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Untapped Potential of Clinical Text for Opioid Surveillance

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[1]Virginia Commonwealth University, Richmond, VA; [2]Loyola University Medical Center, Chicago, IL; [3]Loyola University, Chicago, IL; [4]Rush University, Chicago, IL; [5]University of Chicago, Chicago, IL; [6]Northwestern Medicine, Chicago, IL; [7]Virginia Commonwealth University Health System, Richmond, VA

The Opioid Epidemic

Each day an average of 130 Americans die from overdosing on opioids[1].

Accurate surveillance is needed to combat the opioid epidemic for effective resource mobilization[2].

Current surveillance methods are not timely[3], and rely on diagnostic codes, which potentially miss overdose encounters as their purpose is for billing; thus, current prevalence numbers may be under-estimated[4,5].

Related Work

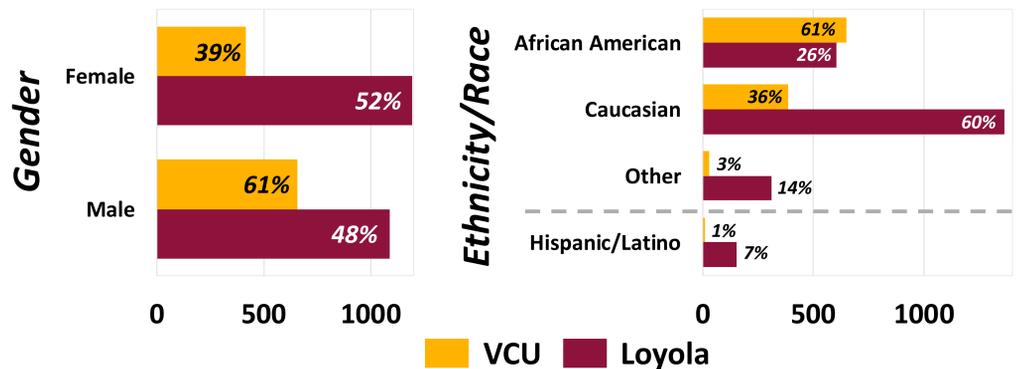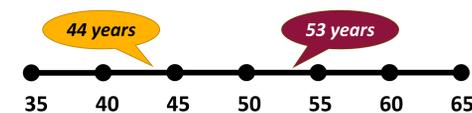|	Opioid Misuse	Opioid Overdose
Rule-Based	Carrell et al[6] 2015 Palmer et al[8] 2015 Hylan et al[7] 2015 Haller et al[9] 2017	Hazlehurst et al[12] 2019 Green et al[13] 2019
Machine Learning	Lingeman et al[10] 2018 Dligach et al[11] 2019	

Demographics

VCU
Virginia Commonwealth University Medical Center, located in downtown Richmond, VA, serves the Metro Richmond area as a safety net hospital.

Loyola
Loyola University Medical Center is a tertiary academic center serving the western suburbs of Chicago, IL.

Gender
- Female: 39% (VCU), 52% (Loyola)
- Male: 61% (VCU), 48% (Loyola)

Ethnicity/Race
- African American: 61% (VCU), 26% (Loyola)
- Caucasian: 36% (VCU), 60% (Loyola)
- Other: 3% (VCU), 14% (Loyola)
- Hispanic/Latino: 1% (VCU), 7% (Loyola)

Legend: VCU (yellow), Loyola (maroon)

Average Age
- 44 years (VCU)
- 53 years (Loyola)
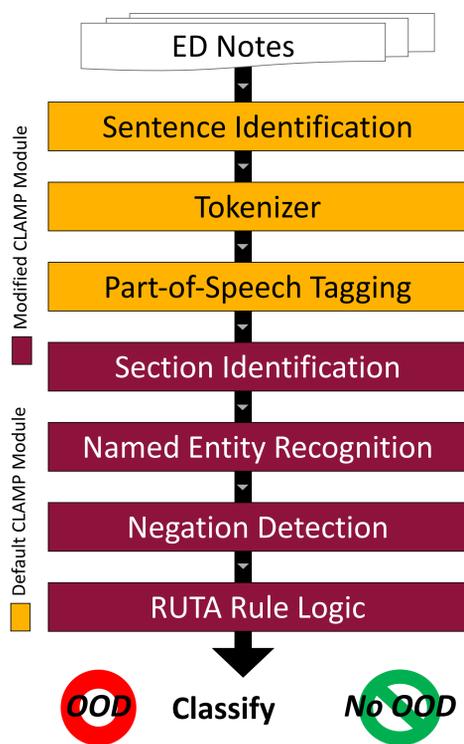
Note: Demographic data is from the set of patients identified as positive for opioid overdose using NLP and ICD classification pipelines (see Methods).

