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The Classification and Modification of A.I. Generated Drug Diversion Signals in a Hospital System Setting

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Background

- Drug Diversion – illegal distribution or abuse of prescription drugs for purposes not intended by the prescriber
- High presence of drug diversion related events in North America
- Push for diversion related mitigation strategies
- Use of custom computer logic to flag possible diversion related events
- Previous study on computer logic mediated drug diversion:
  - Tom Knight, et al, Detecting drug diversion in health-system data using machine learning and advanced analytics, American Journal of Health-System Pharmacy, Volume 79, Issue 16, 15 August 2022, Pages 1345–1354, https://doi.org/10.1093/ajhp/zxac035

Methods

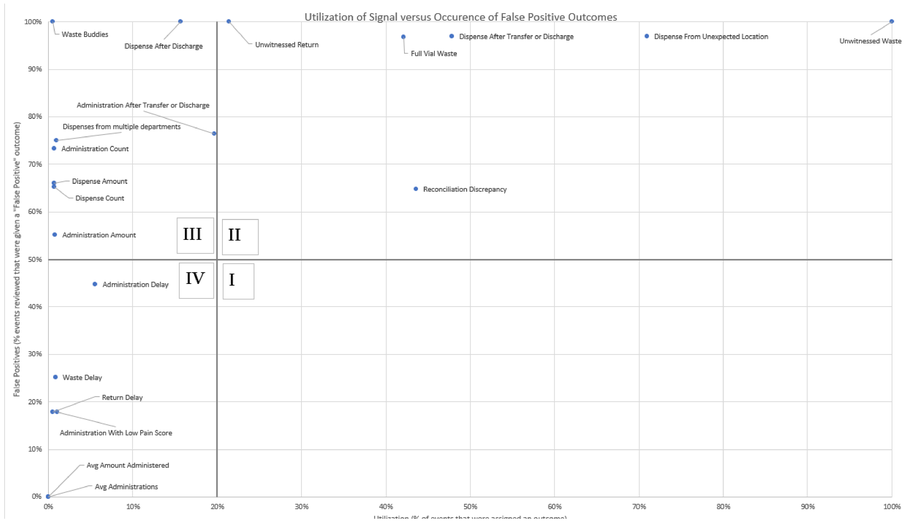
- Using drug diversion software from LogicStream™ Health
- Six months of computer-generated data taken from healthcare ministry headquartered in Springfield, IL.
- 15 total facilities ranging from acute care to Level 1 trauma centers across Illinois, Missouri and Wisconsin (January 1 – July 31 2022)
- Data was analyzed and sorted in Microsoft Excel® in order to create end-user friendly deliverables and determine accuracy of current iteration of drug diversion program
- Two primary deliverables: Modular scorecard detailing ministry-wide trend data, and additional modular scatterplot to determine program accuracy versus overall signal utilization
- Scatterplot Quadrant Definitions:
  - Class I: functioning signal, ideal
  - Class II: High utilization, High False Positive Rate
  - Class III: Low utilization, High False Positive Rate
  - Class IV: Low utilization, Low False Positive Rate
- Use developed tools to postulate improvements to Diversion App

QR Codes (must have SIUe Login)

