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## Indicators for avoidable emergency medical service calls: Mapping of Paramedic Clinical Impression Codes to Ambulatory Care Sensitive Conditions and Mental Health Conditions in the UK and Canada

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3 **Indicators for avoidable emergency medical service calls: Mapping of Paramedic Clinical**  
4 **Impression Codes to Ambulatory Care Sensitive Conditions and Mental Health**  
5 **Conditions in the UK and Canada**  
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## Abstract:

**Background:** Paramedic assessment data have not been used for research on avoidable calls. Paramedic impression codes are designated by paramedics upon responding to a 911/999 medical emergency after an assessment of the presenting condition. Ambulatory Care Sensitive Conditions (ACSCs) are non-acute health conditions not needing hospital admission when properly managed.

**Methods:** The current study focused on paramedic impression codes from the East Midlands Region, UK and from Southern Ontario, Canada and mapped them to existing definitions of ambulatory care sensitive conditions (ACSCs) and mental health conditions. Mapping was iterative first identifying the common ACSCs shared between the two countries then identifying the respective clinical impression codes for each country that mapped to those shared ACSCs as well as to mental health conditions.

**Results:** Experts from the UK-Canada Emergency Calls Data analysis and GEospatial mapping (EDGE) Consortium contributed to both phases and were able to independently match the codes and then compare results. Clinical impression codes for paramedics in the UK were more extensive than those in Ontario. The mapping revealed some interesting inconsistencies between paramedic impression codes, but also demonstrated that it was possible.

**Conclusion:** This is an important first step in determining the numbers of ASCSs and mental health conditions that paramedics attend to, and in examining the clinical pathways of these individuals across the health system. This work lays the foundation for international comparative health services research on integrated pathways in primary care and EMS.

### What is already known on this topic

- Paramedic clinical impression codes are a valuable data source that have been underutilized in prior research and are critical for understanding the clinical pathways of patients with ambulatory care sensitive conditions (ACSCs) and mental health conditions as they transition through the emergency healthcare system.
- No study has mapped paramedic clinical impression codes to these conditions, which is needed to facilitate this novel area research.

### What this study adds

- This study successfully mapped the clinical impression codes available to paramedics in their mandatory reporting forms to ACSCs and mental health conditions for both the UK and Ontario, Canada contexts.

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3 ● Clinical impression codes for paramedics in the UK were found to be more extensive  
4 than those available to paramedics in Ontario, and the potential impact of some noted  
5 inconsistencies between the two regions are discussed in this paper.  
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8 **How this study might affect research, practice or policy**  
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- 10 ● This work lays the foundation for future international comparative studies in prehospital  
11 emergency care and primary care research, examining the clinical pathways of patients  
12 where emergency care may be avoided, reducing the burden on emergency health  
13 systems.  
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## Introduction

Paramedic assessment data are often used in pre-hospital research [1,2], but rarely for research on avoidable calls.[1] Paramedic impression codes are designated by paramedics during a 911/999 medical emergency response after completing a patient assessment.[3,4] This is critical information for primary care research, capturing the hitherto unknown clinical 'pathway' of a patient, namely: (a) the clinical situation *between* the primary care setting and the emergency department (ED), or (b) details of clinical cases assessed by paramedics but *not* transported to hospital. Importantly, the latter scenario typically comprises lower acuity calls contributing to emergency health system burden that may be better addressed by primary care.[1]

Ambulatory Care Sensitive Conditions (ACSCs) are non-acute health conditions not requiring hospital admission when properly managed or prevented by accessible primary care in the community.[5] ACSCs are routinely monitored and are quality indicators for primary, community, and hospital care.[6] Although they can be managed within the community, ACSCs place significant demand on hospitals.[7–9] Canadian data demonstrate that, excluding physician costs, ED visits for unmanaged ACSCs average \$280 CDN[9] and hospitalizations \$5700 CDN.[9] Recent studies indicate that ACSCs may also be contributing to the rise in 911/999 calls for emergency medical services.[1,10,11] UK 999 calls have been rising by 7% each year [12], whilst 911 calls in Ontario increased by 4.2% [13], outpacing population growth. To address this burden and reduce avoidable calls for ACSCs, community paramedicine or alternative paramedicine models are being developed and implemented.[1] However, literature examining ACSCs and 911/999 calls has used dispatch data [14], ED visits via ambulance [15], and patient self-reported reasons for calling.[12] Research has found that dispatch data does not correspond closely with paramedic clinical impression [16], suggesting that dispatch data is not representative of the true nature of the call after the paramedic has completed their assessment. Increasingly, prehospital research studies are utilising clinical impressions for this reason.[1,17]

Next, ED visit research may underestimate the burden of ACSCs on 911/999 because 16-38% of patients are not transported to ED [17–19] and these non-transportations may be primarily for low-acuity conditions.[18,19] Lastly, self-report data may suffer from bias in who can be contacted, self-selection bias, recall bias, social desirability bias, and errors due to incorrect responses (e.g. poor health literacy). Therefore, being able to identify ACSCs from paramedic impression codes in administrative datasets would be valuable for health system research; for



