulatory Chronic - Cardiovascular Rehab	543	
	Psychology - Neuropsychology - C&Y Addictions - C&Y Ambulatory	530 503	
	Acute Home Treatment Program Liver - Behavioural	484 474	
	ENT	473	
	Older Adults - Transition Sleep	455 451	
	Lab - Island Health - Genetics Chronic - Child & Youth Developmental - Community	442 424	
85	Ambulatory Chronic - Cardiovascular Treatment	396	
120	Neurology - Chronic Care Nutrition	390 387	
	Ambulatory Episodic - Cardiovascular Treatment Psychology - Developmental Disabilities	379 370	
124	Ambulatory - Infants, Toddlers	370	
	Chronic - Child & Youth Physical - Developmental-Clinic Older Adults at Risk - Home Support	366 361	
	Oncology - Telehealth Kidney Care	360 344	
74	Acute Care - Palliative	307	
152	Wound Care Telehealth - Misc	259 246	
	Long-term Community/Clinic-based Treatment & Support - Child & Youth (secondary level)	240	
	MHSU Adults - Mixed Ambulatory-Group Dialysis	239 217	
61	Older Adults - Palliative	215	
60	Electro-Convulsive Therapy Older Adults - Rehab - Acute Care	211 195	
	Respiratory Ambulatory - Adults - Moderate Intensity Ambulatory - Breast Health	173 147	
125	Ambulatory - Young Children - Developmental	135	
33	Spasticity (Adults) Telepsychiatry - Adults	122 112	
	Med-Surg - Ambulatory Episodic - Palliative Personality Disorder (DBT)	108 105	
50	Misc - MHSU	105	
151	Surgery - Same Day - Child & Youth Administrative	105 75	
	Telehealth - Thoracic Endocrine - Pediatric	64 59	
131	Rehab - Physical - Intensive Ambulatory	55	
	Genetics - Telehealth Home Dialysis	53 45	
	Telehealth - Seniors - Psych Diabetes Education - Pediatric	39 26	
119	Respiratory Ambulatory - Chronic - Adults - High Intensity	26	
	Acute Care - Intensive - Pediatric Residential Care - Brain Injury - Intellectual Disability	25 22	
	Telehealth - Homecare Residential Care - MHSU - Older Adults	21 20	
153	Ambulatory Care Palliative	20	
	Social Work Therapy Ambulatory - Child & Youth Developmental	13 11	
	Acute Care - Infants Oncology - Child & Youth	8	
54	Residential Care - CHS - Family Care Home	5	
118	Respiratory Ambulatory - Chronic - C&Y - High Intensity	5	
	Ambulatory Episodic - Cardiovascular Assessment - Cath	1	



Psychotic Illness

ds %>% unique_sums("service_location") %>% arrange(desc(n_people)) %>% neat()

service_location	n_people	n_encounters
Ambulatory Clinic	76327	456760
Hospital	68302	588521
Medical Imaging	53602	257325
IH Lab	47813	303276
NA	29487	121139
Home	14234	24849
Community	12959	25641
Community Facility	5088	8248
Morgue	2366	2502
Hospital-ED	1771	2473
Pharmacy	1703	1830
Telehealth	806	1772
	240	241
Administrative	75	77
Family Care Home	5	5

ds %>% unique_sums("population_age") %>% arrange(desc(n_people)) %>% neat() population_age _people n_encounters

Mixed Ages	75040	1411543
Adults, some adols, older adults	65557	192125
NA	29487	121139
Older Adults Exclusively	8116	31647
Mother-Baby	6127	22717
Children, Adolescents	5496	14498
Young Children	505	663
	240	241
Administrative	75	77
Infants	8	9

Psych Illine (n = 78532)

General MHSU Cohort

service_location	n_people	n_encounters			
Hospital	151715	1279618			
Ambulatory Clinic	147479	934561			
Medical Imaging	119550	648411			
IH Lab	109263	834940			
Home	79798	134912			
NA	60551	213732			
Community	20404	38351			
Community Facility	17824	28539			
Morgue	12533	12809			
Pharmacy	6494	7050			
Hospital-ED	4218	5688			
Telehealth	3758	9159			
	240	241			
Administrative	214	222			
Family Care Home	8	8			
ds %>% unique_sum:	s("populati	on_age") %>% ar	rrange(desc(n	_people)) %>%	nea
population_age		n_people n_	encounters		
Mixed Ages		163842	3541256		

Adminis

class, a category of service locations that were judged to be homogeneous with respect to the nature of services they provide. The product of applying Clinical Context Coding Scheme (CCCS) of Island Health.

