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Identifying mental health and substance use disorders using emergency department and hospital records: diagnostic concordance and disease attribution

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Working title: Identifying mental health and substance use disorders using emergency department and hospital records: diagnostic concordance and disease attribution

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Abstract

Objectives: Administrative data are increasingly being used for surveillance and monitoring of mental health and substance use disorders (MHSUD) across Canada. However, the validity of the diagnostic codes specific to MHSUD are unknown in emergency departments (EDs). Our objective was to determine the concordance, and individual- and hospital-level factors associated with concordance, between diagnosis codes assigned in ED and at discharge from hospital for MHSUD related conditions.

Design: Population-based retrospective cohort study.

Setting: EDs and hospitals within Vancouver Coastal Health Authority (VCH), British Columbia, Canada.

Participants: 16,926 individuals who were admitted into a VCH hospital following an ED visit from April 1st 2009 to March 31st 2017, contributing to 48,116 pairs of ED and hospital discharge diagnoses.

Primary and secondary outcome measures: We examined concordance in identifying MHSUD between the primary discharge diagnosis codes (*ICD-9-CA* and *ICD-10-CA*) assigned in the ED and those assigned in the hospital among all ED visits resulting in a hospital admission. We calculated the percent overall agreement, positive agreement, negative agreement, and Cohen's kappa coefficient. We performed multiple regression analyses to identify factors independently associated with discordance.

Results: We found a high level of concordance for broad categories of MH conditions (overall agreement=0.89, positive agreement=0.74, kappa=0.67), and a fair level of concordance for SUDs (overall agreement=0.89, positive agreement=0.31, kappa=0.27). SUDs were less likely to be indicated as the primary cause in ED as opposed to in hospital (3.8% vs. 11.7%). In multiple regression analyses, ED visits occurring during holidays, weekends, and overnight (9:00PM-8:59AM) were associated with increased odds of discordance in identifying MH conditions (aOR: 1.46[1.11-1.92]; 1.23[1.11-1.35]; 1.30[1.19-1.42], respectively).

Conclusions: ED data could be used to improve surveillance and monitoring of MHSUD. Future efforts are needed to improve screening for individuals with MHSUD and subsequently connect them to treatment and follow-up care.

Keywords: acute health care, mental health, substance use, surveillance and monitoring, diagnostic codes, validation study

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Strengths and limitations of this study

- Concordance between ED and hospital diagnostic codes were assessed within a population-based cohort identified from the linkage of two comprehensive health administrative datasets of acute care.
- Among the few studies that examine the validity of diagnostic codes used for MHSUD in acute care, informing their use in surveillance and monitoring.
- Analysis was limited to ED visits admitted to hospital and may not be representative of diagnostic accuracy of ED visits discharged directly from ED.
- Data capture was limited to primary diagnostic codes assigned in ED; thus, improved detection of SUDs are possible in settings where more diagnostic codes are available.

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Introduction

Mental health conditions and substance use disorders (SUD) are the leading cause of the global burden of diseases, posing substantial health and economic impacts on individuals and society.[1] Individuals with a mental health and/or SUD are at increased risk of emergency department (ED) use and hospitalization,[2] and often access the ED as first contact point for medical care.[3] While health administrative data are increasingly being used for surveillance and performance monitoring across Canada,[3-6] ED data are often not included in these efforts,[4,6] partially due to the lack of consistency in ED data collection and reporting across country.[7]

Vancouver Coastal Health (VCH) is one of BC's five regional health authorities, serving approximately one million residents, including the Downtown Eastside (DTES) neighborhood, one which has historically featured a high prevalence of substance use, mental illness, infectious diseases, and homelessness.[8] In 2015, prior to the declaration of a public health emergency in opioid overdose, VCH made integrated, comprehensive care delivery among the cornerstones of its DTES Second Generation Strategy (DTES-2GS) to acknowledge the unique needs of this population, which often present to care with multiple concurrent disorders and social problems.[9] Reducing SUD-related acute care visits is a central aim in both the overdose response and the DTES-2GS initiative, hence diagnostic information collected in these visits is of central importance to surveillance, monitoring, and evaluation[10,11].

While diagnostic codes assigned in hospital are subject to nationally-coordinated cleaning and validation[12,13], the validity of the diagnostic codes specific to mental health and SUD in ED are unknown. Our objectives were to determine the concordance, and individual- and hospital-level factors associated with concordance between *ICD-9-CA* and *ICD-10-CA* diagnosis codes assigned in the ED and at discharge from hospital for any mental health and substance use related conditions observed in VCH between 2007 and 2017.

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Methods

Study population and data sources

We obtained our data from a cohort of individuals residing in or having a record of receiving community-based services in Vancouver's DTES neighborhood between April 1st 2009 and March 31st 2017. The cohort was defined using health administrative databases held by VCH, including the CommunityMart database (capturing community-based health service referrals), the EDMart database (capturing emergency department visits), and the discharge abstract database (DAD) (capturing hospitalizations). Data linkage was performed by VCH data stewards based on unique Personal Health Numbers recorded in each database. We extracted data on individuals with at least one ED or hospital record during study follow-up to identify any indication of mental health conditions or SUD. All records of ED visits resulting in hospital admission were used to assess concordance in diagnostic codes within the two databases. While the ED data contain records since April 2007, only those collected after April 1st 2012 were subject to national-level data quality control.[14,15] In contrast, hospitalization data is standardized nationally with VCH DAD data dated back to April 1st 2007, with key fields (including diagnosis codes) subjected to error checks and validation.[12]

Measures

We considered the primary diagnosis field in ED (coded using *ICD-10-CA* from April 1st 2012 onward, and a combination of *ICD-9-CA* and *ICD-10-CA* prior to this date), and any of the up to 25 primary and secondary diagnosis fields (coded by *ICD-10-CA* exclusively) in hospital. We defined mental health conditions and SUD using *ICD-9-CA* from 290-319, or their *ICD-10-CA* equivalents from F00-F99, consistent with the Canadian surveillance system.[4,6] In addition, we considered more specific codes to identify alcohol use disorder (AUD), opioid use disorder (OUD), other SUD, mood disorders, depression, psychoses, neurotic/stress/ somatoform disorders (NSS), anxiety disorders, and personality disorders (specific codes provided in the **supplementary appendix**).

We also considered demographic characteristics including gender, age, DTES residence (ever), and homeless status, as well as event urgency using the Canadian Triage Acuity Scale (CTAS)[16], length of ED visit (<6 hours, ≥6 hours; defined as the difference between date/time of triage or registration in ED and date/time the patient left the nursing unit), time (day: 9:00am-8:59pm, 9:00pm-8:59am), day (weekday, weekend, holiday), fiscal year of ED visit (2007-2011, 2012-2014, 2015-2017), and a hospital indicator variable.

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Statistical analysis

We examined the proportion of acute care visits with an indication of mental health conditions or SUD identified by hospital records only, by both ED and hospital records, and by ED records only. Among all ED visits resulting in a hospital admission, we examined the concordance between the primary-cause assigned in ED and in hospital. We calculated the percent overall agreement, positive agreement, negative agreement, and the Cohen's kappa coefficient - a statistic which measures agreement for categorical items, taking into account the possibility of the agreement occurring by chance of ED-hospital discharge diagnosis pairs.[17] Landis and Koch's classifications were used to interpret the Kappa statistics produced: 0 as no agreement, 0.01-0.2 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as high, and 0.81–1.00 as almost perfect agreement.[18] In addition, treating hospital discharge diagnosis as the reference standard, we calculated sensitivity, specificity, positive predictive value, and negative predictive value of the primary-cause of visit assigned in an ED. We repeated these analyses for each specific type of mental health and substance use disorder. Further, we examined the concordance between primary-cause assigned in ED against any-cause assigned in hospital.

Finally, among ED visits transferred to hospital with at least one diagnosis code in either hospital or ED indicating a mental health or substance use disorder, we performed a multiple regression analysis to identify patient- and ED visit-related factors independently associated with discordance. We used a generalized linear mixed effects model (GLMM) with a logit link and binomial distribution to account for intra-individual correlation between repeated acute care visits.[19] We repeated the analysis for any substance use disorders and any mental health conditions. All analyses were performed using SAS statistical software version 9.4.

Patient and public involvement

Patients and public were not involved in the design, conduct, and reporting of this research.

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Results

Among 56,875 DTES cohort participants, 43,017 (75.6%) had at least one ED or hospital record between April 1st 2007 and March 31st 2017 and were included in our analyses. Among them, 16,996 (39.5%) had an indication of a mental health or substance use disorder (**Table 1**). It is notable that ED data increased attribution of mental health and substance use disorders within the study cohort by 25.5%. The proportions of missed case identification without ED records were comparable for AUD, OUD, and other SUDs (21.9%-27.8%), and higher for most mental health conditions (27.9%-65.3%), except for personality disorders (8.8%) (**Table 1**).

A total of 16,926 individuals were admitted into a VCH hospital following an ED visit, contributing to 48,116 pairs of ED and hospital discharge diagnoses (**Table 2)**. 15.4% of ED visits resulted in hospitalization during the study period. We found a high level of overall agreement between ED and hospital primary diagnoses in classifying whether a visit was related to a mental health condition or SUD (overall agreement=0.89, positive agreement=0.82, kappa=0.74). Compared to primary diagnosis code at hospital discharge, the primary diagnosis code assigned at ED discharge was less likely to classify a visit as SUD-related (11.8% vs. 3.8%), resulting in a fair level of agreement between ED and hospital in identifying any SUD-related visits (positive agreement=0.31, kappa=0.27). In contrast, ED and hospital classified a more comparable proportion of visits as mental health-related (21.7% vs 22.0%) with a high level of agreement (overall agreement=0.89, positive agreement=0.74, kappa=0.67).

The primary diagnoses in ED had consistently high specificity (0.93-1.00) in classifying mental health and SUD, however, sensitivity varied widely (0.09-0.78). The positive predictive values ranged from 0.41-0.67 for SUD and 0.16-0.67 for mental health conditions (**Table 2**). These values increased to 0.80-0.94 and 0.30-0.75, respectively, if any of the up to 25 diagnosis codes in hospital were considered (**Table 2A**).

In a multiple regression analysis, we found younger age and shorter length of ED visit were associated with increased odds of discordance between ED and hospital in identifying substance use disorders (**Table 3**). In contrast, they were associated with decreased odds of discordance in identifying mental health conditions. Otherwise, ED visits occurring during holidays, weekends, and overnight (9:00 PM-8.59 AM) were associated with increased odds of discordance in identifying mental health conditions (aOR: 1.46 [1.11-1.92]; 1.23 [1.11-1.35]; and 1.30 [1.19-1.42], respectively). However, we did not observe such associations for discordance in identifying substance use disorders. Lastly, ED visits occurring in more recent years were associated with

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reduced odds of discordance in identifying substance use disorders compared to visits prior to April 1st 2012 (aOR: 0.53 [0.44-0.63]; 0.74 [0.60-0.91], respectively, for fiscal years 2012-2014, and 2015-2017).

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Discussion

Using hospital and ED administrative records from VCH, we found a high proportion (39.5%) of individuals with an indication of a mental health or SUD, 25.5% of which would not have been identified without the use of ED data. We found a high level of overall agreement between ED and hospital in classifying whether a visit was related to any MHSUD. The concordance was higher for determining any mental health-related visit as opposed to SUDs. An individuals' age and several ED visit-specific factors were found to be independently associated with the concordance between ED and hospital, with the direction of associations differing in identifying mental health conditions and SUDs.