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2  
3 example, studies on the differential rates in 911/999 non-transports for ACSC and non-ACSC  
4 calls, and potential primary care interventions.  
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6 Although mental health conditions are not traditionally considered ACSCs, they have  
7 similar characteristics and health system implications. Specifically, the majority of depressive  
8 and mood-related disorder cases can be better managed in primary care and community  
9 settings [20,21], avoiding visits to the ED.[22] However, mental health conditions represent 4%  
10 of ED visits [23] based on hospital discharge data, and 8-11% of 911/999 calls [24,25], based  
11 on dispatch data. As with ACSCs, these data sources provide some indication but do not  
12 accurately represent the true prevalence of mental health conditions in the pre-hospital  
13 emergency environment; instead, this would be better captured using paramedic clinical  
14 impression codes - a gap in the current literature.  
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20 This study focused on paramedic impression codes from the East Midlands Region, UK  
21 and from Southern Ontario, Canada. These are two international regions with universal  
22 healthcare, established ambulance/paramedic services, and electronic records for each pre-  
23 hospital emergency patient interaction. Comparative research to understand the variation  
24 between healthcare systems is critical to inform future improvements. In understanding the  
25 differences, the revealed complexity provides opportunities for multiple areas of health-systems  
26 learning. Though this type of research has been initiated in primary care [26] it has not been  
27 conducted internationally between ambulance services. A detailed understanding of patient  
28 pathways as they negotiate healthcare from the emergency 911/999 call through prehospital  
29 health services, with or without a hospital visit, is required. ACSCs therefore, provide an  
30 excellent way to explore and trace similar conditions through the primary care and prehospital  
31 system.  
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39 Our objective was to map paramedic clinical impression codes to ACSCs and mental  
40 health conditions in two international regions (UK and Ontario, Canada) with universal  
41 healthcare but different contexts (e.g. policy, programs, resources, built environment), thereby  
42 laying groundwork for future cross-jurisdictional comparative primary care or prehospital  
43 research.  
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## 47 **Methods**

### 48 **Study Design**

49 The mapping was accomplished iteratively with two main phases: (a) identifying the  
50 common ACSCs shared between the two countries; and (b) identifying the respective clinical  
51 impression codes for each country that map to those shared ACSCs as well as to mental health  
52 conditions. The results of this study will be integral to subsequent international health services  
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3 research examining out-of-hospital emergency responses for ACSCs and mental health  
4 conditions.  
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### 8 **Setting and Participants**

9 A panel of experts from the UK-Canada Emergency Calls Data analysis and GEospatial  
10 mapping (EDGE) Consortium contributed to both phases. The EDGE Consortium was formed in  
11 2019, comprising academics from relevant disciplines, including but not limited to: primary care,  
12 paramedicine, rural health, health services and policy, biostatistics, and geography. Some  
13 members of the EDGE Consortium are also senior leaders of paramedic services and/or  
14 practicing primary care physicians (i.e. family doctors or general practitioners). For the first  
15 phase (identifying the list of common ACSCs), all 13 members of the EDGE consortium as of  
16 April 3rd 2020 participated. The second phase (mapping clinical impression codes to ACSCs  
17 and mental health conditions), involved one paramedic and one primary care physician from  
18 each country.  
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### 27 **Patient and Public Involvement**

28 No patients were involved in this study.  
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### 32 **Data Sources**

33 Ambulance services under the National Health Service (NHS) in the UK record the  
34 paramedic's clinical impression in the 'ambulance electronic patient record system' and after  
35 patient assessment it is the main diagnostic source of paramedic clinical data.[6] Similarly,  
36 paramedic services in Ontario, Canada, have paramedics record their clinical impression after  
37 patient assessment using 'problem codes' in the 'ambulance call report'.[27] On first encounter  
38 with the patient, both a primary and secondary problem code can be documented as the main  
39 clinical impression, and then a final set of primary and secondary problem codes can be  
40 documented as the ultimate clinical diagnoses when transferring care of the patient to the  
41 receiving facility, when the interaction has been resolved, or when the patient has refused  
42 transport.[5,6] The initial secondary problem code and the set of final problem codes are  
43 optional, but an initial primary problem code must be recorded for each patient encounter.  
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### 52 **Data Collection**

53 Phase 1: The ACSCs used as health system indicators by each government were  
54 retrieved from institutional websites. In Ontario, the Canadian members of the EDGE  
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3 consortium identified the Canadian Institute for Health Information [28] and Health Quality  
4 Ontario [29] as the most appropriate institutional sources for ACSCs used for health system  
5 indicators. In the UK, the NHS Institute for Innovation and Improvement was identified as the  
6 most appropriate source.[7,26]  
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9 Phase 2: The clinical impression codes common to all Ontario paramedic services were  
10 obtained from the Ontario Ministry of Health and Long-Term Care manual for completing  
11 ambulance call reports, under the heading 'problem codes'. [3] For the UK, the list of clinical  
12 impression codes were obtained from the East Midlands Ambulance Service electronic patient  
13 report template within the Medusa electronic medical record platform.  
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## 18 19 **Analysis**

20 Phase 1: The ACSCs were first compared within each location (Ontario and UK) and  
21 then between locations. Within each location, the institutional lists of ACSCs were cross-  
22 referenced to determine if they contained the same conditions. All conditions were maintained,  
23 even if they only appeared on one list, but discrepancies were noted. Next, the lists for each  
24 location were compared against each other in a meeting with all EDGE Consortium members,  
25 aligning the conditions from each location by consensus. The final list of ACSCs was restricted  
26 to the conditions both locations had in common (i.e. shared ACSCs).  
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31 Phase 2: Using the shared ACSCs from Phase 1 and "mental health," paramedic clinical  
32 impression codes were matched to each condition. Within each location, a physician and  
33 paramedic independently matched the clinical impression codes to the conditions. Next, these  
34 results were compared for agreement. The paramedic and physician discussed any  
35 inconsistencies until they achieved consensus; the rationale for final codes selected is  
36 described in the results below. Where consensus could not be achieved, the  
37 paramedic/physician pair from the other country formed an arbitration panel to resolve  
38 disagreement.  
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## 46 **Results**