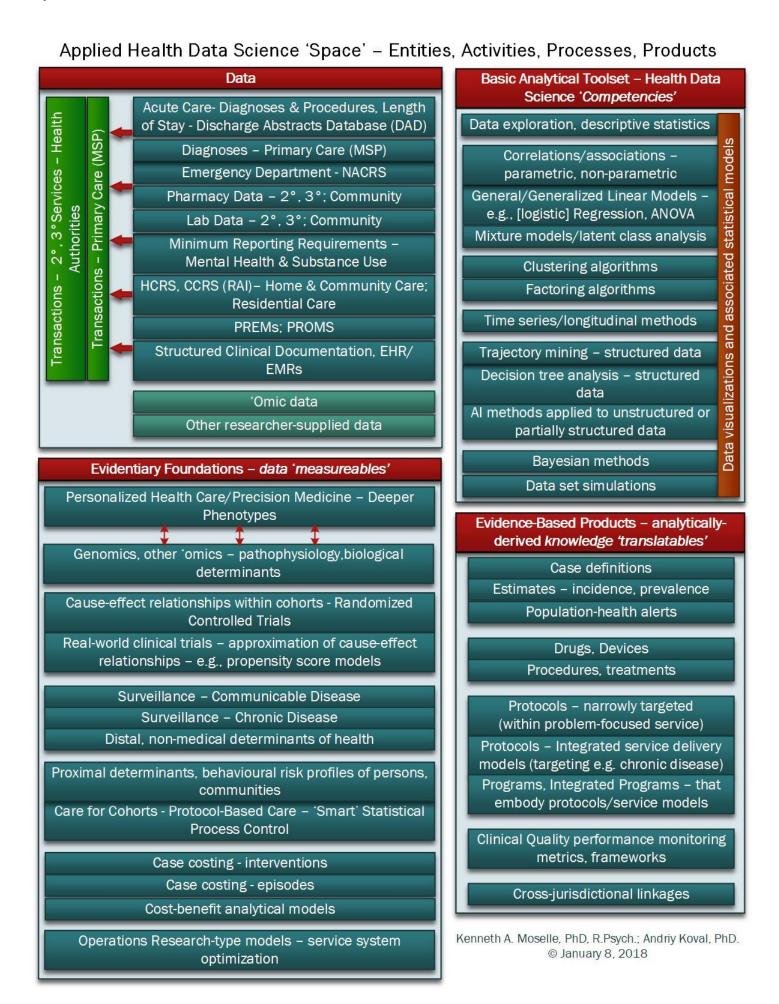
Number of unique patients and encounters per each *location*

Workflow

lays out the elements and processes involved in generating clinically useful discoveries in the patient-oriented research while adhering to standards of reproducible software design.

TIA space

invites to assemble concrete research initiatives by describing relationships among data sources, analytic methods, and products



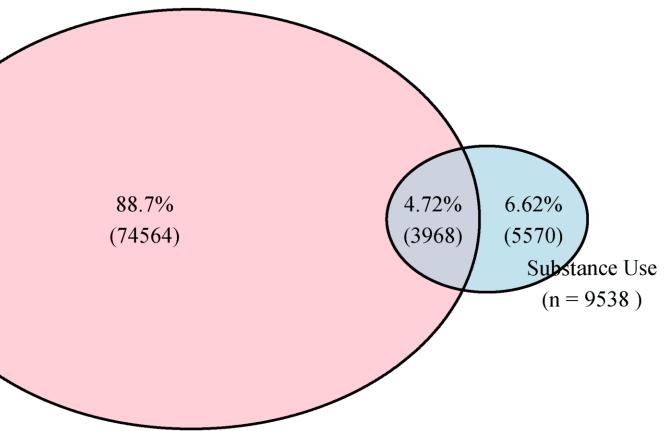
Tally: Class

ds %>% unique_sums(c("location_class_code","location_class

rrange(desc(n_people)) %>% neat()