It is important to emphasize the fact that 25.5% of individuals with mental health or SUD could not have been identified using only hospital records. The value of these data for disease surveillance and the monitoring and evaluation of changes in policy and practice are clear, however, it is notable that SUD overall, and illicit drug use in particular, were largely under-detected in the EDs as compared to hospitals. While there are many competing priorities in ED settings, improving screening for SUDs can help connect individuals to treatment and follow-up care and reduce the likelihood of subsequent readmission.[20]

Otherwise, we found a comparable proportion of contacts in EDs and hospitals which were identified to be mental health-related. This was consistent with a systematic review of mental health diagnoses accuracy in administrative data that showed comparable accuracy for diagnoses made in inpatient settings compared to other settings.[21] Moreover, we found a high level of agreement between hospital and ED diagnoses in determining any mental health conditions in general, with high concordance for psychoses, moderate concordance for mood disorders, but low concordance for anxiety disorders and personality disorders. Our findings were consistent with a systematic review which concluded administrative data were generally predictive of true diagnosis of psychotic categories, but were less satisfactory in identifying anxiety disorders.[21]

Given the inherent complexity in diagnosing mental health conditions, it is not surprising there is inadequate reliability in the diagnosis of specific types of mental health conditions. Notably, we found ED visits occurring during holidays and weekends, as well as those during overnight shifts were associated with higher odds of mental health diagnostic discordance between ED and hospital. Various studies have investigated the "weekend effect" in healthcare, suggesting poorer health outcomes among individuals admitted to hospitals during the weekend as opposed to weekdays. Two Canadian studies of ED admission found weekend admissions were associated

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with significantly higher in-hospital mortality rates.[22,23] To our knowledge, this study is the first to identify an independent association between ED visit timing and mental health diagnosis accuracy. Several factors might explain these associations, including the intensity of care and medical staff, the volume of ED visits at different times of the day and week, as well as potential impairment of physical and cognitive abilities of medical staff due to sleep deprivation especially during nighttime.[24,25] Some adjustments to staffing models at the ED might be made to improve diagnosis accuracy.

Several limitations are worth noting. First, we assessed the validity of the ED diagnostic code in a limited and selective subset of all ED visits; those subsequently admitted to hospital no doubt had symptoms of higher severity, and such cases may not be representative of diagnostic accuracy of ED visits discharged directly from ED. Further, diagnostic codes assigned in hospital are not an ideal 'gold standard' as they have been reported to have high specificity but moderate sensitivity in identifying mental health conditions and SUD.[26] Nonetheless, in the absence of an external 'gold standard', an analysis of concordance between ED and hospital diagnosis codes can help illuminate data quality.[27] Third, only primary diagnosis codes were available in VCH ED records. In settings where more diagnosis codes are available, there may be improved detection of SUDs.

In conclusion, we found a high level of diagnostic concordance between ED and hospital for broad categories of mental health conditions, and a fair level of concordance for SUD. A large proportion of individuals with an indication of a mental health condition or SUD would be missed without ED records. Future efforts are needed to improve screening for individuals with mental health and substance use disorders and connect them to treatment and follow-up care.

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Contributors

LW, DP, and BN designed the study, conceptualized the analysis and wrote the first draft of the manuscript. FH and LW performed data cleaning and conducted the analyses. FH, LAP, and DP provided critical input on and revised the manuscript. BN and CM are principal investigators of the parent study. RM and RB provided input on the manuscript on behalf of VCH. All authors read and approved the final manuscript.

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Competing interests

None declared.

Ethics approval

Ethical approval was obtained from the Providence Health Care Research Institute (H16-00516) and the Simon Fraser University Office of Research Ethics (2016s0670).

Data sharing statement

Data and computing code required to replicate results are held at the BC Centre for Excellence in HIV/AIDS in Vancouver, Canada. Inquiries can be sent by email to: bnosyk@cfenet.ubc.ca. Opportunities for collaboration are provided at the discretion of Vancouver Coastal Health Authority.

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Table 1. Identification of mental health and substance use disorders using hospital (any diagnosis codes) and emergency department records among DTES cohort participants (N=56,875).[a]

	Total		Proportion of individuals identified by data source		
Health conditions	Number of individuals	Prevalence (%)	Hospital records only N (%)	ED records only N (%)	Both hospital and ED records N (%)
Mental health and substance use disorders	16996	29.9	5024 (29.6)	4330 (25.5)	7642 (45.0)
Any selected substance use disorders	12638	22.2	5252 (41.6)	3238 (25.6)	4148 (32.8)
Alcohol use disorders	6206	10.9	2877 (46.4)	1727 (27.8)	1602 (25.8)
Other substance use disorders [b]	9865	17.3	4938 (50.1)	2160 (21.9)	2767 (28.0)
Opioid use disorder	5407	9.5	2778 (51.4)	1465 (27.1)	1164 (21.5)
Any selected mental health disorders	9163	16.1	2059 (22.5)	2705 (29.5)	4399 (48.0)
Mood disorders [c]	4286	7.5	1792 (41.8)	1195 (27.9)	1299 (30.3)
Depression	3245	5.7	1231 (37.9)	1226 (37.8)	788 (24.3)
Psychoses	4763	8.4	799 (16.8)	1410 (29.6)	2554 (53.6)
Neurotic/stress/somatoform disorders [d]	4189	7.4	1408 (33.6)	2142 (51.1)	639 (15.3)
Anxiety disorders	2515	4.4	681 (27.1)	1642 (65.3)	192 (7.6)
Personality disorders	1860	3.3	1488 (80.0)	164 (8.8)	208 (11.2)

[a] Cases identified using at least one hospital or emergency department record of diagnosis code; [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 2. Concordance between the primary diagnosis code assigned in the ED and the primary diagnosis code assigned at hospital discharge following an ED visit for any mental health conditions or SUDs (N=16926, 48116 pairs).

	Condition indicated in				Concordance statistics				Validity statistics (assume hospital discharge diagnosis as "gold-standard")			
Health conditions	Any N (%)	ED only N (%)	Hospital only N (%)	ED and hospital N (%)	Overall agree	Positive agree	Negative agree	Kappa (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
Mental health and substance	17520 (36.4)	1040 (2.2)	4275 (8.9)	12205 (25.4)	0.89	0.82	0.92	0.74 (0.74-0.75)	0.74 (0.73-0.75)	0.97 (0.97-0.97)	0.92 (0.92-0.93)	0.88 (0.87-0.88)
Any selected substance use	6299 (13.1)	639 (1.3)	4492 (9.3)	1168 (2.4)	0.89	0.31	0.94	0.27 (0.26-0.28)	0.21 (0.2-0.22)	0.99 (0.98-0.99)	0.65 (0.62-0.67)	0.90 (0.9-0.91)
Alcohol use disorders	604 (1.3)	90 (0.2)	452 (0.9)	62 (0.1)	0.97	0.48	0.98	0.47 (0.44-0.49)	0.38 (0.35-0.4)	0.99 (0.99-0.99)	0.67 (0.64-0.7)	0.97 (0.97-0.98)
Other substance use	2314 (4.8)	359 (0.7)	1222 (2.5)	733 (1.5)	0.92	0.17	0.96	0.15 (0.14-0.17)	0.10 (0.09-0.11)	0.99 (0.99-0.99)	0.54 (0.5-0.58)	0.93 (0.93-0.93)
Opioid use disorder	4035 (8.4)	330 (0.7)	3320 (6.9)	385 (0.8)	0.99	0.19	0.99	0.18 (0.14-0.22)	0.12 (0.09-0.15)	1.00 (1.00-1.00)	0.41 (0.33-0.49)	0.99 (0.99-0.99)
Any selected mental health	13226 (27.5)	2644 (5.5)	2761 (5.7)	7821 (16.3)	0.89	0.74	0.93	0.67 (0.66-0.68)	0.74 (0.73-0.75)	0.93 (0.93-0.93)	0.75 (0.74-0.76)	0.93 (0.92-0.93)
Mood disorders [c]	2070 (4.3)	874 (1.8)	775 (1.6)	421 (0.9)	0.95	0.43	0.97	0.40 (0.39-0.42)	0.39 (0.37-0.41)	0.98 (0.98-0.98)	0.48 (0.46-0.51)	0.97 (0.97-0.97)
Depression	157 (0.3)	71 (0.1)	73 (0.2)	13 (0.0)	0.97	0.34	0.98	0.32 (0.3-0.34)	0.35 (0.32-0.38)	0.98 (0.98-0.98)	0.33 (0.3-0.35)	0.98 (0.98-0.98)
Psychoses	582 (1.2)	104 (0.2)	433 (0.9)	45 (0.1)	0.92	0.72	0.95	0.67 (0.66-0.68)	0.78 (0.77-0.79)	0.94 (0.94-0.94)	0.67 (0.66-0.68)	0.96 (0.96-0.97)
Neurotic/stress/somatofor	9323 (19.4)	2592 (5.4)	1459 (3.0)	5272 (11.0)	0.97	0.13	0.99	0.11 (0.09-0.14)	0.10 (0.08-0.12)	0.99 (0.99-0.99)	0.18 (0.15-0.22)	0.98 (0.98-0.98)
Anxiety disorders	3468 (7.2)	1015 (2.1)	1500 (3.1)	953 (2.0)	1.00	0.15	1.00	0.15 (0.08-0.23)	0.15 (0.08-0.24)	1.00 (1.00-1.00)	0.16 (0.09-0.25)	1.00 (1.00-1.00)
Personality disorders	1316 (2.7)	396 (0.8)	832 (1.7)	88 (0.2)	0.99	0.14	0.99	0.14 (0.1-0.18)	0.09 (0.07-0.12)	1.00 (1.00-1.00)	0.30 (0.23-0.38)	0.99 (0.99-0.99)

Abbreviation: ED, emergency department; CI: confidence interval; a [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 3. Factors associated with discordance between the primary diagnosis code assigned in the emergency department and the primary diagnosis code assigned at hospital discharge following an emergency department visit [a]