### 47 **Phase 1: ACSCs**

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49 The ACSC list from Health Quality Ontario [29] contained seven conditions: (a) angina;  
50 (b) asthma; (c) congestive heart failure (CHF) and pulmonary edema; (d) chronic obstructive  
51 pulmonary disease (COPD); (e) diabetes; (f) grand mal status and other epileptic convulsions;  
52 and, (g) hypertension. The Canadian Institute for Health Information list of ACSCs [28] had two  
53 groups: Group A had the same seven conditions as those from Healthy Quality Ontario listed  
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above, and Group B was solely lower respiratory infections. Therefore, there was substantial agreement between the two institutional lists, and all eight conditions were maintained for the Ontario ACSC list (see Table 1).

The lists of ACSCs from UK institutional sources were much more extensive and included gynecological, dental, gastroenterological, upper respiratory, and vaccine preventable conditions. A King's Fund Report from 2012 [7] highlighted and clarified the NHS Institute for Innovation and Improvement's [26] definition of 19 ACSCs: (a) angina, (b) asthma, (c) cellulitis, (d) congestive heart failure, (e) convulsions and epilepsy, (f) chronic obstructive pulmonary disease, (g) dehydration and gastroenteritis, (h) dental conditions, (i) diabetes complications, (j) ear, nose and throat infections, (k) gangrene, (l) hypertension, (m) influenza and pneumonia, (n) iron-deficiency anaemia, (o) nutritional deficiency, (p) other vaccine preventable diseases, (q) pelvic inflammatory disease, (r) perforated/bleeding ulcer and (s) pyelonephritis (see Table 1).[7]

When the two regional lists were compared by the EDGE Consortium members, agreement was readily reached that the following conditions were common ACSCs for both countries: (a) Diabetes; (b) COPD; (c) Asthma; (d) Angina; (e) Grand mal status and other epileptic convulsions or Convulsions and Epilepsy; (f) Heart Failure and Pulmonary edema; (g) HTN; and, (h) Lower respiratory or Influenza and Pneumonia. Terminology was slightly different for seizure related conditions and lower respiratory conditions. Notably, all ACSCs from the Ontario list were captured within the UK list and neither list included mental health conditions (see Table 1).

**Table 1: Ambulatory care sensitive conditions common to both Ontario, Canada and the United Kingdom**

Ontario ACSC List	UK ACSC List	Ontario/UK agreement
Diabetes	Diabetes complications	Agree
Chronic obstructive pulmonary disease	Chronic obstructive pulmonary disease	Agree
Asthma	Asthma	Agree
Angina	Angina	Agree
Grand mal status and other epileptic convulsions	Convulsions and epilepsy	Agree
Congestive heart failure and pulmonary edema	Congestive heart failure	Agree
Hypertension	Hypertension	Agree
	Cellulitis	No comparable ACSC in Ontario

	Dehydration and gastroenteritis	No comparable ACSC in Ontario
	Dental conditions	No comparable ACSC in Ontario
	Ear, nose and throat infections	No comparable ACSC in Ontario
	Gangrene	No comparable ACSC in Ontario
Lower Respiratory	Influenza and pneumonia	Agree
	Iron-deficiency anaemia	No comparable ACSC in Ontario
	Nutritional deficiency	No comparable ACSC in Ontario
	Other vaccine-preventable diseases	No comparable ACSC in Ontario
	Pelvic inflammatory disease	No comparable ACSC in Ontario
	Perforated/bleeding ulcer	No comparable ACSC in Ontario
	Pyelonephritis	No comparable ACSC in Ontario

Note: ACSC = Ambulatory Care Sensitive Condition

## Phase 2: Clinical Impression Codes Mapped to ACSCs and mental health

Clinical impression codes for paramedics in the UK were more extensive than those in Ontario (see Table 2 and Supplementary File 1). For example Ontario has three problem codes for respiratory conditions describing the aetiology and the general presenting issue or symptom, whereas the UK has five codes covering a mixture of causes, symptoms and diagnoses or diseases. For mental health, the Ontario clinical impression codes are extremely broad, including a whole medical discipline, while the UK codes cover both mechanisms and diagnoses.

**Table 2: Paramedic Impression Codes in Ontario and the UK for Respiratory and Mental Health Conditions**

Category	Ontario Problem Codes	UK Clinical Impression Codes
Respiratory	21: Dyspnea 24: Respiratory Arrest 11: Obstruction (Partial/Complete)	COPD Other Respiratory Problem Chest Infection Choking Asthma Influenza