Severe addiction

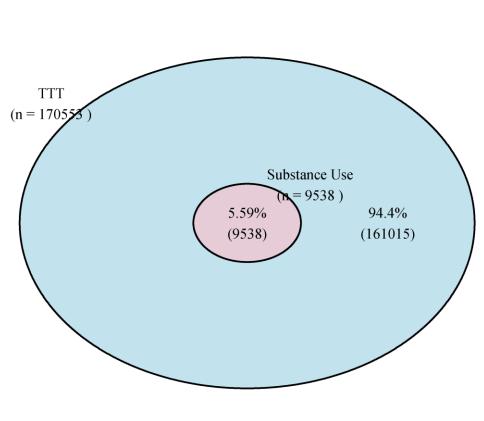
-Cohort description tools



s, some adols, older adults	/2031	207886
	60551	213732
Adults Exclusively	36336	99021
en, Adolescents	18426	48885
er-Baby	10241	30071
g Children	4382	6311
:S	599	616
	240	241
nistrative	214	222

Number of unique patients and encounters per each value of

service location and *population age,* two of the components in the Clinical Context Coding Scheme (CCCS) that reduced ~1700 unique VIHA locations into ~150 *location classes*



Substance Use

service_location n	_people n	encounters	
mbulatory Clinic	9538	42523	
lospital	8338	83613	
NA	6777	59897	
Medical Imaging	6005	19218	
H Lab	5159	24312	
lome	873	1386	
Community	583	1101	
Morgue	321	371	
Community Facility	186	273	
Hospital-ED	91	136	
Pharmacy	32	32	
Administrative	19	19	
	11	11	
Felehealth	7	13	
ds %>% unique_sums("	population_	_age) %2% an	auge(desc(u [_] t
population_age		n_people n_e	ncounters
lixed Ages		8972	140668
dults, some adols, ol	der adults	8351	26902
NA		6777	59897
Children, Adolescents		1831	3513
Mother-Baby		443	1463
Older Adults Exclusive	ly	197	424
Administrative		19	19
		11	11