	Outcomes: Discordance in identifying		
	Mental health or SUD (N=17,503)	Any SUD (N=6,294)	Any mental health conditions (N=13,214)
Characteristics	Odds Ratios (95% CI)		
Male	0.95 (0.86-1.04)	0.94 (0.79-1.13)	0.95 (0.86-1.05)
Age at visit			
≥65	Reference	Reference	Reference
55-64	**0.49 (0.41-0.57)**	1.25 (0.87-1.79)	**0.60 (0.48-0.76)**
45-54	**0.38 (0.33-0.44)**	**1.60 (1.14-2.24)**	**0.78 (0.63-0.97)**
35-44	**0.29 (0.25-0.34)**	**1.87 (1.33-2.62)**	**0.80 (0.65-0.99)**
25-34	**0.26 (0.23-0.31)**	**2.58 (1.81-3.68)**	**0.79 (0.64-0.98)**
<25	**0.36 (0.30-0.44)**	**2.51 (1.66-3.79)**	0.99 (0.78-1.25)
Ever residing in DTES [b]	1.07 (0.97-1.17)	0.99 (0.82-1.19)	**1.19 (1.08-1.32)**
Homeless at time of visit [c]	1.00 (0.90-1.10)	0.88 (0.74-1.05)	**1.26 (1.13-1.41)**
Year of visit			
2007-2011	Reference	Reference	Reference
2012-2014	**0.71 (0.65-0.78)**	**0.53 (0.44-0.63)**	1.04 (0.95-1.15)
2015-2017	**0.66 (0.60-0.73)**	**0.74 (0.60-0.91)**	1.09 (0.97-1.21)
Day of visit			
Weekday	Reference	Reference	Reference
Weekend	**1.21 (1.11-1.32)**	0.90 (0.77-1.05)	**1.23 (1.11-1.35)**
Holiday	**1.51 (1.19-1.92)**	1.25 (0.76-2.04)	**1.46 (1.11-1.92)**
Time of visit			
9:00 AM-8.59 PM	Reference	Reference	Reference
9:00 PM-8.59 AM	**1.27 (1.17-1.37)**	1.06 (0.91-1.24)	**1.30 (1.19-1.42)**
Triage acuity at ED			
Semi to none urgent	Reference	Reference	Reference
Urgent	0.98 (0.87-1.11)	0.77 (0.58-1.02)	**1.19 (1.04-1.36)**
Resuscitation-Emergency	0.99 (0.87-1.12)	0.99 (0.73-1.33)	**1.23 (1.07-1.42)**
Discharge status at ED			
Hospitalized/Transferred	Reference	Reference	Reference
Discharged Home	1.10 (0.99-1.21)	0.91 (0.76-1.08)	**1.86 (1.67-2.07)**
Leaving against medical advice	**2.34 (1.72-3.18)**	**0.46 (0.31-0.69)**	**2.25 (1.39-3.62)**
Emergency department hospital			
St. Paul's hospital	Reference	Reference	Reference
Lions gate hospital	**1.31 (1.04-1.65)**	0.69 (0.47-1.00)	**1.53 (1.16-2.02)**
Mount Saint Joseph hospital	**1.92 (1.50-2.46)**	**0.29 (0.20-0.43)**	**2.47 (1.61-3.80)**
Other	0.68 (0.20-2.26)	0.23 (0.02-2.16)	1.37 (0.42-4.50)
Richmond hospital	**2.58 (2.17-3.06)**	**0.65 (0.49-0.86)**	**3.82 (3.02-4.85)**
Vancouver general hospital	**0.63 (0.58-0.69)**	0.96 (0.80-1.14)	0.97 (0.88-1.06)
Length of ED visit			
< 6 hours	Reference	Reference	Reference
>=6 hours	**1.14 (1.02-1.27)**	**0.63 (0.49-0.82)**	**1.28 (1.14-1.43)**

[a] Among visits with either hospital or emergency department record indicating a case.
[b] Determined by known postal code or homeless user of VCH services, or DTES indication in CommunityMart data

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[c] Determined by presence of postal code V6Y2A1 (used if no fixed address or postal code in discharge abstract database/EDMart data); postal code “XX” (used for transient/homeless populations in discharge abstract database/EDMart); postal code A0A 0A0 (assigned if no postal code for emergency department visit in EDMart and CommunityMart); indication of homelessness in EDMart/CommunityMart data.

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Appendix

Table 1A. Identification of mental health and substance use disorders using hospital (any diagnosis codes) and ED records among DTES cohort participants (using data from April 1st 2012 onward) (N=56,875).[a]

	Total	Proportion of individuals identified by data source		
Health conditions	Number of individuals	Hospital records only N (%)	ED records only N (%)	Both hospital and ED records N (%)
Mental health and substance use disorders	12355	3632 (29.4)	3388 (27.4)	5335 (43.2)
Any substance use disorders	9655	3844 (39.8)	2872 (29.7)	2939 (30.4)
Alcohol use disorders	4587	1928 (42.0)	1518 (33.1)	1141 (24.9)
Non-alcohol substance use disorders [b]	7418	3686 (49.7)	1813 (24.4)	1919 (25.9)
Opioid use disorder	4317	2079 (48.2)	1360 (31.5)	878 (20.3)
Any mental health disorders	6225	1370 (22.0)	1890 (30.4)	2965 (47.6)
Mood disorders [c]	2709	1063 (39.2)	869 (32.1)	777 (28.7)
Depression	2015	719 (35.7)	860 (42.7)	436 (21.6)
Psychoses	3438	513 (14.9)	1077 (31.3)	1848 (53.8)
Neurotic, stress and somatoform disorders [d]	2434	1039 (42.7)	1150 (47.2)	245 (10.1)
Anxiety disorders	1797	412 (22.9)	1265 (70.4)	120 (6.7)
Personality disorders	1260	1062 (84.3)	80 (6.3)	118 (9.4)

[a] Cases identified using at least one hospital or emergency department record of diagnosis code indicating a case; [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 2A. Concordance between the primary diagnosis code assigned in the ED and any diagnosis codes assigned at hospital discharge following an ED visit for any mental health and substance use-related conditions (N=16926, 48116 pairs).

Health conditions	Condition indicated in				Concordance statistics				Validity statistics (assume hospital discharge diagnosis as "gold-standard")			
	Any N (%)	ED only N (%)	Hospital only N (%)	ED and hospital N (%)	Overall agree	Positive agree	Negative agree	Kappa (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
Mental health and substance	30775 (64.0)	214 (0.4)	17530 (36.4)	13031 (27.1)	0.63	0.59	0.66	0.34 (0.34-0.35)	0.43 (0.42-0.43)	0.99 (0.99-0.99)	0.98 (0.98-0.99)	0.50 (0.49-0.5)
Any selected substance use	23733 (49.3)	78 (0.2)	21926 (45.6)	1729 (3.6)	0.54	0.14	0.69	0.07 (0.07-0.07)	0.07 (0.07-0.08)	1.00 (1.00-1.00)	0.96 (0.95-0.97)	0.53 (0.52-0.53)
Alcohol use disorders	8127 (16.9)	30 (0.1)	7975 (16.6)	122 (0.3)	0.83	0.20	0.90	0.16 (0.16-0.17)	0.11 (0.1-0.12)	1.00 (1.00-1.00)	0.94 (0.92-0.95)	0.83 (0.82-0.83)
Other substance use	9320 (19.4)	66 (0.1)	8228 (17.1)	1026 (2.1)	0.63	0.07	0.77	0.04 (0.04-0.04)	0.04 (0.03-0.04)	1.00 (1.00-1.00)	0.92 (0.9-0.94)	0.62 (0.62-0.63)
Opioid use disorder	18644 (38.7)	56 (0.1)	17929 (37.3)	659 (1.4)	0.83	0.03	0.91	0.02 (0.02-0.03)	0.02 (0.01-0.02)	1.00 (1.00-1.00)	0.80 (0.73-0.86)	0.83 (0.83-0.84)
Any selected mental health	16034 (33.3)	1330 (2.8)	5569 (11.6)	9135 (19.0)	0.86	0.73	0.90	0.63 (0.62-0.64)	0.62 (0.61-0.63)	0.96 (0.96-0.96)	0.87 (0.87-0.88)	0.85 (0.85-0.86)
Mood disorders [c]	3199 (6.6)	687 (1.4)	1904 (4.0)	608 (1.3)	0.92	0.39	0.95	0.35 (0.34-0.37)	0.28 (0.26-0.29)	0.99 (0.98-0.99)	0.66 (0.64-0.68)	0.93 (0.92-0.93)
Depression	927 (1.9)	59 (0.1)	843 (1.8)	25 (0.1)	0.95	0.32	0.97	0.29 (0.27-0.31)	0.24 (0.23-0.26)	0.99 (0.98-0.99)	0.47 (0.44-0.5)	0.96 (0.96-0.96)
Psychoses	3192 (6.6)	49 (0.1)	3043 (6.3)	100 (0.2)	0.91	0.72	0.94	0.67 (0.66-0.68)	0.70 (0.69-0.71)	0.95 (0.95-0.95)	0.75 (0.74-0.76)	0.94 (0.93-0.94)
Neurotic/stress/somatofor	10387 (21.6)	1976 (4.1)	2523 (5.2)	5888 (12.2)	0.95	0.10	0.97	0.09 (0.07-0.1)	0.06 (0.05-0.07)	0.99 (0.99-0.99)	0.31 (0.27-0.36)	0.95 (0.95-0.95)
Anxiety disorders	5348 (11.1)	672 (1.4)	3380 (7.0)	1296 (2.7)	0.98	0.05	0.99	0.05 (0.03-0.07)	0.03 (0.02-0.04)	1.00 (1.00-1.00)	0.30 (0.2-0.41)	0.98 (0.98-0.98)
Personality disorders	2803 (5.8)	333 (0.7)	2319 (4.8)	151 (0.3)	0.94	0.06	0.97	0.06 (0.04-0.07)	0.03 (0.03-0.04)	1.00 (1.00-1.00)	0.67 (0.59-0.75)	0.94 (0.93-0.94)

Abbreviation: ED, emergency department; CI: confidence interval; [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 3A. Factors associated with discordance between the primary diagnosis code assigned in the emergency department and any diagnosis codes assigned at hospital discharge following an emergency department visit [a]

	Outcomes: Discordance in identifying		
	Mental health and substance use disorders (N=30,722)	Any selected substance use (N=23,688)	Any selected mental health disorders (N=16,017)
Characteristics	Odds Ratios (95% CI)		
Male	**0.87 (0.80-0.94)**	0.96 (0.84-1.10)	**0.89 (0.81-0.98)**
Age at visit			
>=65	Reference	Reference	Reference
55-64	**0.69 (0.60-0.78)**	1.16 (0.90-1.50)	**0.40 (0.33-0.48)**
45-54	**0.51 (0.45-0.57)**	1.13 (0.89-1.44)	**0.34 (0.29-0.41)**
35-44	**0.32 (0.29-0.37)**	1.13 (0.88-1.45)	**0.27 (0.23-0.32)**
25-34	**0.26 (0.23-0.30)**	**1.41 (1.08-1.83)**	**0.25 (0.21-0.30)**
<25	**0.25 (0.21-0.30)**	1.25 (0.91-1.71)	**0.33 (0.27-0.41)**
Ever residing in DTES [b]	**1.43 (1.32-1.56)**	**1.21 (1.05-1.40)**	1.09 (0.99-1.21)
Homeless at time of visit [c]	0.92 (0.84-1.01)	**0.80 (0.70-0.92)**	**1.10 (1.00-1.22)**
Year of visit			
2007-2011	Reference	Reference	Reference
2012-2014	**0.74 (0.68-0.79)**	**0.62 (0.54-0.71)**	0.93 (0.85-1.02)
2015-2017	**0.73 (0.67-0.80)**	**0.75 (0.64-0.88)**	0.95 (0.86-1.05)
Day of visit			
Weekday	Reference	Reference	Reference
Weekend	**1.24 (1.16-1.33)**	0.90 (0.80-1.01)	**1.28 (1.17-1.40)**
Holiday	**1.39 (1.14-1.70)**	0.96 (0.66-1.38)	**1.67 (1.30-2.14)**
Time of visit			
9:00 AM-8.59 PM	Reference	Reference	Reference
9:00 PM-8.59 AM	**1.39 (1.30-1.48)**	0.91 (0.81-1.02)	**1.34 (1.24-1.46)**
Triage acuity at ED			
Semi to none urgent	Reference	Reference	Reference
Urgent	**0.79 (0.71-0.87)**	**0.60 (0.49-0.74)**	**1.15 (1.01-1.30)**
Resuscitation-Emergency	**0.80 (0.72-0.89)**	**0.65 (0.53-0.81)**	**1.20 (1.05-1.36)**
Discharge status at ED			
Hospitalized/Transferred	Reference	Reference	Reference
Discharged Home	**0.52 (0.48-0.57)**	**0.59 (0.51-0.69)**	**1.33 (1.20-1.47)**
Leaving against medical advice	**1.98 (1.52-2.57)**	**0.47 (0.35-0.65)**	**2.63 (1.69-4.10)**
Emergency department hospital			
St Paul hospital	Reference	Reference	Reference
Lions gate hospital	**0.57 (0.45-0.72)**	**0.36 (0.26-0.50)**	**1.57 (1.21-2.03)**
Mount Saint Joseph hospital	**1.27 (1.05-1.52)**	**0.32 (0.24-0.41)**	**2.63 (1.87-3.70)**
Other	0.68 (0.28-1.66)	0.60 (0.11-3.21)	1.19 (0.43-3.26)
Richmond hospital	1.14 (0.95-1.35)	**0.39 (0.30-0.51)**	**3.47 (2.78-4.33)**
Vancouver general hospital	**0.48 (0.45-0.52)**	**0.80 (0.70-0.91)**	**0.82 (0.75-0.89)**
Length of ED visit			
< 6 hours	Reference	Reference	Reference
>=6 hours	0.93 (0.86-1.01)	**0.57 (0.47-0.69)**	**1.32 (1.19-1.46)**

[a] Among visits with either hospital or emergency department record indicating a case.