Mental Health	45: Behaviour / Psychiatric 81: Drug / Alcohol Overdose	Attempted Suicide Intentional Drug Overdose DOLS (Deprivation of Liberty Safeguards) Anxiety Psychosis Effects of Alcohol Social Problem Under MHA Section Accidental Overdose / Poisoning Depression Panic / Anxiety Attack Other Mental Health Problem Dementia Query Intoxicated
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The physician and paramedic pair from Ontario each independently selected the clinical impression codes that best matched each condition based on their clinical expertise (see Supplementary File 2). The physician selected more codes in order to reflect the breadth of scope of conditions, though the paramedic had selected mainly one code. Agreement was reached that in actual practice, a single impression code would be chosen by paramedics to represent conditions encountered. A greater number of codes was likely to cause a low specificity in mapping of clinical conditions. For example, for chronic obstructive airways disease (COPD), the physician chose five separate codes to represent conditions that may have caused respiratory changes, that a paramedic could have observed attending to someone experiencing a COPD exacerbation; codes covered 'dyspnea', 'temporary loss of consciousness', and 'weakness/dizziness/unwell' were identified. The paramedic chose two codes: 'dyspnea' as the main code and 'respiratory arrest' as an alternate code. At the ensuing discussion, the common clinical circumstances requiring 911 calls were elucidated and discussed in detail. Extremes of presentation were considered, as well as the usual paramedic options for clinical impression and those that were most often used in reality. Consensus was reached that a code of 'dyspnea' would be the most specific in capturing people who called 911 for COPD.

The physician and paramedic pair from the East Midlands also each selected the clinical impression codes that best matched each condition based on their clinical expertise (see Supplementary File 2). Both physician and paramedic selected clinical impression codes independently, followed by a discussion of any differences. For example, for "angina" the

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3 paramedic only selected “cardiac chest pain” whereas the physician selected “cardiac chest  
4 pain”, “ECG Confirmed ST Segment Elevated MI” and “Cardiac Problem”. Similar to the  
5 selection in Ontario, the paramedic was more selective, and the physician was more inclusive.  
6 We agreed for the purpose of this exercise to be inclusive rather than exclusive. The UK  
7 paramedic and physician selected identical clinical impressions for all other conditions.  
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11 In both Ontario and the UK there was no clinical code found for hypertension. In Ontario,  
12 three of the ACSCs have the same code (dyspnea) whereas in the UK, each ACSC has a more  
13 unique descriptive code. The mental health codes were completely different between Ontario  
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## Discussion

This paper has successfully mapped clinical impression codes generated by paramedics attending to patients with ACSCs and mental health conditions in Canada and the UK. However, some interesting factors have emerged that researchers should be aware of when analyzing any paramedic clinical impression codes for primary care or prehospital research purposes. Hypertension, though classified as an ACSC, could not be distinguished specifically enough from any of the existing paramedic impression codes for either Canada or the UK. The codes, however, did contain clinical scenarios that might have included hypertension-induced emergencies, such as cerebrovascular accidents or heart failure. Therefore, although hypertension is very common in primary care and its complications lead to emergency situations, it cannot easily be detected in paramedic impression codes. However the issue of clinical misclassification is not limited only to this situation. Literature shows that ICD-10 codes used by clinicians often do not match the ACSC codes.[30] This can make it difficult for clinicians when trying to classify the presentation of the patient they just saw.

As noted in Table 1, there are many more paramedic impression codes in the UK compared to the Canadian codes in Ontario. The inconsistency in the two countries' codes resulted in the mapping process being more difficult, though it was achieved. Having too many or too few paramedic impression codes may result in paramedics not being able to choose the appropriate codes for certain conditions when in the clinical field. Therefore it is possible that some Canadian clinical impression codes may be undifferentiated between the clinical impressions, leading to lack of variability in the data. When Ontario chooses to revise their ACSC lists, they may consider looking at some of the UK codes to provide a greater breadth of conditions. However the UK has a much greater degree of granularity, combining diagnoses as well as symptoms and causes, which may be too detailed, leading to mis-classifications. Ultimately, both scenarios will render the identification of ACSCs retrospectively technically difficult and might warrant more consideration as ambulance services refine their data collection tools. The best scenario would be to have a unified system of paramedic impression codes that would be relevant for all countries and adopted internationally, allowing for ease of comparisons.

Although mental health was not an ACSC according to either country's institutional lists, our cross-country research team included it because it is a term that encompasses conditions that could be better managed through primary care but that often lead to emergency health system use, e.g. suicidal crisis as a result of chronic depressive disorder. It would be appropriate for mental health to be included whenever the institutions revise their ACSC lists in



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3 the future. It is important to note that mental health constituting an ACSC would not describe  
4 any acute psychotic presentations, but rather depression and other mood-related disorders that  
5 are commonly managed in general practice.  
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8 Having any information about patient pathways is important in healthcare systems as we  
9 try to set up integrated care. As discussion around integrated care proceeds, understanding the  
10 unmet healthcare needs of patients with certain avoidable conditions is crucial in healthcare  
11 planning. These types of discussion are already happening at healthcare planning tables in the  
12 UK and Canada. Now that paramedic indicators for potentially avoidable calls have been  
13 identified in this paper, these discussions may fuel a series of quality improvement and research  
14 papers on these unique patient pathways. Indeed, for patients who have health issues that lead  
15 to a 999/911 call, but are not needed to be transported to the hospital, paramedic clinical  
16 impression codes are the only place this function of the healthcare system is captured, therefore  
17 they are a very important tool to use. This paper lays down important groundwork to allow future  
18 between-country comparisons to start, and to determine which health service practices may  
19 benefit our patient populations more or less, as we learn from each other's mistakes and  
20 successes.  
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### 30 **Limitations**

31 Though paramedic data can be linked to ACSCs, we cannot be absolutely sure that we  
32 have identified the conditions that have manifested as ACSCs. This study has uncovered how  
33 vague (Canada) or over-prescriptive (UK) some of the impression codes are. This will definitely  
34 affect the quality of any data analytical work that would ensue from any epidemiological  
35 examination of the paramedic data. Future work should focus on subsequent validation studies,  
36 such as a more rigorous Delphi method, followed by validation against actual administrative  
37 data that includes details about hospital visits and diagnostic codes further down the line of  
38 health system patient involvement.  
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### 46 **Conclusion**

47 Clinical impression codes generated by paramedics upon attending to acute call patients can be  
48 mapped to cover ACSCs and mental health conditions, both in the UK and in Ontario, Canada.  
49 This is an important first step in determining the numbers of ASCSs and mental health  
50 conditions that paramedics attend to, and in examining the clinical pathways of these individuals  
51 across the health system. This work lays the foundation for international comparative health  
52 services research on integrated pathways in primary care and EMS.  
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## **Declarations**

### **Ethics Approval and Consent to Participate**

Not applicable.