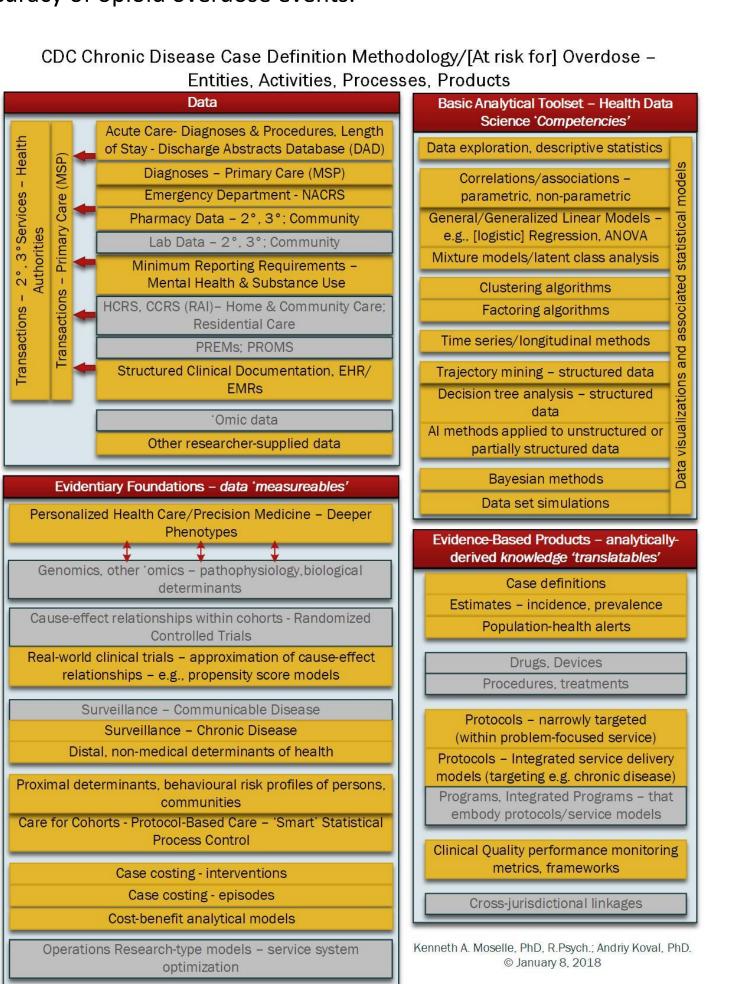


Andriy V. Koval Kate Smolina Scott M. Hofer Kenneth A. Moselle

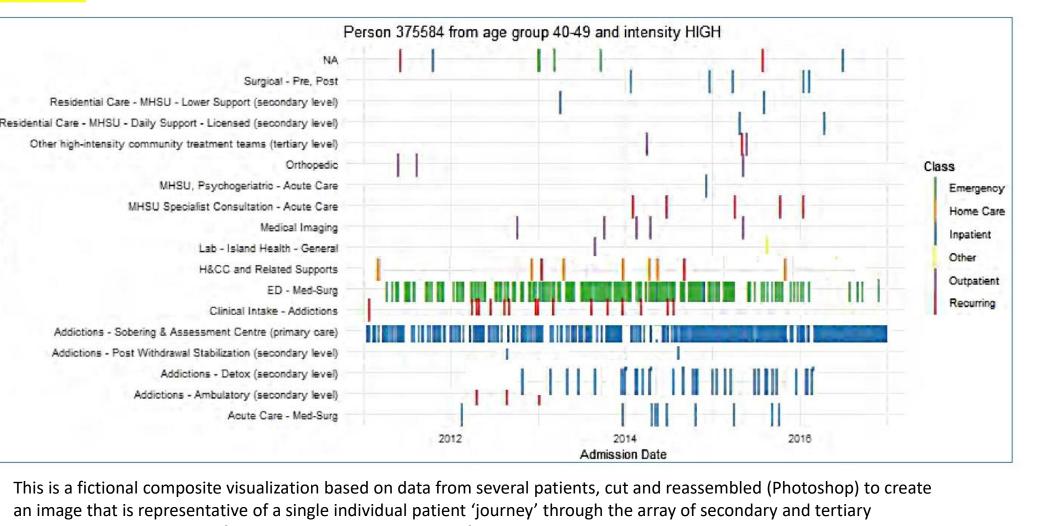


Target Information Architecture for enhancing case definitions of chronic mental health conditions and improving detection accuracy of opioid overdose events.

Entities. Activities, Processes, Products

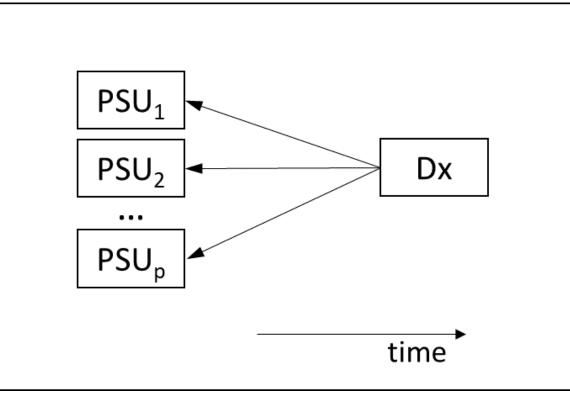


Case Study: Addiction



services, but not actually reflecting at a row level the data of any patient.

Stratifications of Clinical Histories



Question: Do individuals with certain diagnoses/event tend to have similar patterns of service utilization?

Premise: Transactional records of secondary and tertiary health services of Island Health are linked with substance use profile from MHSU-MRR profile, emergency room, and acute care records to assemble a data frame for estimating and training statistical models for identifying patterns of service use (PSU) related to specific health outcomes.