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[b] Determined by known postal code or homeless user of VCH services, or DTES indication in CommunityMart data

[c] Determined by presence of postal code V6Y2A1 (used if no fixed address or postal code in discharge abstract database/emergency department database); postal code “XX” (used for transient/homeless populations in discharge abstract database/EDMart); postal code A0A 0A0 (assigned if no postal code for visit in EDMart and CommunityMart); indication of homelessness in EDMart/CommunityMart data.

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Table 4A. Classification of any and specific types of mental and substance use disorders based on ICD-9-CA and ICD-10-CA codes.

Health conditions	ICD-9-CA	ICD-10-CA
Mental health and substance use disorders	290-319	F00-F99
Any selected substance use disorders		
Alcohol use disorders	291, 303, 305.0, 357.5, 425.5, 535.3, 571.0-571.3, 655.4,760.71,V65.42	F10, Z50.2, Z71.4, Z72.1,G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3, Q86.0
Other substance use disorders [b]	292, 304, 305.2-305.9, 965.0, 969.x (4,6,7), 970.81, E850.0-E850.2, E853.2, E854.1,E854.2, 648.3, 760.73,760.75, 779.5	F11-F16, F19, T40, T42.4, T43.6, X42, X62, Y12, Z50.3, Z71.5, Z72.2, P04.4, P96.1
Opioid use disorder	304.0, 304.7, 305.5, 965.0, E850.0-E850.2	F11, X42 & (T40.0-T40.4 or T40.6), X62 & (T40.0-T40.4 or T40.6), Y12 & (T40.0-T40.4 or T40.6)
Any selected mental health disorders		
Mood disorders [c]	296, 311,300.4	F30–F31 F32–F33, F34, F38, F39
Depression	296.2, 296.3, 296.5,311, 300.4	F31.3-F31.5, F32,F33, F34.1
Psychoses	295,297,298	F20, F22-F25, F28,F29
Neurotic/stress/somatoform disorders [d]	300, 308, 309,	F40-45, F48
Anxiety disorders	300.0, 300.2	F40, F41
Personality disorders	301	F60–F62, F69, F21

[b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Section & Topic	No	Item	Reported on page #
TITLE OR ABSTRACT			
	1	Identification as a study of diagnostic accuracy using at least one measure of accuracy (such as sensitivity, specificity, predictive values, or AUC)	1
ABSTRACT			
	2	Structured summary of study design, methods, results, and conclusions (for specific guidance, see STARD for Abstracts)	2
INTRODUCTION			
	3	Scientific and clinical background, including the intended use and clinical role of the index test	4
	4	Study objectives and hypotheses	4
METHODS			
Study design	**5**	Whether data collection was planned before the index test and reference standard were performed (prospective study) or after (retrospective study)	5
Participants	**6**	Eligibility criteria	5
	7	On what basis potentially eligible participants were identified (such as symptoms, results from previous tests, inclusion in registry)	5
	8	Where and when potentially eligible participants were identified (setting, location and dates)	5
	9	Whether participants formed a consecutive, random or convenience series	
Test methods	**10a**	Index test, in sufficient detail to allow replication	5
	10b	Reference standard, in sufficient detail to allow replication	6
	11	Rationale for choosing the reference standard (if alternatives exist)	6
	12a	Definition of and rationale for test positivity cut-offs or result categories of the index test, distinguishing pre-specified from exploratory	5, 20
	12b	Definition of and rationale for test positivity cut-offs or result categories of the reference standard, distinguishing pre-specified from exploratory	5, 20
	13a	Whether clinical information and reference standard results were available to the performers/readers of the index test	
	13b	Whether clinical information and index test results were available to the assessors of the reference standard	
Analysis	**14**	Methods for estimating or comparing measures of diagnostic accuracy	6
	15	How indeterminate index test or reference standard results were handled	
	16	How missing data on the index test and reference standard were handled	
	17	Any analyses of variability in diagnostic accuracy, distinguishing pre-specified from exploratory	6
	18	Intended sample size and how it was determined	
RESULTS			
Participants	**19**	Flow of participants, using a diagram	
	20	Baseline demographic and clinical characteristics of participants	7
	21a	Distribution of severity of disease in those with the target condition	
	21b	Distribution of alternative diagnoses in those without the target condition	
	22	Time interval and any clinical interventions between index test and reference standard	
Test results	**23**	Cross tabulation of the index test results (or their distribution) by the results of the reference standard	7
	24	Estimates of diagnostic accuracy and their precision (such as 95% confidence intervals)	7
	25	Any adverse events from performing the index test or the reference standard	
DISCUSSION			
	26	Study limitations, including sources of potential bias, statistical uncertainty, and generalisability	10
	27	Implications for practice, including the intended use and clinical role of the index test	
OTHER INFORMATION			
	28	Registration number and name of registry	
	29	Where the full study protocol can be accessed	11
	30	Sources of funding and other support; role of funders	11

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STARD 2015

AIM

STARD stands for "Standards for Reporting Diagnostic accuracy studies". This list of items was developed to contribute to the completeness and transparency of reporting of diagnostic accuracy studies. Authors can use the list to write informative study reports. Editors and peer-reviewers can use it to evaluate whether the information has been included in manuscripts submitted for publication.

EXPLANATION

A **diagnostic accuracy study** evaluates the ability of one or more medical tests to correctly classify study participants as having a **target condition.** This can be a disease, a disease stage, response or benefit from therapy, or an event or condition in the future. A medical test can be an imaging procedure, a laboratory test, elements from history and physical examination, a combination of these, or any other method for collecting information about the current health status of a patient.

The test whose accuracy is evaluated is called **index test.** A study can evaluate the accuracy of one or more index tests. Evaluating the ability of a medical test to correctly classify patients is typically done by comparing the distribution of the index test results with those of the **reference standard**. The reference standard is the best available method for establishing the presence or absence of the target condition. An accuracy study can rely on one or more reference standards.

If test results are categorized as either positive or negative, the cross tabulation of the index test results against those of the reference standard can be used to estimate the **sensitivity** of the index test (the proportion of participants *with* the target condition who have a positive index test), and its **specificity** (the proportion *without* the target condition who have a negative index test). From this cross tabulation (sometimes referred to as the contingency or "2x2" table), several other accuracy statistics can be estimated, such as the positive and negative **predictive values** of the test. Confidence intervals around estimates of accuracy can then be calculated to quantify the statistical **precision** of the measurements.

If the index test results can take more than two values, categorization of test results as positive or negative requires a **test positivity cut-off**. When multiple such cut-offs can be defined, authors can report a receiver operating characteristic (ROC) curve which graphically represents the combination of sensitivity and specificity for each possible test positivity cut-off. The **area under the ROC curve** informs in a single numerical value about the overall diagnostic accuracy of the index test.

The **intended use** of a medical test can be diagnosis, screening, staging, monitoring, surveillance, prediction or prognosis. The **clinical role** of a test explains its position relative to existing tests in the clinical pathway. A replacement test, for example, replaces an existing test. A triage test is used before an existing test; an add-on test is used after an existing test.

Besides diagnostic accuracy, several other outcomes and statistics may be relevant in the evaluation of medical tests. Medical tests can also be used to classify patients for purposes other than diagnosis, such as staging or prognosis. The STARD list was not explicitly developed for these other outcomes, statistics, and study types, although most STARD items would still apply.

DEVELOPMENT

This STARD list was released in 2015. The 30 items were identified by an international expert group of methodologists, researchers, and editors. The guiding principle in the development of STARD was to select items that, when reported, would help readers to judge the potential for bias in the study, to appraise the applicability of the study findings and the validity of conclusions and recommendations. The list represents an update of the first version, which was published in 2003.

More information can be found on http://www.equator-network.org/reporting-guidelines/stard.

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Identifying mental health and substance use disorders using emergency department and hospital records: a population-based retrospective cohort study of diagnostic concordance and disease attribution

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Title: Identifying mental health and substance use disorders using emergency department and hospital records: a population-based retrospective cohort study of diagnostic concordance and disease attribution

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Abstract

Objectives: Administrative data are increasingly being used for surveillance and monitoring of mental health and substance use disorders (MHSUD) across Canada. However, the validity of the diagnostic codes specific to MHSUD are unknown in emergency departments (EDs). Our objective was to determine the concordance, and individual- and hospital-level factors associated with concordance, between diagnosis codes assigned in ED and at discharge from hospital for MHSUD related conditions.

Design: Population-based retrospective cohort study.

Setting: EDs and hospitals within Vancouver Coastal Health Authority (VCH), British Columbia, Canada.

Participants: 16,926 individuals who were admitted into a VCH hospital following an ED visit from April 1st 2009 to March 31st 2017, contributing to 48,116 pairs of ED and hospital discharge diagnoses.

Primary and secondary outcome measures: We examined concordance in identifying MHSUD between the primary discharge diagnosis codes (*ICD-9-CA* and *ICD-10-CA*) assigned in the ED and those assigned in the hospital among all ED visits resulting in a hospital admission. We calculated the percent overall agreement, positive agreement, negative agreement, and Cohen's kappa coefficient. We performed multiple regression analyses to identify factors independently associated with discordance.

Results: We found a high level of concordance for broad categories of MH conditions (overall agreement=0.89, positive agreement=0.74, kappa=0.67), and a fair level of concordance for SUDs (overall agreement=0.89, positive agreement=0.31, kappa=0.27). SUDs were less likely to be indicated as the primary cause in ED as opposed to in hospital (3.8% vs. 11.7%). In multiple regression analyses, ED visits occurring during holidays, weekends, and overnight (9:00PM-8:59AM) were associated with increased odds of discordance in identifying MH conditions (aOR: 1.47[1.11-1.93]; 1.27[1.16-1.40]; 1.30[1.19-1.42], respectively).

Conclusions: ED data could be used to improve surveillance and monitoring of MHSUD. Future efforts are needed to improve screening for individuals with MHSUD and subsequently connect them to treatment and follow-up care.

Keywords: acute health care, mental health, substance use, surveillance and monitoring, diagnostic codes, validation study

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Strengths and limitations of this study

- Concordance between ED and hospital diagnostic codes were assessed within a population-based cohort identified from the linkage of two comprehensive health administrative datasets of acute care.
- Among the few studies that examine the validity of diagnostic codes used for MHSUD in acute care, informing their use in surveillance and monitoring.
- Analysis was limited to ED visits admitted to hospital and may not be representative of diagnostic accuracy of ED visits discharged directly from ED.
- Data capture was limited to primary diagnostic codes assigned in ED; thus, improved detection of SUDs are possible in settings where more diagnostic codes are available.