### **Availability of Data and Materials**

Data sharing is not applicable to this article as no new data were created in this study.

### **Competing Interests**

The authors declare that they have no competing interests.

### **Funding**

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### **Authors' contributions**

All authors conceived of the study as a necessary step in the work of the EDGE consortium. GA and ANS led the study activities in Canada and the UK, respectively. GA, ANS, BM, RS, and GW participated in the mapping and arbitration process. GA, ANS, and MP drafted the manuscript. All authors contributed to the interpretation and review of the final manuscript.

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## Supplementary File 1

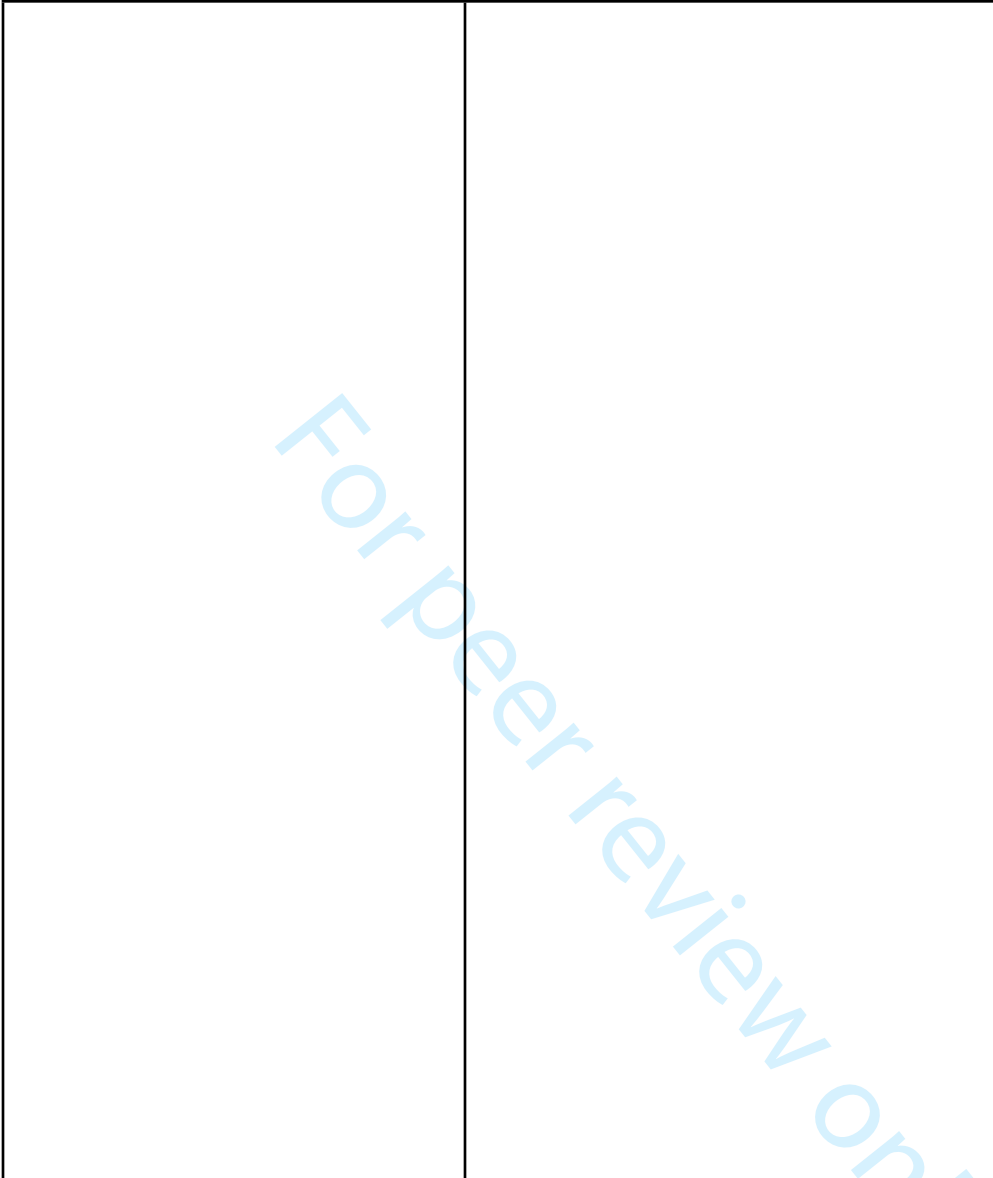
**Table S1. Clinical Impression Codes available to paramedics in Ontario, Canada and the United Kingdom**