Applied Objective: Demonstrate *clinical heterogeneity of diagnostically* homogeneous cohorts by describing the variability in their clinical histories.

Methodological Question: How can we stratify patients on severity of condition and burden of disease based on their clinical history?



n_people n_encounters location_class_code location_class_description 8056 16106 35 Clinical Intake - Addictions 78 ED - Med-Surg 8017 68942 6750 59718 NA NA 148 Medical Imaging 6005 19218 146 Lab - Island Health - General 5156 24269 34 Clinical Intake - Adult MHSU 2630 4728 1901 4462 66 Acute Care - Med-Surg - Mixed Age 140 Surgery - Same Day - Mixed Ages 1567 2003 48 Addictions - C&Y Ambulatory 16 Time-limited Ambulatory Tre (secondary level) 108 Orthopedic - Ambulatory Lower Inten 142 Surgery - Post - Acute Care 969 1823 145 Electrodiagnostics 57 H&CC Services 6 Acute Care - Psychiatric - Regular - Adult (secondary level 8 Psychiatric [only] Clinic Services - A 46 MHSU Specialist Consultation - Acut 138 Surgery - Prep - Recovery - Mixed Age 613 821 135 Med-Surg - Ambulatory Mixed Episodic - Chronic - Mixed Ages 143 Surgery - Misc Ambulatory Service 134 Med-Surg - Ambulatory Episodic - Mixed Ag 82 Ambulatory Episodic - Cardiovasc 68 Acute Care - Maternity, Perinatal (secondary level) 79 Crisis Response - Walk 104 Neurology - Diagnostic 20 MHSU Rehab Services - High Inter 150 Morgue 23 Obstetrics - Ambulatory 130 Rehab - Phys - Cog (Therapies) 70 Acute Care - Children, Adolescents 238 490 81 Ambulatory Episodic - Urgent Assessmer 121 Pain 139 Surgery - Procedure - Mixed Ages 221 316 127 Ambulatory - Child & Youth Physical Disabil 209 275 115 Respiratory - Mixed Ages - Moderate Intensity 88 Diabetes Education - Mixed Ages 107 Neurology - Ambulatory Episodic 196 264 95 Colposcopy 188 303 13 Opthamology 1 NA 103 Urological - Cystoscopy 141 168 29 Residential Care - MHSU - Daily support Support (secondary level) 75 Acute Care - Intensive - Mixed Ages 37 Clerical Intake - Older Adults 136 Med-Surg - Ambulatory Mixed E 106 Neurology - Urgent Follow-40 Psychology - Adults Acute Care - Adjunctive Therapies - N 57 Acute Care - Med-Surg ED - Mixed Ag 45 Early Psychosis Intervention (EPI 9 Acute Care - Psychiatric Intensive care 122 Sleep 44 Psychiatric [only] Clinic Services - Child 73 Acute Care - Rehab-Phys/Cog (Therap 49 Multi-Service - MHSU Acute Care - Psychiatric - Regula 65 Perinatal Mental Health 5 Residential Care - MHSU - Rental Supp 72 Acute Care - Adjunctive Therapies - Respirator 84 Ambulatory Episodic - Cardiovascular Treatmer 52 5 114 Wound Care 109 Orthopedic - Ambulatory High Intensity 47 Acute Home Treatment Program 47 61 93 ENT 86 Ambulatory Chronic - Cardiovascular Rehal 44 20 16 Respiratory Ambulatory - Adults - Moderate Intensity 53 Residential Care - CHS - Licensed 38 5 147 Lab - Island Health - Genetics 129 Chronic - Child & Youth Physical - De 38 Psychology - Neuropsychology -149 Pharmacy 102 Urological - Treatment 17 Time-limited Ambula Youth (secondary lev 51 Older Adults - Palliative 36 Clinical Intake - Older Adul 74 Acute Care - Palliative 128 Chronic - Child & Youth De 1 Personality Disorder (DBT) 85 Ambulatory Chronic - Cardiovascu 3 Ambulatory Treatment Services - Geriatric (seconda 5 Residential Care - CHS - Assisted L 7 Surgery - Anaestesia Consult - C 21 MHSU Rehab services - Moderat 87 Ambulatory - Breast Healt 151 Administrative 97 Kidney Care 18 28 141 Surgery - Same Day - Child & Youth 39 Psychology - Developmental Disabilities 17 29 60 Older Adults - Rehab - Acute Care 50 Misc - MHSU 19 Ambulatory Treatment Services - Psychogeriatric (secondary level) 100 Liver - Behavioural 144 Primary Care - Island Health 13 Long-term Community/C Youth (secondary level) 98 Dialysis 132 Spasticity (Adults) 110 Oncology - Ambulatory - Adults 131 Rehab - Physical - Intensive Ambulato 64 Older Adults at Risk - Home Support 124 Ambulatory - Infants, Toddlers 154 Med-Surg - Ambulatory Episodic - Palliat 92 Endocrine - Pediatric 52 MHSU Adults - Mixed Ambulatory-Group 77 Acute Care - Intensive - Pediatric 152 Telehealth - Misc 32 Residential Care - Brain Injury - Intellectual Disability 112 Oncology - Telehealth