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Introduction

Mental health conditions and substance use disorders (SUD) are the leading cause of the global burden of diseases, posing substantial health and economic impacts on individuals and society.(1) Individuals with a mental health and/or SUD are at increased risk of emergency department (ED) use and hospitalization(2), and often access the ED as first contact point for medical care.(3) While health administrative data are increasingly being used for surveillance and performance monitoring across Canada(3-6), ED data are often not included in these efforts(4, 6), partially due to the lack of consistency in ED data collection and reporting across the country.(7)

Vancouver Coastal Health (VCH) is one of BC's five regional health authorities, serving approximately one million residents. This includes the Downtown Eastside (DTES) neighborhood, one which has historically featured a high prevalence of substance use, mental illness, infectious diseases, and homelessness.(8) In 2015, prior to the declaration of a public health emergency in opioid overdose, VCH made integrated, comprehensive care delivery among the cornerstones of its DTES Second Generation Strategy (DTES-2GS) to acknowledge the unique needs of this population, which often presents to care with multiple concurrent disorders and social problems.(9) Reducing SUD-related acute care visits is a central aim in both the overdose response and the DTES-2GS initiative. Thus, diagnostic information collected in these visits is of central importance to surveillance, monitoring, and evaluation.(10, 11)

While diagnostic codes assigned in hospital are subject to nationally-coordinated cleaning and validation(12, 13), the validity of the diagnostic codes specific to mental health and SUD in the ED are unknown. One systematic review identified 39 studies which examined the accuracy of mental health diagnoses in administrative data, yet none of these studies assessed the diagnostic accuracy in ED.(14) Our objectives were to determine the concordance, and individual- and hospital-level factors associated with concordance, between *the International Statistical Classification of Diseases and Related Health Problems (ICD), Ninth and Tenth Revisions, Canada* (*ICD-9-CA* and *ICD-10-CA)* diagnosis codes assigned in the ED and at discharge from hospital for any mental health and substance use related conditions observed in VCH between 2007 and 2017.

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Methods

Study population and data sources

We obtained our data from a cohort of individuals residing in or having a record of receiving community-based services in Vancouver's DTES neighborhood between April 1st 2009 and March 31st 2017. The cohort was defined using health administrative databases held by VCH, including the CommunityMart database (capturing community-based health service referrals), the EDMart database (capturing emergency department visits), and the discharge abstract database (DAD) (capturing hospitalizations). The DAD contains data on inpatient acute care, day care, and rehabilitation care at 11 hospitals under the purview of VCH, and the ED contains data on emergency department visits at 11 hospitals and acute care clinics under the purview of VCH. Available detail on each ED is included in Appendix 1.

Data linkage was performed by VCH data stewards based on unique Personal Health Numbers recorded in each database. We extracted data on individuals with at least one ED or hospital record during study follow-up to identify any indication of mental health conditions or SUD. All records of ED visits resulting in hospital admission were used to assess concordance in diagnostic codes within the two databases. Linkage of ED visits to the resulting hospital admission was ascertained based on the following data fields and criteria: (if an ED visit had the same 'ContinuumID' as the hospital admission OR if the hospital admission occurred within one day of the ED visit) AND (the ED visit had a flag indicating admission to an hospital OR the hospital admission indicated an entry code of 'E' (emergency department)). The 'ContinuumID' was a unique ID used within a VCH facility to track patient movement across different health systems at each visit, and therefore might not capture the ED visit that resulted in admission at another hospital. Therefore, we supplemented this by capturing hospital admission within the same day of ED visit. These linkages were further ascertained using available data fields in ED ('AdmittedFlag') and in DAD ('Entrycode') to confirm ED visits which resulted in hospital admission. While the ED data contain records since April 2007, only those collected after April 1st 2012 were subject to national-level data quality control.(15, 16) In contrast, hospitalization data is standardized nationally with VCH DAD data dated back to April 1st 2007, with key fields (including diagnosis codes) subjected to error checks and validation.(12)

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Measures

We considered the primary diagnosis field in ED (coded using *ICD-10-CA* from April 1st 2012 onward, and a combination of *ICD-9-CA* and *ICD-10-CA* prior to this date), and any of the up to 25 primary and secondary diagnosis fields (coded by *ICD-10-CA* exclusively) in hospital. We defined mental health conditions and SUD using *ICD-9-CA* from 290-319, or their *ICD-10-CA* equivalents from F00-F99, consistent with the Canadian surveillance system.(4, 6) In addition, we considered more specific codes to identify alcohol use disorder (AUD), opioid use disorder (OUD), other SUD, mood disorders, depression, psychoses, neurotic/stress/somatoform disorders (NSS), anxiety disorders, and personality disorders (specific codes provided in **Appendix 1**).

We defined an a priori list of patient- and ED visit-related factors which might be associated with the diagnostic discordance as informed by the literature(17) and given data availability, including gender (male, female), age (<25, 25-34, 35-44, 45-54, 55-64, ≥65), homelessness status (yes, no), event urgency using the Canadian Triage Acuity Scale (CTAS)(18), length of ED visit (<6 hours, ≥6 hours; defined as the difference between date/time of triage or registration in ED and date/time the patient left the nursing unit), and the time (9:00am-8:59pm, 9:00pm-8:59am) and day (weekday, weekend, holiday) of ED visit. Additionally, we considered the fiscal year of ED visit (2007-2011, 2012-2014, 2015-2017) and a hospital indicator variable to examine the potential differences in diagnostic discordance over time, and across hospitals, respectively. Finally, we considered whether the patient ever resided in the DTES (yes, no) given the features of high disease prevalence and high vulnerability of the DTES neighborhood.(8)

Statistical analysis

We examined the proportion of acute care visits with an indication of mental health conditions or SUD identified by hospital records only, by both ED and hospital records, and by ED records only. Among all ED visits resulting in a hospital admission, we examined the concordance between the primary cause assigned in ED and in hospital. We calculated the percent overall agreement, positive agreement, negative agreement, and the Cohen's kappa coefficient - a statistic which measures agreement for categorical items, taking into account the possibility of the agreement occurring by chance of ED-hospital discharge diagnosis pairs.(19) Landis and Koch's classifications were used to interpret the Kappa statistics produced: 0 as no agreement, 0.01-0.2 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as high, and 0.81–1.00 as almost perfect agreement.(20) In addition, treating hospital discharge diagnosis as the reference standard, we calculated sensitivity, specificity, positive predictive value, and negative predictive

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value of the primary cause of visit assigned in an ED. We repeated these analyses for each specific type of mental health and substance use disorder. Further, we examined the concordance between the primary cause assigned in ED against any cause assigned in hospital.

Finally, among ED visits transferred to hospital with at least one diagnosis code in either hospital or ED indicating a mental health or substance use disorder, we performed a multiple regression analysis to identify patient- and ED visit-related factors independently associated with discordance. We used a generalized linear mixed effects model (GLMM) with a logit link and binomial distribution to account for intra-individual correlation between repeated acute care visits.(21) We repeated the analysis for any substance use disorders and any mental health conditions. All analyses were performed using SAS statistical software version 9.4.

Patient and public involvement

Patients and public were not involved in the design, conduct, and reporting of this research.

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Results

Among 56,875 DTES cohort participants, 43,017 (75.6%) had at least one ED or hospital record between April 1st 2007 and March 31st 2017 and were included in our analyses. Among them, 16,996 (39.5%) had an indication of a mental health or substance use disorder (**Table 1**). It is notable that ED data increased attribution of mental health and substance use disorders within the study cohort by 25.5% compared with using hospital records only. The proportions of missed case identification without ED records were comparable for AUD, OUD, and other SUDs (21.9%-27.8%), and higher for most mental health conditions (27.9%-65.3%), except for personality disorders (8.8%) (**Table 1**).

A total of 16,926 individuals were admitted into a VCH hospital following an ED visit, contributing to 48,116 pairs of ED and hospital discharge diagnoses (**Table 2**), and 15.4% of ED visits resulted in hospitalization during the study period. We found a high level of overall agreement between ED and hospital primary diagnoses in classifying whether a visit was related to a mental health condition or SUD (overall agreement=0.89, positive agreement=0.82, kappa=0.74). Compared to primary diagnosis code at hospital discharge, the primary diagnosis code assigned at ED discharge was less likely to classify a visit as SUD-related (11.8% vs. 3.8%), resulting in a fair level of agreement between ED and hospital in identifying any SUD-related visits (positive agreement=0.31, kappa=0.27). In contrast, ED and hospital classified a more comparable proportion of visits as mental health-related (21.7% vs 22.0%) with a high level of agreement (overall agreement=0.89, positive agreement=0.74, kappa=0.67).

The primary diagnoses in ED had consistently high specificity (0.93-1.00) in classifying mental health and SUD. However, sensitivity varied widely (0.09-0.78). The positive predictive values ranged from 0.41-0.67 for SUD and 0.16-0.67 for mental health conditions (**Table 2**). These values increased to 0.80-0.94 and 0.30-0.75, respectively, if any of the up to 25 diagnosis codes in hospital were considered (see supplementary **Appendix 2** for further details).

In a multiple regression analysis, we found younger age and shorter length of ED visit were associated with increased odds of discordance between ED and hospital settings in identifying substance use disorders (**Table 3**). In contrast, they were associated with decreased odds of discordance in identifying mental health conditions. Otherwise, ED visits occurring during holidays, weekends, and overnight (9:00pm-8:59am) were associated with increased odds of discordance in identifying mental health conditions (aOR: 1.47 [1.11,1.93]; 1.27 [1.16,1.40]; and 1.30 [1.19,1.42], respectively). However, we did not observe such associations for discordance in

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identifying substance use disorders. Lastly, ED visits occurring in more recent years were associated with reduced odds of discordance in identifying substance use disorders compared to visits prior to April 1st 2012 (aOR: 0.53 [0.44,0.63]; 0.74 [0.60,0.91]; respectively, for fiscal years 2012-2014, and 2015-2017).

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Discussion

Using hospital and ED administrative records from VCH, we found a high proportion (39.5%) of individuals with an indication of a mental health or SUD, 25.5% of which would not have been identified without the use of ED data. We found a high level of overall agreement between ED and hospital in classifying whether a visit was related to any MHSUD. The concordance was higher for determining any mental health-related visit as opposed to SUDs. An individuals' age and several ED visit-specific factors were found to be independently associated with the concordance between ED and hospital, with the direction of associations differing in identifying mental health conditions and SUDs.

It is important to emphasize the fact that 25.5% of individuals with mental health or SUD could not have been identified using only hospital records. The value of these data for disease surveillance and the monitoring and evaluation of changes in policy and practice are clear. However, it is notable that SUD overall, and illicit drug use in particular, were largely under-detected in the EDs as compared to hospitals. While there are many competing priorities in ED settings, improving screening for SUDs can help connect individuals to treatment and follow-up care and reduce the likelihood of subsequent readmission.(22)

Otherwise, we found a comparable proportion of contacts in EDs and hospitals which were identified to be mental health-related. This was consistent with a systematic review of mental health diagnoses accuracy in administrative data that showed comparable accuracy for diagnoses made in inpatient settings compared to other settings.(14) Moreover, we found a high level of agreement between hospital and ED diagnoses in determining any mental health conditions in general, with high concordance for psychoses, moderate concordance for mood disorders, but low concordance for anxiety disorders and personality disorders. Our findings were consistent with a systematic review that concluded administrative data were generally predictive of true diagnosis of psychotic categories, but were less satisfactory in identifying anxiety disorders.(14)

Given the inherent complexity in diagnosing mental health conditions, it is not surprising there is inadequate reliability in the diagnosis of specific types of mental health conditions. Diagnostic accuracy is further limited in ED given only one primary diagnosis code was available. Notably, we found ED visits occurring during holidays and weekends, as well as those during overnight shifts were associated with higher odds of mental health diagnostic discordance between ED and hospital. Various studies have investigated the "weekend effect" in healthcare, suggesting poorer health outcomes among individuals admitted to hospitals during the weekend as opposed to

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weekdays. Two Canadian studies of ED admission found weekend admissions were associated with significantly higher in-hospital mortality rates.(23, 24) To our knowledge, this study is the first to identify an independent association between ED visit timing and mental health diagnosis accuracy. Several factors might explain these associations, including the intensity of care and medical staff, the volume of ED visits at different times of the day and week, as well as potential impairment of physical and cognitive abilities of medical staff due to sleep deprivation especially during overnight shifts.(25, 26) Some adjustments to staffing models at the ED might be made to improve diagnosis accuracy. Future studies should further investigate whether increased diagnostic discordance associated with visit timing will result in adverse patient outcomes.