Ministry-wide Scorecard

Drug Diversion Scorecard (NBC - 2023)					Last Update:	8/25/2022
Date Range:	1/1/2022	to				7/1/2022
Ministry-Wide Data						
Total Events		Total Events w/ Outcome		% of All Events that were assigned an outcome		
120,263		14,489		12.05%		
Ministry-wide False Positives Trends						
Total False Positives		Total False Positives/ Total Events with assigned outcome				
10,025		69.17%				
Ministry: Diversion Signals by Event Count						
Signal Name	Event Count	Events with an assigned Ou	% total events with outcome	# of False Posit	# of True Flagged Ev	% of reviewed events that are FP
Administration Delay	27677	1539	5.56%	689	850	44.77%
Waste Delay	27677	183	0.82%	46	137	25.14%
Reconciliation Discrepancy	22354	3250	43.57%	5393	3257	64.75%
Dispense Amount	21229	53	0.73%	35	18	66.04%
Dispense Count	7269	49	0.68%	32	17	65.31%
Administration Count	7255	45	0.63%	33	12	73.33%
Administration Amount	8557	49	0.79%	27	22	55.10%
Full Vial Waste	6228	2561	42.10%	2480	81	96.84%
Waste Buddies	6083	30	0.50%	30	0	100.00%
Return Delay	6003	28	0.54%	5	23	17.86%
Administration With Low Pain Score	5197	28	1.04%	5	23	17.86%
Dispense From Unexpected Location	2694	515	70.94%	499	16	96.89%
Dispenses from multiple departments	726	4	0.94%	3	1	75.00%
Dispense After Transfer or Discharge	427	100	47.85%	97	3	97.00%
Administration After Transfer or Discharge	209	34	13.65%	26	8	76.47%
Dispense After Discharge	173	13	15.66%	13	0	100.00%
Unwitnessed Return	83	9	21.43%	9	0	100.00%
Avg Amount Administered	42	0	0.00%	0	0	0.00%
Avg Administrations	39	0	0.00%	0	0	0.00%
Unwitnessed Waste	15	3	100.00%	3	0	100.00%
Ministry: Most Unused Diversion Signals by Unprocessed Event Count				Ministry: Bottom Diversion Signals By Event Count		
Signal Name	Event Count	Unprocessed Events (No o	total events unprocess	Signal Name	Event Count	Events with Outcom	% of total events with an outcome
Administration Delay	27677	26138	94.44%	Administration With Low Pain Score	2694	28	1.04%
Waste Delay	22354	22171	99.18%	Dispense From Unexpected Location	726	515	70.94%
Reconciliation Discrepancy	21229	11979	56.43%	Dispenses from multiple departments	427	4	0.94%
Dispense Amount	7269	7216	99.27%	Dispense After Transfer or Discharge	209	100	47.85%
Dispense Count	7255	7206	99.32%	Administration After Transfer or Discharge	173	34	19.65%
Administration Count	8557	6512	99.31%	Dispense After Discharge	83	13	15.66%
Administration Amount	6228	6179	99.21%	Unwitnessed Return	42	9	21.43%
Waste Buddies	6003	5973	99.50%	Avg Amount Administered	39	0	0.00%
Return Delay	5197	5169	99.46%	Avg Administrations	15	0	0.00%
Trends by Hospital							
Hospital Name	Number of even	% of total ministry events	# of events with outcon	% of signal usage	# of False Posit	# of True Flagged Ev	% of Outcomes that were False Po
	43890	36.7%	9311	21.2%	7325	1986	78.7%
	17358	14.5%	2	0.0%	1	1	50.0%
	13640	11.4%	1743	12.8%	1013	730	58.1%
	12426	10.4%	1404	11.3%	468	936	33.3%
	8607	7.2%	27	0.3%	13	14	48.1%
	5947	5.0%	764	12.8%	464	300	60.7%
	3728	3.1%	411	11.0%	303	108	73.7%
	3446	2.9%	493	14.3%	233	260	47.3%
	2747	2.3%	5	0.2%	1	4	20.0%
	1982	1.6%	21	1.1%	12	9	57.1%
	1726	1.4%	192	11.1%	125	67	65.1%
	1599	1.3%	114	7.1%	67	47	58.8%
	1171	1.0%	0	0.0%	0	0	0.0%
	1043	0.9%	2	0.2%	0	2	0.0%
	300	0.3%	0	0.0%	0	0	0.0%

Scatterplot to Determine Program Accuracy



Results

- Over 6 months, 120,263 total events were created,
- Of those, 14,489 events were reviewed by an end user.
- Most fired signals: Administration Delay (27,677 events), Waste Delay (27,677 events), Reconciliation Discrepancy (22,354 events), Dispense Amount (21,229 events), and Dispense Count (7,269 events)
- Most under processed signals(%): Administration Delay (94.44%), Waste Delay (99.18%), Dispense Amount (99.27%), Dispense Count (99.32%)
- Hospital with most events: (A) - 43,890 events (36.7% of ministry events).
  - Of the 9,311 events reviewed, 7,325 events (21.2%) labeled as False Positive

Conclusions

Scorecard

- Top five signals that fired ministry wide were also the top five most under-reviewed
- Uneven event distribution between hospitals
- Uneven utilization of signals between hospitals

Scatterplot

- Most signals require some form of adjustment to mitigate false positive percentage
- Possible Signal Improvements based on quadrant
  - Class II: Adjust signal parameters (timing, criteria)
  - Class III: Same as Class II changes, focus on user-perceived signal importance, reduce number of events occurring
  - Class IV: Reevaluate signal importance, bolster utilization above threshold to determine true false positive rate

Confounding Variables/ Limitations:

- Low signal utilization overall
- End user bias towards reviewing certain signals
- Short term time, financial and personnel restrictions
- Unbalanced usage of program between hospitals

Implications

- Continued research in the application of custom computer programs into healthcare systems and data mining.
- Established baseline scoring tools to assess and improve the Drug Diversion app's accuracy at detecting possible diversion events
- Eventual reduction in costs associated with drug diversion inpatient.
- Further study and refinement of scoring tool warranted.