Ontario Problem Codes	UK Clinical Impression Codes
Vital Signs Absent	Injury Trauma
1: Cardiac/Medical	Gunshot
2: Traumatic	Abdominal Injury
Airway	Near Drowning
11: Obstruction	Explosive / Blast Injury
(Partial/Complete)	Stab Wound
Breathing	Limb Injury
21: Dyspnea	Penetrating Trauma
24: Respiratory Arrest	Head Injury
Circulation	Neck Injury
31: Hemorrhage	Smoke Inhalation
33: Hypotension	Diving Incident
34: Suspected sepsis	Fall Non - Injury
Neurological	Chest Injury
40: Traumatic Brain Injury	Thermal Injury
41: Stroke / TIA	Back Injury
42: Temporary Loss of	Carbon Monoxide Poisoning
Consciousness	Drowning
43: Altered Level of	Electrocution
Consciousness	Chemical Exposure
44: Headache	Multi-System Trauma
45: Behaviour / Psychiatric	Cold Exposure
45.01: Excited Delirium	CBRNE Incident
46: Active Seizure	Back Pain Non-Traumatic
47: Paralysis / Spinal Trauma	Unintentional Overdose
48: Confusion / Disorientation	Alleged Assault
49: Unconscious	Soft Tissue Injury
50: Post-ictal	Suspected Neck of Femur
Cardiac	Gastrointestinal
51: Ischemic	Acute Abdominal Problem
53: Palpitations	Constipation
54: Pulmonary Edema	Diarrhea & Vomiting
55: Post Arrest	Gastrointestinal Bleed
56: Cardiogenic Shock	Other Abdominal Problem
57: STEMI	Urinary
58: Hyperkalemia	Urinary Problem
Non-Traumatic	Urinary Tract Infection
60: Non Ischemic Chest Pain	Catheter Problem
61: Abdominal / Pelvic /	Allergic
Perineal / Rectal Pain	Allergic Reaction
62: Back Pain	Bite / Sting
	Neurological/stroke
	Faint
	Collapse Unknown Cause
	Collapse ? Cause

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4	Gastrointestinal	Convulsion
5	63: Nausea/ Vomiting/ Diarrhea	Other Neurological Problem
6	Musculoskeletal/Trauma	Febrile Convulsion
7	66: Musculoskeletal	Confusion
8	67: Trauma / Injury	Chronic Neurological Problem
9	Obstetrical/Gynecological	Headache
10	71: Obstetrical Emergency	Meningitis
11	72: Gynecological Emergency	Faint/Dizziness
12	73: Newborn / Neonatal	Obstetric or gynaecological
13	Endocrine/Toxicological	Ectopic Pregnancy
14	81: Drug / Alcohol Overdose	Other Gynae Problem
15	81.1: Suspected Opioid	Eclampsia
16	Overdose	Chronic Gynae Problem
17	82: Poisoning / Toxic Exposure	Other Obstetric Problem
18	83: Diabetic Emergency	New Born Infant
19	84: Allergic Reaction	Delivery Complication
20	85: Anaphylaxis	Antepartum Haemorrhage
21	86: Adrenal Crisis	Miscarriage
22	General and Minor	Postpartum Haemorrhage
23	87: Novel Medications	Pre-eclampsia
24	88: Home Medical Technology	In Labour
25	89: Lift Assist	PV Bleed
26	90: Inter-facility Transfer	Baby Delivered
27	91: Environmental Emergency	Non-specific
28	92: Weakness / Dizziness /	Other Medical Problem
29	Unwell	Unknown Problem
30	93: Treatment / Diagnosis &	Transport Only
31	Return	No Apparent Problem
32	94: Convalescent / Invalid /	Cardiovascular
33	Return Home	Arrhythmia / Palpitations
34	95: Infectious Disease	ECG Confirmed ST Segment
35	96: Organ Retrieval / Transfer	Elevated MI
36	98: Organ Recipient	Cardiac Problem
37	99:Other Medical / Trauma	Cardiac Arrest
38		DVT
39		Cardiac Chest Pain
40		AAA ([ruptured] abdominal aorti
41		aneurysm)
42		Ischaemic Limb
43		Heart Failure
44		Suspected PE
45		TIA
46		Stroke
47		Sickle Cell Crisis
48		Chest Pain Non-Cardiac
49		Respiratory
50		COPD
51		Other Respiratory Problem
52		Chest Infection
53		Choking
54		Asthma
55		Influenza
56		Psychosocial
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4	Attempted Suicide
5	Intentional Drug Overdose
6	DOLS (Deprivation of Liberty
7	Safeguards)
8	Anxiety
9	Psychosis
10	Effects of Alcohol
11	Social Problem
12	Under MHA Section
13	Accidental Overdose / Poisoning
14	Depression
15	Panic / Anxiety Attack
16	Other Mental Health Problem
17	Dementia
18	Query Intoxicated
19	ENT/otthalmological
20	Dental Problem
21	Other ENT Problem
22	Eye Problem
23	Epistaxis
24	Infections
25	Sepsis
26	Pyrexia Unknown Origin
27	Other Infection
28	Hyperthermia
29	Palliative care/frailty
30	Palliative Terminal Care
31	Off Legs / Poor Mobility
32	Endocrine
33	Hyperglycaemia
34	Hypoglycaemia
35	Other Diabetic Problem
36	Endocrine Emergency
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**Supplementary File 2**