Several limitations are worth noting. First, we assessed the validity of the ED diagnostic codes in a limited and selective subset of all ED visits; those subsequently admitted to hospital no doubt had symptoms of higher severity, and such cases may not be representative of diagnostic accuracy of ED visits discharged directly from ED. Further, diagnostic codes assigned in hospital are not an ideal 'gold standard' as they have been reported to have high specificity but moderate sensitivity in identifying mental health conditions and SUD.(27) Nonetheless, in the absence of an external 'gold standard', an analysis of concordance between ED and hospital diagnosis codes can help illuminate data quality.(28) Third, only primary diagnosis codes were available in VCH ED records. In settings where more diagnosis codes are available, there may be improved detection of SUDs. Fourth, we did not consider diagnoses codes related to intentional self-harm, which was a common reason for hospitalization due to a mental health disorder. However, among the ED visits that resulted in hospitalization only 0.24% had a hospital diagnosis code indication of intentional self-harm. Furthermore, our sensitivity analyses which used all (up to 25) diagnoses codes in hospital captured 90% of the self-harm related hospital admissions as those admissions are likely to have a diagnosis code between 290-319 (or F00-F99) in addition to the self-harm diagnoses codes. Finally, caution should be exercised while generalizing our findings to other settings, noting that our study population represents a highly socioeconomically disadvantaged patient population with high prevalence of MHSUD. The study team had limited access to information on the clinical context of emergency departments, such as the availability of psychiatrists and other specialized services, which may help to explain variation in concordance across settings and may limit generalizability to health administrative data used for these purposes in other jurisdictions.

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In conclusion, we found a high level of diagnostic concordance between ED and hospital for broad categories of mental health conditions, and a fair level of concordance for SUD. A large proportion of individuals with an indication of a mental health condition or SUD would be missed without ED records. Future efforts are needed to improve screening for individuals with mental health and substance use disorders and connect them to treatment and follow-up care.

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Contributors

LW, DP, and BN designed the study, conceptualized the analysis and wrote the first draft of the manuscript. FH and LW performed data cleaning and conducted the analyses. FH, LAP, and DP provided critical input on and revised the manuscript. BN and CM are principal investigators of the parent study. RM and RB provided input on the manuscript on behalf of VCH. All authors read and approved the final manuscript.

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Competing interests

None declared.

Ethics approval

Ethical approval was obtained from the Providence Health Care Research Institute (H16-00516) and the Simon Fraser University Office of Research Ethics (2016s0670).

Data sharing statement

Data and computing code required to replicate results are held at the BC Centre for Excellence in HIV/AIDS in Vancouver, Canada. Inquiries can be sent by email to: bnosyk@cfenet.ubc.ca. Opportunities for collaboration are provided at the discretion of Vancouver Coastal Health Authority.

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Table 1. Identification of mental health and substance use disorders using hospital (any diagnosis codes) and emergency department records among DTES cohort participants (N=56,875).[a]

	Total		Proportion of individuals identified by data source		
Health conditions	Number of individuals	Prevalence (%)	Hospital records only N (%)	ED records only N (%)	Both hospital and ED records N (%)
Mental health and substance use disorders	16996	29.9	5024 (29.6)	4330 (25.5)	7642 (45.0)
Any selected substance use disorders	12638	22.2	5252 (41.6)	3238 (25.6)	4148 (32.8)
Alcohol use disorders	6206	10.9	2877 (46.4)	1727 (27.8)	1602 (25.8)
Other substance use disorders [b]	9865	17.3	4938 (50.1)	2160 (21.9)	2767 (28.0)
Opioid use disorder	5407	9.5	2778 (51.4)	1465 (27.1)	1164 (21.5)
Any selected mental health disorders	9163	16.1	2059 (22.5)	2705 (29.5)	4399 (48.0)
Mood disorders [c]	4286	7.5	1792 (41.8)	1195 (27.9)	1299 (30.3)
Depression	3245	5.7	1231 (37.9)	1226 (37.8)	788 (24.3)
Psychoses	4763	8.4	799 (16.8)	1410 (29.6)	2554 (53.6)
Neurotic/stress/somatoform disorders [d]	4189	7.4	1408 (33.6)	2142 (51.1)	639 (15.3)
Anxiety disorders	2515	4.4	681 (27.1)	1642 (65.3)	192 (7.6)
Personality disorders	1860	3.3	1488 (80.0)	164 (8.8)	208 (11.2)

[a] Cases identified using at least one hospital or emergency department record of diagnosis code; [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 2. Concordance between the primary diagnosis code assigned in the ED and the primary diagnosis code assigned at hospital discharge following an ED visit for any mental health conditions or SUDs (N=16,926, 48,116 pairs).

Health conditions	Condition indicated in				Concordance statistics				Validity statistics (assume hospital discharge diagnosis as "gold-standard")			
	Any N (%)	ED only N (%)	Hospital only N (%)	ED and hospital N (%)	Overal l agree	Positiv e agree	Negativ e agree	Kappa (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
Mental health and substance use disorders	17520 (36.4)	1040 (2.2)	4275 (8.9)	12205 (25.4)	0.89	0.82	0.92	0.74 (0.74,0.75)	0.74 (0.73,0.75)	0.97 (0.97,0.97)	0.92 (0.92,0.93)	0.88 (0.87,0.88)
Any selected substance use disorders	6299 (13.1)	639 (1.3)	4492 (9.3)	1168 (2.4)	0.89	0.31	0.94	0.27 (0.26,0.28)	0.21 (0.20,0.22)	0.99 (0.98,0.99)	0.65 (0.62,0.67)	0.90 (0.90,0.91)
Alcohol use disorders	604 (1.3)	90 (0.2)	452 (0.9)	62 (0.1)	0.97	0.48	0.98	0.47 (0.44,0.49)	0.38 (0.35,0.40)	0.99 (0.99,0.99)	0.67 (0.64,0.70)	0.97 (0.97,0.98)
Other substance use disorders [b]	2314 (4.8)	359 (0.7)	1222 (2.5)	733 (1.5)	0.92	0.17	0.96	0.15 (0.14,0.17)	0.10 (0.09,0.11)	0.99 (0.99,0.99)	0.54 (0.50,0.58)	0.93 (0.93,0.93)
Opioid use disorder	4035 (8.4)	330 (0.7)	3320 (6.9)	385 (0.8)	0.99	0.19	0.99	0.18 (0.14,0.22)	0.12 (0.09,0.15)	1.00 (1.00,1.00)	0.41 (0.33,0.49)	0.99 (0.99,0.99)
Any selected mental health disorders	13226 (27.5)	2644 (5.5)	2761 (5.7)	7821 (16.3)	0.89	0.74	0.93	0.67 (0.66,0.68)	0.74 (0.73,0.75)	0.93 (0.93,0.93)	0.75 (0.74,0.76)	0.93 (0.92,0.93)
Mood disorders [c]	2070 (4.3)	874 (1.8)	775 (1.6)	421 (0.9)	0.95	0.43	0.97	0.40 (0.39,0.42)	0.39 (0.37,0.41)	0.98 (0.98,0.98)	0.48 (0.46,0.51)	0.97 (0.97,0.97)
Depression	157 (0.3)	71 (0.1)	73 (0.2)	13 (0.0)	0.97	0.34	0.98	0.32 (0.30,0.34)	0.35 (0.32,0.38)	0.98 (0.98,0.98)	0.33 (0.30,0.35)	0.98 (0.98,0.98)
Psychoses	582 (1.2)	104 (0.2)	433 (0.9)	45 (0.1)	0.92	0.72	0.95	0.67 (0.66,0.68)	0.78 (0.77,0.79)	0.94 (0.94,0.94)	0.67 (0.66,0.68)	0.96 (0.96,0.97)
Neurotic/stress/somatoform disorders[d]	9323 (19.4)	2592 (5.4)	1459 (3.0)	5272 (11.0)	0.97	0.13	0.99	0.11 (0.09,0.14)	0.10 (0.08,0.12)	0.99 (0.99,0.99)	0.18 (0.15,0.22)	0.98 (0.98,0.98)
Anxiety disorders	3468 (7.2)	1015 (2.1)	1500 (3.1)	953 (2.0)	1.00	0.15	1.00	0.15 (0.08,0.23)	0.15 (0.08,0.24)	1.00 (1.00,1.00)	0.16 (0.09,0.25)	1.00 (1.00,1.00)
Personality disorders	1316 (2.7)	396 (0.8)	832 (1.7)	88 (0.2)	0.99	0.14	0.99	0.14 (0.10,0.18)	0.09 (0.07,0.12)	1.00 (1.00,1.00)	0.30 (0.23,0.38)	0.99 (0.99,0.99)

Abbreviation: ED, emergency department; CI: confidence interval; a [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 3. Factors associated with discordance between the primary diagnosis code assigned in the emergency department and the primary diagnosis code assigned at hospital discharge following an emergency department visit [a]

	Outcomes: Discordance in identifying		
	Mental health or SUD (N=17,503)	Any SUD (N=6,294)	Any mental health conditions (N=13,214)
Characteristics	Odds Ratios (95% CI)		
Male	0.95 (0.87,1.04)	0.94 (0.79,1.13)	0.96 (0.86,1.06)
Age at visit			
≥65	Reference	Reference	Reference
55-64	**0.49 (0.42,0.58)**	1.24 (0.87,1.78)	**0.63 (0.50,0.79)**
45-54	**0.39 (0.34,0.45)**	**1.56 (1.11,2.18)**	0.85 (0.68,1.05)
35-44	**0.30 (0.26,0.35)**	**1.83 (1.30,2.57)**	0.86 (0.70,1.06)
25-34	**0.27 (0.23,0.32)**	**2.50 (1.76,3.56)**	0.85 (0.69,1.06)
<25	**0.37 (0.31,0.45)**	**2.44 (1.62,3.68)**	1.07 (0.84,1.36)
Ever residing in DTES [b]	1.07 (0.98,1.18)	0.98 (0.81,1.17)	**1.19 (1.08,1.33)**
Homeless at time of visit [c]	1.00 (0.91,1.11)	0.88 (0.74,1.05)	**1.26 (1.13,1.41)**
Year of visit			
2007-2011	Reference	Reference	Reference
2012-2014	**0.71 (0.65,0.78)**	**0.53 (0.44,0.63)**	1.04 (0.94,1.14)
2015-2017	**0.66 (0.60,0.73)**	**0.74 (0.60,0.91)**	1.09 (0.98,1.21)
Day of visit			
Weekday	Reference	Reference	Reference
Weekend	**1.22 (1.12,1.33)**	0.90 (0.77,1.05)	**1.27 (1.16,1.40)**
Holiday	**1.51 (1.19,1.92)**	1.25 (0.76,2.05)	**1.47 (1.11,1.93)**
Time of visit			
9:00 AM-8.59 PM	Reference	Reference	Reference
9:00 PM-8.59 AM	**1.27 (1.17,1.38)**	1.06 (0.91,1.23)	**1.30 (1.19,1.42)**
Triage acuity at ED			
Semi to none urgent	Reference	Reference	Reference
Urgent	0.98 (0.86,1.11)	0.77 (0.58,1.02)	**1.19 (1.04,1.36)**
Resuscitation-Emergency	0.98 (0.86,1.12)	0.99 (0.74,1.33)	**1.21 (1.05,1.40)**
Emergency department hospital			
St. Paul's hospital	Reference	Reference	Reference
Lions gate hospital	**1.32 (1.05,1.66)**	**0.67 (0.46,0.97)**	**1.41 (1.07,1.85)**
Mount Saint Joseph hospital	**1.91 (1.49,2.44)**	**0.29 (0.20,0.43)**	**2.22 (1.44,3.41)**
Other	0.67 (0.20,2.23)	0.23 (0.03,2.21)	1.18 (0.36,3.91)
Richmond hospital	**2.62 (2.21,3.11)**	**0.62 (0.47,0.82)**	**3.45 (2.72,4.36)**
Vancouver general hospital	**0.62 (0.57,0.68)**	0.99 (0.83,1.17)	**0.83 (0.76,0.91)**
Length of ED visit			
< 6 hours	Reference	Reference	Reference
>=6 hours	**1.17 (1.05,1.30)**	**0.61 (0.47,0.79)**	**1.37 (1.23,1.53)**