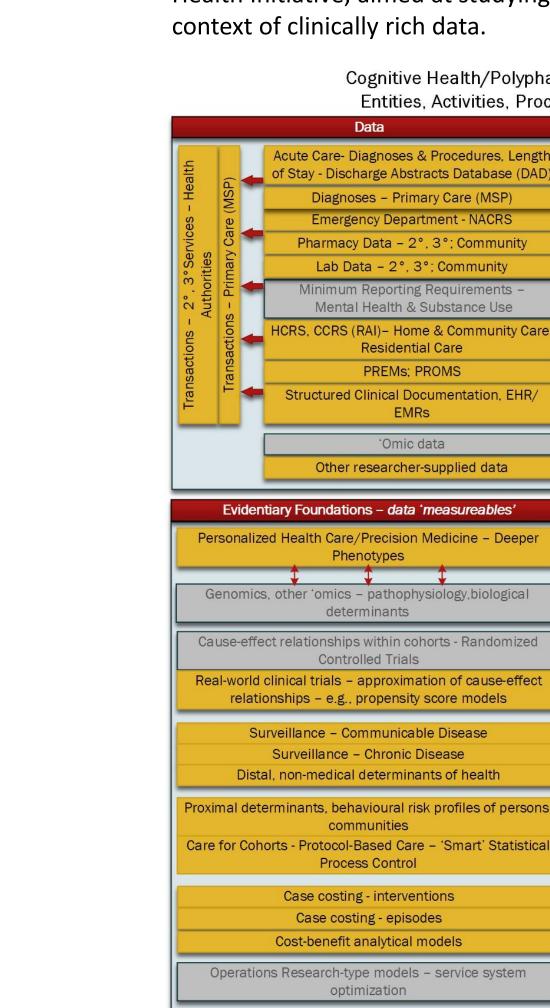


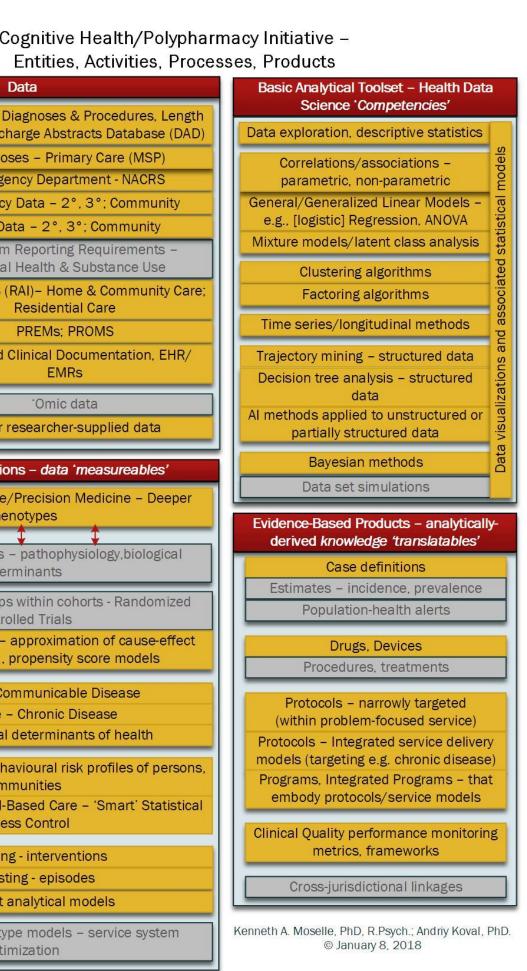


Health System Impact Fellow, CIHR Observatory for the Population and Public Health, BCCDC, UBC Institute on Aging and Lifelong Health, University of Victoria Applied Clinical Research Unit, Vancouver Island Health Authority



Target Information Architecture for engaging transactional data from Island Health to pursue research goals of Cognitive Health Initiative, aimed at studying cognitive aging in the





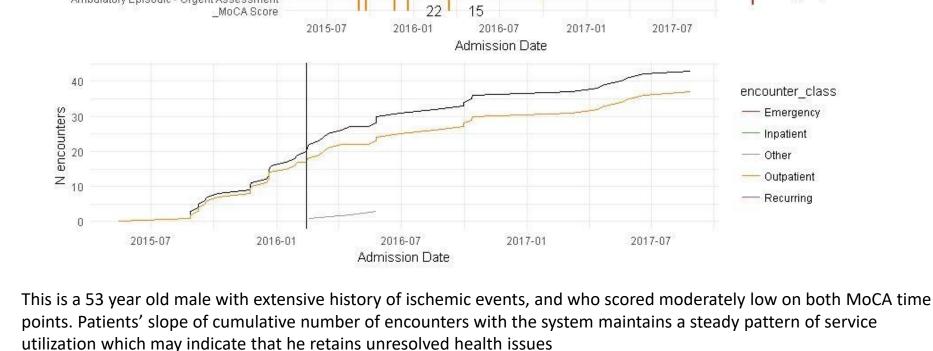
encounter class

Recurring

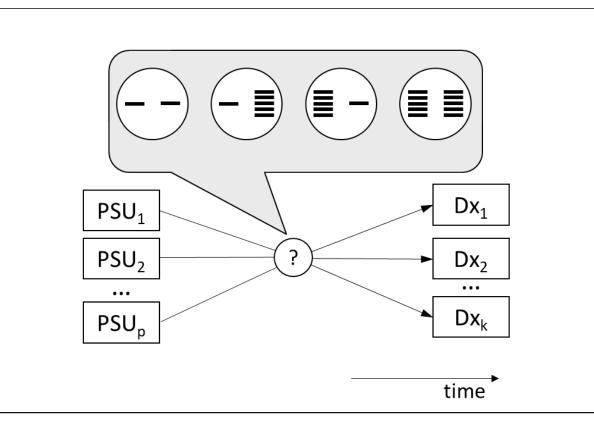
Dutpatier

- Person description tools

Case Study: Stroke Mimic 1B18542 - Male, age 53 - MoCA: Baseline = 22 ; Blind = 15 Surgical - Pre, Post Stroke Unit Opthamology Neurological Medical Imaging Lab - Island Health - General Lab-Genetics Endoscopy Electrodiagnostics ED - Med-Surg Cardiovascula



Predictive Utility of Service Use



Question: What patterns of service utilization can help identify individuals at risk for an overdose event?

Premise: Using mathematical operationalizations of PSUs generated in Part 1 ("Models of Clinical Histories") we establish statistical relationship between exhibiting a particular PSU and subsequently experiencing an overdose event(s)

Applied Objective: Identify the features of service use that differentiate individuals who go on to experience an opioid overdose event.

Methodological Question: A conceptualized and operationalized PSU may not have a strong predictive relationship with the outcome, so how do we screen for PSU that would be useful in predicting a particular health outcome?