**Table S2. Paramedic Impression Codes Mapped to Ambulatory Care Sensitive Conditions**

ACSC variable	Ontario Codes			UK Codes			Final Codes for Use	
	Paramedic-supplied	Physician-supplied	Combined/Corroborated	Paramedic-supplied	Physician-supplied	Combined/Corroborated	Ontario	UK
<b>Diabetes</b>	83: Diabetic Emergency <u>Alternate:</u> 41: Stroke/TIA 43: Altered Level of Consciousness 48: Confusion/Disorientation 49: Unconscious 63: Nausea/Vomiting/Diarrhea 92: Weakness/Dizziness/Unwell	83: Diabetic Emergency 42: Temporary Loss of Consciousness 63: Nausea/Vomiting/ Diarrhea 92: Weakness/Dizziness/Unwell	83: Diabetic Emergency	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	83: Diabetic Emergency	Hyperglycaemia Hypoglycaemia Other Diabetic Problem
<b>COPD</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/Dizziness/Unwell	21: Dyspnea	COPD	COPD	COPD	21: Dyspnea	COPD
<b>Asthma</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/	21: Dyspnea	Asthma	Asthma	Asthma	21: Dyspnea	Asthma

		Dizziness/Unwell						
<b>Angina</b>	51: Ischemic <u>Alternate:</u> 53: Palpitations 55: Post Arrest 56: Cardiogenic Shock 57: STEMI 61: Abdominal/ Pelvic/Perineal/ Rectal Pain	21: Dyspnea 51: Ischemic 92: Weakness/ Dizziness/Unwell	51: Ischemic	Cardiac Chest Pain	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain	51: Ischemic 57: STEMI	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain
<b>Grand Mal and other epileptic convulsions</b>	46: Active Seizure <u>Alternate:</u> 42: Temporary Loss of Consciousness 43: Altered Level of Consciousness 48: Confusion /Disorientation 49: Unconscious 50: Post-ictal	46: Active Seizure 50: Post-ictal 42: Temporary Loss of Consciousness 44: Headache 45: Behaviour/ Psychiatric 48: Confusion/ Disorientation 89: Lift Assist 92: Weakness/ Dizziness/Unwell	46: Active Seizure 50: Post-ictal	Convulsion Epilepsy	Convulsion Epilepsy	Convulsion Epilepsy	46: Active Seizure 50: Post-ictal	Convulsion Epilepsy
<b>HF and Pulm Edema</b>	54: Pulmonary Edema <u>Alternate:</u> 24: Respiratory Arrest 51: Ischemic 55: Post Arrest 56: Cardiogenic Shock 57: STEMI	21: Dyspnea 54: Pulmonary Edema 60: Non Ischemic Chest Pain 92: Weakness/ Dizziness/ Unwell	54: Pulmonary Edema	Heart Failure	Heart Failure	Heart Failure	54: Pulmonary Edema	Heart Failure

<b>Hypertension</b>	99: Other Medical/ Trauma <u>Alternate:</u> 41: Stroke/TIA 44: Headache 51: Ischemic 53: Palpitations 54: Pulmonary Edema 57: STEMI	44: Headache 92: Weakness/ Dizziness/ Unwell 99: Other Medical/Trauma	No code available	None	None	No code available	No code available	No code available
<b>Lower Respiratory</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 33: Hypotension 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/ Dizziness/ Unwell	21: Dyspnea	Chest infection	Chest infection	Chest Infection	21: Dyspnea	Chest Infection
<b>Mental Health - anxiety, depression, panic attack</b>	45: Behaviour/ Psychiatric <u>Alternate:</u> 43: Altered Level of Consciousness 53: Palpitations	21: Dyspnea 45: Behaviour/ Psychiatric 42: Temporary Loss of Consciousness 44: Headache 48: Confusion/ Disorientation 60: Non Ischemic Chest Pain 63: Nausea/ Vomiting/ Diarrhea 92: Weakness/ Dizziness/ Unwell	45: Behaviour/ Psychiatric	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	45: Behaviour/ Psychiatric 81: Intentional drug overdose	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack

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		89: Lift Assist 45.01 Excited Delirium						
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Notes: COPD = chronic obstructive pulmonary disease; ECG = electrocardiogram; MI = myocardial infarction; ST Elevation = elevation of the ST segment on an electrocardiogram; STEMI = ST elevation myocardial infarction; TIA = transient ischemic attack

For peer review only

# BMJ Open

## Development of Indicators for Avoidable Emergency Medical Service Calls by Mapping Paramedic Clinical Impression Codes to Ambulatory Care Sensitive Conditions and Mental Health Conditions in the UK and Canada

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2023-073520.R1
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Date Submitted by the Author:	19-Oct-2023
Complete List of Authors:	Agarwal, Gina; Hamilton, Department of Family Medicine Siriwardena, Aloysius; University of Lincoln, Lincoln School of Health and Social Care McLeod, Brent; Hamilton Paramedic Service Spaight, Robert; East Midlands Ambulance Service NHS Trust Whitley, Gregory; East Midlands Ambulance Service NHS Trust Ferron, Richard; Niagara Emergency Medical Services Pirrie, Melissa; McMaster University, Department of Family Medicine Angeles, Ricardo; McMaster University, Department of Family Medicine Moore, Harriet; University of Lincoln Gussy, Mark; University of Lincoln Consortium, EDGE; McMaster University
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Emergency medicine, General practice / Family practice, Health policy
Keywords:	Primary Health Care, ACCIDENT & EMERGENCY MEDICINE, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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3 **Development of Indicators for Avoidable Emergency Medical Service Calls by Mapping**  
4 **Paramedic Clinical Impression Codes to Ambulatory Care Sensitive Conditions and**  
5 **Mental Health Conditions in the UK and Canada**  
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## Abstract:

**Background:** Paramedic assessment data have not been used for research on avoidable calls. Paramedic impression codes are designated by paramedics upon responding to a 911/999 medical emergency after an assessment of the presenting condition. Ambulatory Care Sensitive Conditions (ACSCs) are non-acute health conditions not needing hospital admission when properly managed.