[a] Among visits with either hospital or emergency department record indicating a case.
[b] Determined by known postal code or homeless user of VCH services, or DTES indication in CommunityMart data
[c] Determined by presence of postal code V6Y2A1 (used if no fixed address or postal code in discharge abstract database/EDMart data); postal code "XX" (used for transient/homeless populations in discharge abstract database/EDMart); postal code A0A 0A0 (assigned if no postal code for emergency department visit in EDMart and CommunityMart); indication of homelessness in EDMart/CommunityMart data.

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Appendix for the manuscript "*Identifying mental health and substance use disorders using emergency department and hospital records: a population-based retrospective cohort study of diagnostic concordance and disease attribution*"

Appendix 1

Table 1: Service hours and mental health services available in 11 hospitals/acute care clinics under the purview of VCH

Emergency department*	No. of ED visits in the past year (No. visits resulting in hospital admission in the past year)	Hours	Psychiatrists or Mental health crisis teams on site?
St Paul's Hospital	210488 (29967)	24 hours	Yes. The emergency department contains an Acute Behavioral Stabilization Unit which provides specialized care for patients with complex mental health and substance use needs. The unit is managed by Emergency with the staffing support being an interdisciplinary team of emergency physicians, emergency nurses, psychiatrists, registered psychiatric nurses (or equivalent), psychiatric assessment nurses and workers, as well as input from consultative services such as the specialized Addictions Consultation Team.
Vancouver General Hospital	91836 (17832)	24 hours	Yes. Psychiatric Emergency Assessment & Triage (PEAT) service is a co-managed space in the VGH Emergency Department for assessing and triaging ED clients who present with MHSU conditions.
Mount St. Joseph Hospital	22008 (2822)	08:00-20:00	Yes. Geriatric psychiatry service: provides acute care and consultation, initial assessment, and follow-up care for ambulatory patients over the age of 65 who are experiencing complex psychiatric disorders.
Lions Gate Hospital	15594 (2167)	24 hours	Yes. There is a Psychiatric Emergency Program which provides access to prompt psychiatric assessments through the emergency department at Lions Gate Hospital. Mental Health nurses staffed in the emergency department provide mental health assessment in consultation with the on call psychiatrist.
Richmond Hospital	11689 (2093)	24 hours	Yes. The Psychiatry Assessment and Emergency Unit provide short-term assessment, stabilization and treatment services for individuals experiencing a psychiatric/mental health crisis. Provides a 4-bed brief stay (72 hours or less) unit for assessment, stabilization and treatment of individuals experiencing a psychiatric/mental health crisis. The interdisciplinary team is able to access both hospital and community resources, on an as needed basis.
Powell River General Hospital	1856 (142)	24 hours	Yes. In-Patient Psychiatry: a 7-bed unit on the 4th Floor of the Powell River General Hospital provides acute care for people suffering from an acute psychiatric illness that are unable to be cared for at home or in supportive community programs.
University of British Columbia (UBC) Health Sciences Centre	3996 (151)	8:00-20:00	No.
Squamish General Hospital	555 (49)	24 hours	No. Squamish General Hospital does not have a psychiatric ward or mental health beds. People in

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			acute mental health distress will be transported from the Squamish emergency department to Lions Gate Hospital. If the issue is not acute, emergency room doctors can help the patient access a treatment team that includes two psychiatrists in Squamish.
Whistler D & T Centre	287 (9)	8:00-20:00	Yes. The Whistler Health Centre which provides emergency care also provides Mental Health and Substance Use services at the same location. Outpatient individual and group counseling for people with mental health and/or addiction problems. It also has an Adult Mental Health and Substance Use Program, which serves clients over the age of 19 who are diagnosed with a major mental illness and experiencing significant problems that interfere with their functioning in the community.
Pemberton D & T Centre	161 (9)	8:30-20:30	The Pemberton Health Centre which provides emergency care also provides Mental Health and Substance Use services at the same location. Outpatient individual and group counselling are available for people with mental health and/or addiction problems.
Sechelt Hospital	1052 (150)	24 hours	The Psychiatry Assessment and Emergency Unit provides short-term assessment, stabilization, and treatment services for individuals experiencing a psychiatric/mental health crisis. A mental health emergency services nurse is on site Monday to Friday.

*Data for Mount St.Joseph Hospital, Powell River General Hospital and St, Paul Hospital are available from April 1 2009, onward. Data for Sechelt Hospital are from October 17, 2012 onward. Data for Whistler D & T Centre, and Pemberton D & T Centre are from April 1 2015 onward.

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Table 2. Classification of any and specific types of mental and substance use disorders based on ICD-9-CA and ICD-10-CA codes.

Health conditions	ICD-9-CA	ICD-10-CA
Mental health and substance use disorders	290-319	F00-F99
Any selected substance use disorders		
Alcohol use disorders	291, 303, 305.0, 357.5, 425.5, 535.3, 571.0-571.3, 655.4,760.71,V65.42	F10, Z50.2, Z71.4, Z72.1,G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3, Q86.0
Other substance use disorders [b]	292, 304, 305.2-305.9, 965.0, 969.x (4,6,7), 970.81, E850.0-E850.2, E853.2, E854.1,E854.2, 648.3, 760.73,760.75, 779.5	F11-F16, F19, T40, T42.4, T43.6, X42, X62, Y12, Z50.3, Z71.5, Z72.2, P04.4, P96.1
Opioid use disorder	304.0, 304.7, 305.5, 965.0, E850.0-E850.2	F11, X42 & (T40.0-T40.4 or T40.6), X62 & (T40.0-T40.4 or T40.6), Y12 & (T40.0-T40.4 or T40.6)
Any selected mental health disorders		
Mood disorders [c]	296, 311,300.4	F30–F31 F32–F33, F34, F38, F39
Depression	296.2, 296.3, 296.5,311, 300.4	F31.3-F31.5, F32,F33, F34.1
Psychoses	295,297,298	F20, F22-F25, F28,F29
Neurotic/stress/somatoform disorders [d]	300, 308, 309,	F40-45, F48
Anxiety disorders	300.0, 300.2	F40, F41
Personality disorders	301	F60–F62, F69, F21

[b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Appendix 2

Table 1A. Identification of mental health and substance use disorders using hospital (any diagnosis codes) and ED records among DTES cohort participants (using data from April 1st 2012 onward) (N=56,875).[a]

	Total	Proportion of individuals identified by data source		
Health conditions	Number of individuals	Hospital records only N (%)	ED records only N (%)	Both hospital and ED records N (%)
Mental health and substance use disorders	12355	3632 (29.4)	3388 (27.4)	5335 (43.2)
Any substance use disorders	9655	3844 (39.8)	2872 (29.7)	2939 (30.4)
Alcohol use disorders	4587	1928 (42.0)	1518 (33.1)	1141 (24.9)
Non-alcohol substance use disorders [b]	7418	3686 (49.7)	1813 (24.4)	1919 (25.9)
Opioid use disorder	4317	2079 (48.2)	1360 (31.5)	878 (20.3)
Any mental health disorders	6225	1370 (22.0)	1890 (30.4)	2965 (47.6)
Mood disorders [c]	2709	1063 (39.2)	869 (32.1)	777 (28.7)
Depression	2015	719 (35.7)	860 (42.7)	436 (21.6)
Psychoses	3438	513 (14.9)	1077 (31.3)	1848 (53.8)
Neurotic, stress and somatoform disorders [d]	2434	1039 (42.7)	1150 (47.2)	245 (10.1)
Anxiety disorders	1797	412 (22.9)	1265 (70.4)	120 (6.7)
Personality disorders	1260	1062 (84.3)	80 (6.3)	118 (9.4)

[a] Cases identified using at least one hospital or emergency department record of diagnosis code indicating a case; [b] Included opioid use disorder;
[c] Included depression; [d] Included anxiety disorders.

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Table 2A. Concordance between the primary diagnosis code assigned in the ED and any diagnosis codes assigned at hospital discharge following an ED visit for any mental health and substance use-related conditions (N=16926, 48116 pairs).

Health conditions	Condition indicated in				Concordance statistics				Validity statistics (assume hospital discharge diagnosis as "gold-standard")			
	Any N (%)	ED only N (%)	Hospital only N (%)	ED and hospital N (%)	Overall agree	Positive agree	Negative agree	Kappa (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
Mental health and substance use disorders	30775 (64.0)	214 (0.4)	17530 (36.4)	13031 (27.1)	0.63	0.59	0.66	0.34 (0.34,0.35)	0.43 (0.42,0.43)	0.99 (0.99,0.99)	0.98 (0.98,0.99)	0.50 (0.49,0.50)
Any selected substance use disorders	23733 (49.3)	78 (0.2)	21926 (45.6)	1729 (3.6)	0.54	0.14	0.69	0.07 (0.07,0.07)	0.07 (0.07,0.08)	1.00 (1.00,1.00)	0.96 (0.95,0.97)	0.53 (0.52,0.53)
Alcohol use disorders	8127 (16.9)	30 (0.1)	7975 (16.6)	122 (0.3)	0.83	0.20	0.90	0.16 (0.16,0.17)	0.11 (0.10,0.12)	1.00 (1.00,1.00)	0.94 (0.92,0.95)	0.83 (0.82,0.83)
Other substance use disorders [b]	9320 (19.4)	66 (0.1)	8228 (17.1)	1026 (2.1)	0.63	0.07	0.77	0.04 (0.04,0.04)	0.04 (0.03,0.04)	1.00 (1.00,1.00)	0.92 (0.90,0.94)	0.62 (0.62,0.63)
Opioid use disorder	18644 (38.7)	56 (0.1)	17929 (37.3)	659 (1.4)	0.83	0.03	0.91	0.02 (0.02,0.03)	0.02 (0.01,0.02)	1.00 (1.00,1.00)	0.80 (0.73,0.86)	0.83 (0.83,0.84)
Any selected mental health disorders	16034 (33.3)	1330 (2.8)	5569 (11.6)	9135 (19.0)	0.86	0.73	0.90	0.63 (0.62,0.64)	0.62 (0.61,0.63)	0.96 (0.96,0.96)	0.87 (0.87,0.88)	0.85 (0.85,0.86)
Mood disorders [c]	3199 (6.6)	687 (1.4)	1904 (4.0)	608 (1.3)	0.92	0.39	0.95	0.35 (0.34,0.37)	0.28 (0.26,0.29)	0.99 (0.98,0.99)	0.66 (0.64,0.68)	0.93 (0.92,0.93)
Depression	927 (1.9)	59 (0.1)	843 (1.8)	25 (0.1)	0.95	0.32	0.97	0.29 (0.27,0.31)	0.24 (0.23,0.26)	0.99 (0.98,0.99)	0.47 (0.44,0.50)	0.96 (0.96,0.96)
Psychoses	3192 (6.6)	49 (0.1)	3043 (6.3)	100 (0.2)	0.91	0.72	0.94	0.67 (0.66,0.68)	0.70 (0.69,0.71)	0.95 (0.95,0.95)	0.75 (0.74,0.76)	0.94 (0.93,0.94)
Neurotic/stress/somatoform disorders[d]	10387 (21.6)	1976 (4.1)	2523 (5.2)	5888 (12.2)	0.95	0.10	0.97	0.09 (0.07,0.10)	0.06 (0.05,0.07)	0.99 (0.99,0.99)	0.31 (0.27,0.36)	0.95 (0.95,0.95)
Anxiety disorders	5348 (11.1)	672 (1.4)	3380 (7.0)	1296 (2.7)	0.98	0.05	0.99	0.05 (0.03,0.07)	0.03 (0.02,0.04)	1.00 (1.00,1.00)	0.30 (0.20,0.41)	0.98 (0.98,0.98)
Personality disorders	2803 (5.8)	333 (0.7)	2319 (4.8)	151 (0.3)	0.94	0.06	0.97	0.06 (0.04,0.07)	0.03 (0.03,0.04)	1.00 (1.00,1.00)	0.67 (0.59,0.75)	0.94 (0.93,0.94)