Methods

NLP Pipeline

ED Notes
→ Sentence Identification (Modified CLAMP Module)
→ Tokenizer
→ Part-of-Speech Tagging
→ Section Identification (Default CLAMP Module)
→ Named Entity Recognition
→ Negation Detection
→ RUTA Rule Logic
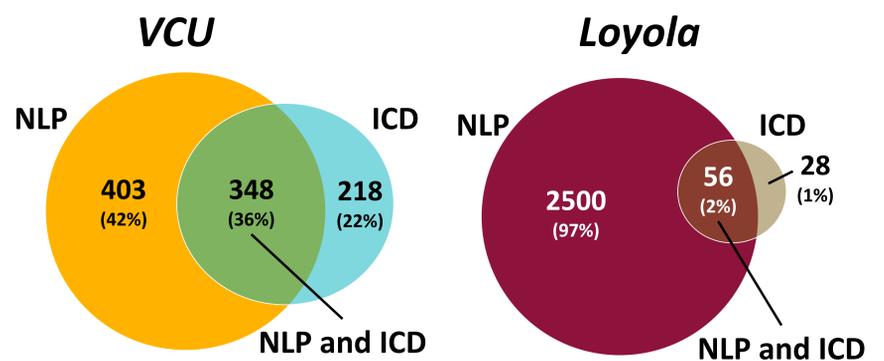→ **Classify**: OOD / No OOD

Cohort
- Emergency Department (ED) visits.
- Admit date between 9/1/16 and 9/1/17.
- Age 18 years or older.
- Records were collected from both VCU and LU.

Classification Methods
- **Diagnostic Codes (ICD)**: Encounter is associated with at least one opioid poisoning-related ICD-10-CM code.

Code	Description ("adverse effect" codes are not included)
T40.0	Poisoning by and under dosing of opium
T40.1	Poisoning by heroin
T40.2	Poisoning by and under dosing of other opioids
T40.3	Poisoning by and under dosing of methadone
T40.4	Poisoning by and under dosing of synthetic narcotics
T40.60	Poisoning by and under dosing of other and unspecified narcotics

- **Natural Language Processing (NLP)**: Rule-based classifier built in CLAMP[14] was run on first 24 hours of ED notes. Select modules were modified to identify opioid-specific terms and phrases.

Results

VCU
NLP: 403 (42%)
NLP and ICD: 348 (36%)
ICD: 218 (22%)

Loyola
NLP: 2500 (97%)
NLP and ICD: 56 (2%)
ICD: 28 (1%)

NLP Identifies Additional Opioid Overdose Encounters

True Positives: Diverse ICD codes related to pneumonitis, syncope and collapse, altered mental status, poisoning of other drugs, opioid misuse, adverse effects, etc.

False Positives: Narcan/naloxone or prescription narcotic drug mention tagged with context not considered (e.g. allergies, current prescriptions).

ICD Coding Errors: Encounters related to pain conditions (e.g. joint pain or sickle cell patient) had secondary ICD codes such as T40.2X6A (underdosing of other opioids) and T40.1X1A (accidental poisoning by heroin); however, encounters made no mention of a possible overdose nor was Narcan administered; thus, the encounter was not flagged by NLP.

Evaluation

Due to a lack of access to a data set annotated for opioid overdose, we randomly chose a subset of 100 encounters from the VCU cohort to manually annotate for evaluation. The clinical impression for the medical expert annotators was used as the gold standard.

	VCU		Related Work*	
	NLP	**ICD**	**Hazlehurst NLP**	**Green NLP**
Precision (PPV)	0.66	0.89	0.86	0.77
Recall (Sensitivity)	0.79	0.98	0.78	-
Specificity	0.71	0.91	0.89	-
F1	0.72	0.93	-	-

* Related work metrics were chosen based on the most similar cohort to the VCU data set (i.e. ED encounters with any type of opioid overdose).

To be continued…

- NLP has the potential to identify OODs missed by current surveillance methods.
- Need to refine our definition of OOD to consider other overdose-related concepts, such as a patient's physical symptoms.
- Future pipeline needs to consider context of statements.
- Need to annotate gold-standard OOD data set at both universities.

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