Abbreviations: ED, emergency department; CI: confidence interval; [b] Included opioid use disorder; [c] Included depression; [d] Included anxiety disorders.

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Table 3A. Factors associated with discordance between the primary diagnosis code assigned in the emergency department and any diagnosis codes assigned at hospital discharge following an emergency department visit[a]

	Outcomes: Discordance in identifying		
	Mental health and substance use disorders (N=30,722)	Any selected substance use (N=23,688)	Any selected mental health disorders (N=16,017)
Characteristics	Odds Ratios (95% CI)		
Male	**0.86 (0.79,0.93)**	0.94 (0.82,1.08)	**0.89 (0.81,0.98)**
Age at visit			
>=65	Reference	Reference	Reference
55-64	**0.68 (0.59,0.77)**	1.12 (0.87,1.45)	**0.41 (0.34,0.49)**
45-54	**0.48 (0.43,0.55)**	1.06 (0.83,1.35)	**0.36 (0.30,0.43)**
35-44	**0.31 (0.27,0.35)**	1.05 (0.82,1.35)	**0.28 (0.24,0.33)**
25-34	**0.25 (0.22,0.28)**	1.28 (0.99,1.66)	**0.27 (0.22,0.32)**
<25	**0.23 (0.20,0.27)**	1.12 (0.82,1.53)	**0.35 (0.29,0.43)**
Ever residing in DTES [b]	**1.45 (1.33,1.58)**	1.20 (1.04,1.39)	1.09 (0.99,1.20)
Homeless at time of visit [c]	0.91 (0.84,1.00)	**0.79 (0.69,0.91)**	**1.11 (1.00,1.23)**
Year of visit			
2007-2011	Reference	Reference	Reference
2012-2014	**0.74 (0.68,0.79)**	**0.61 (0.53,0.70)**	0.93 (0.85,1.02)
2015-2017	**0.74 (0.68,0.80)**	**0.75 (0.64,0.87)**	0.95 (0.86,1.05)
Day of visit			
Weekday	Reference	Reference	Reference
Weekend	**1.22 (1.14,1.30)**	0.89 (0.79,1.00)	**1.30 (1.19,1.41)**
Holiday	**1.38 (1.13,1.69)**	0.96 (0.67,1.39)	**1.67 (1.31,2.14)**
Time of visit			
9:00 AM-8.59 PM	Reference	Reference	Reference
9:00 PM-8.59 AM	**1.40 (1.31,1.49)**	0.92 (0.82,1.03)	**1.34 (1.24,1.45)**
Triage acuity at ED			
Semi to none urgent	Reference	Reference	Reference
Urgent	**0.78 (0.71,0.86)**	**0.60 (0.49,0.73)**	**1.15 (1.01,1.30)**
Resuscitation-Emergency	**0.79 (0.71,0.87)**	**0.64 (0.52,0.80)**	**1.19 (1.04,1.35)**
Emergency department hospital			
St Paul hospital	Reference	Reference	Reference
Lions gate hospital	**0.56 (0.45,0.71)**	**0.35 (0.25,0.48)**	**1.52 (1.17,1.97)**
Mount Saint Joseph hospital	**1.34 (1.11,1.61)**	**0.34 (0.26,0.44)**	**2.51 (1.78,3.53)**
Other	0.70 (0.28,1.71)	0.63 (0.12,3.38)	1.13 (0.41,3.10)
Richmond hospital	1.14 (0.96,1.36)	**0.36 (0.28,0.46)**	**3.35 (2.69,4.17)**
Vancouver general hospital	**0.52 (0.48,0.56)**	**0.85 (0.75,0.97)**	**0.77 (0.71,0.84)**
Length of ED visit			
< 6 hours	Reference	Reference	Reference
>=6 hours	**0.88 (0.81,0.95)**	**0.53 (0.44,0.64)**	**1.36 (1.23,1.51)**

[a] Among visits with either hospital or emergency department record indicating a case.
[b] Determined by known postal code or homeless user of VCH services, or DTES indication in CommunityMart data
[c] Determined by presence of postal code V6Y2A1 (used if no fixed address or postal code in discharge abstract database/emergency department database); postal code "XX" (used for transient/homeless populations in discharge abstract database/EDMart); postal code A0A 0A0 (assigned if no postal code for visit in EDMart and CommunityMart); indication of homelessness in EDMart/CommunityMart data

Section & Topic	No	Item	Reported on page #
TITLE OR ABSTRACT			
	1	Identification as a study of diagnostic accuracy using at least one measure of accuracy (such as sensitivity, specificity, predictive values, or AUC)	1
ABSTRACT			
	2	Structured summary of study design, methods, results, and conclusions (for specific guidance, see STARD for Abstracts)	2
INTRODUCTION			
	3	Scientific and clinical background, including the intended use and clinical role of the index test	4
	4	Study objectives and hypotheses	4
METHODS			
Study design	**5**	Whether data collection was planned before the index test and reference standard were performed (prospective study) or after (retrospective study)	5
Participants	**6**	Eligibility criteria	5
	7	On what basis potentially eligible participants were identified (such as symptoms, results from previous tests, inclusion in registry)	5
	8	Where and when potentially eligible participants were identified (setting, location and dates)	5
	9	Whether participants formed a consecutive, random or convenience series	
Test methods	**10a**	Index test, in sufficient detail to allow replication	5
	10b	Reference standard, in sufficient detail to allow replication	6
	11	Rationale for choosing the reference standard (if alternatives exist)	6
	12a	Definition of and rationale for test positivity cut-offs or result categories of the index test, distinguishing pre-specified from exploratory	5, 20
	12b	Definition of and rationale for test positivity cut-offs or result categories of the reference standard, distinguishing pre-specified from exploratory	5, 20
	13a	Whether clinical information and reference standard results were available to the performers/readers of the index test	
	13b	Whether clinical information and index test results were available to the assessors of the reference standard	
Analysis	**14**	Methods for estimating or comparing measures of diagnostic accuracy	6
	15	How indeterminate index test or reference standard results were handled	
	16	How missing data on the index test and reference standard were handled	
	17	Any analyses of variability in diagnostic accuracy, distinguishing pre-specified from exploratory	6
	18	Intended sample size and how it was determined	
RESULTS			
Participants	**19**	Flow of participants, using a diagram	
	20	Baseline demographic and clinical characteristics of participants	7
	21a	Distribution of severity of disease in those with the target condition	
	21b	Distribution of alternative diagnoses in those without the target condition	
	22	Time interval and any clinical interventions between index test and reference standard	
Test results	**23**	Cross tabulation of the index test results (or their distribution) by the results of the reference standard	7
	24	Estimates of diagnostic accuracy and their precision (such as 95% confidence intervals)	7
	25	Any adverse events from performing the index test or the reference standard	
DISCUSSION			
	26	Study limitations, including sources of potential bias, statistical uncertainty, and generalisability	10
	27	Implications for practice, including the intended use and clinical role of the index test	
OTHER INFORMATION			
	28	Registration number and name of registry	
	29	Where the full study protocol can be accessed	11
	30	Sources of funding and other support; role of funders	11

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AIM

STARD stands for "Standards for Reporting Diagnostic accuracy studies". This list of items was developed to contribute to the completeness and transparency of reporting of diagnostic accuracy studies. Authors can use the list to write informative study reports. Editors and peer-reviewers can use it to evaluate whether the information has been included in manuscripts submitted for publication.

EXPLANATION

A **diagnostic accuracy study** evaluates the ability of one or more medical tests to correctly classify study participants as having a **target condition.** This can be a disease, a disease stage, response or benefit from therapy, or an event or condition in the future. A medical test can be an imaging procedure, a laboratory test, elements from history and physical examination, a combination of these, or any other method for collecting information about the current health status of a patient.

The test whose accuracy is evaluated is called **index test.** A study can evaluate the accuracy of one or more index tests. Evaluating the ability of a medical test to correctly classify patients is typically done by comparing the distribution of the index test results with those of the **reference standard**. The reference standard is the best available method for establishing the presence or absence of the target condition. An accuracy study can rely on one or more reference standards.

If test results are categorized as either positive or negative, the cross tabulation of the index test results against those of the reference standard can be used to estimate the **sensitivity** of the index test (the proportion of participants *with* the target condition who have a positive index test), and its **specificity** (the proportion *without* the target condition who have a negative index test). From this cross tabulation (sometimes referred to as the contingency or "2x2" table), several other accuracy statistics can be estimated, such as the positive and negative **predictive values** of the test. Confidence intervals around estimates of accuracy can then be calculated to quantify the statistical **precision** of the measurements.

If the index test results can take more than two values, categorization of test results as positive or negative requires a **test positivity cut-off**. When multiple such cut-offs can be defined, authors can report a receiver operating characteristic (ROC) curve which graphically represents the combination of sensitivity and specificity for each possible test positivity cut-off. The **area under the ROC curve** informs in a single numerical value about the overall diagnostic accuracy of the index test.

The **intended use** of a medical test can be diagnosis, screening, staging, monitoring, surveillance, prediction or prognosis. The **clinical role** of a test explains its position relative to existing tests in the clinical pathway. A replacement test, for example, replaces an existing test. A triage test is used before an existing test; an add-on test is used after an existing test.

Besides diagnostic accuracy, several other outcomes and statistics may be relevant in the evaluation of medical tests. Medical tests can also be used to classify patients for purposes other than diagnosis, such as staging or prognosis. The STARD list was not explicitly developed for these other outcomes, statistics, and study types, although most STARD items would still apply.

DEVELOPMENT

This STARD list was released in 2015. The 30 items were identified by an international expert group of methodologists, researchers, and editors. The guiding principle in the development of STARD was to select items that, when reported, would help readers to judge the potential for bias in the study, to appraise the applicability of the study findings and the validity of conclusions and recommendations. The list represents an update of the first version, which was published in 2003.

More information can be found on http://www.equator-network.org/reporting-guidelines/stard.

For peer review only