**Methods:** The current study focused on paramedic impression codes from the East Midlands Region, UK and from Southern Ontario, Canada and mapped them to existing definitions of ambulatory care sensitive conditions (ACSCs) and mental health conditions. Mapping was iterative first identifying the common ACSCs shared between the two countries then identifying the respective clinical impression codes for each country that mapped to those shared ACSCs as well as to mental health conditions.

**Results:** Experts from the UK-Canada Emergency Calls Data analysis and GEospatial mapping (EDGE) Consortium contributed to both phases and were able to independently match the codes and then compare results. Clinical impression codes for paramedics in the UK were more extensive than those in Ontario. The mapping revealed some interesting inconsistencies between paramedic impression codes, but also demonstrated that it was possible.

**Conclusion:** This is an important first step in determining the numbers of ASCSs and mental health conditions that paramedics attend to, and in examining the clinical pathways of these individuals across the health system. This work lays the foundation for international comparative health services research on integrated pathways in primary care and EMS.

## Strengths and Limitations of this Study

- To our knowledge, this is the first study to map the clinical impression codes available to paramedics in their mandatory reporting forms to ambulatory care sensitive conditions (ACSCs) and mental health conditions.
- The mapping was conducted for both the UK and Ontario, Canada contexts, supporting future inter-country comparisons between these regions with similar healthcare systems but varying policies and resources.
- Though paramedic data can be linked to ACSCs using the mapping from this study, it cannot be absolutely certain that the conditions with these codes are manifestations of ACSCs.

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- The mapping was only completed for ACSCs as defined by the UK and Ontario, Canada healthcare systems and the mapping method would need to be repeated for other countries to permit their inclusion in future international studies.

For peer review only

## Introduction

Paramedic assessment data are often used in pre-hospital research [1,2], but rarely for research on avoidable calls.[1] Paramedic impression codes are designated by paramedics during a 911/999 medical emergency response after completing a patient assessment.[3,4] This is critical information for primary care research, capturing the hitherto unknown clinical 'pathway' of a patient, namely: (a) the clinical situation *between* the primary care setting and the emergency department (ED), or (b) details of clinical cases assessed by paramedics but *not* transported to hospital. Importantly, the latter scenario typically comprises lower acuity calls contributing to emergency health system burden that may be better addressed by primary care.[1]

Ambulatory Care Sensitive Conditions (ACSCs) are non-acute health conditions not requiring hospital admission when properly managed or prevented by accessible primary care in the community.[5] ACSCs are routinely monitored and are quality indicators for primary, community, and hospital care.[6] While there are some ACSC complications that cannot be prevented, in the majority of cases they can usually be successfully managed within the community; however, ACSCs are still placing significant demand on hospitals.[7–9] Canadian data demonstrate that, excluding physician costs, ED visits for unmanaged ACSCs average \$280 CDN[9] and hospitalizations \$5700 CDN.[9] Recent studies indicate that ACSCs may also be contributing to the rise in 911/999 calls for emergency medical services.[1, 10, 11] UK 999 calls have been rising by 7% each year [12], whilst 911 calls in Ontario increased by 4.2% [13], outpacing population growth. To address this burden and reduce avoidable calls for ACSCs, community paramedicine or alternative paramedicine models are being developed and implemented.[1] However, literature examining ACSCs and 911/999 calls has used dispatch data [14], ED visits via ambulance [15], and patient self-reported reasons for calling.[12] Research has found that dispatch data does not correspond closely with paramedic clinical impression [16], suggesting that dispatch data is not representative of the true nature of the call after the paramedic has completed their assessment. Increasingly, prehospital research studies are utilising clinical impressions for this reason.[1, 17]

Next, ED visit research may underestimate the burden of ACSCs on 911/999 because 16-38% of patients are not transported to ED [17–19] and these non-transportations may be primarily for low-acuity conditions.[18, 19] Lastly, self-report data may suffer from bias in who can be contacted, self-selection bias, recall bias, social desirability bias, and errors due to incorrect responses (e.g. poor health literacy). Therefore, being able to identify ACSCs from paramedic impression codes in administrative datasets would be valuable for health system research; for

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3 example, studies on the differential rates in 911/999 non-transport for ACSC and non-ACSC  
4 calls, and potential primary care interventions.  
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6 Although mental health conditions are not traditionally considered ACSCs, they have  
7 similar characteristics and health system implications. Specifically, the majority of depressive  
8 and mood-related disorder cases can be better managed in primary care and community  
9 settings [20,21], avoiding visits to the ED.[22] However, mental health conditions represent 4%  
10 of ED visits [23] based on hospital discharge data, and 8-11% of 911/999 calls [24,25], based  
11 on dispatch data. As with ACSCs, these data sources provide some indication but do not  
12 accurately represent the true prevalence of mental health conditions in the pre-hospital  
13 emergency environment; instead, this would be better captured using paramedic clinical  
14 impression codes - a gap in the current literature.  
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20 This study focused on paramedic impression codes from the East Midlands Region, UK  
21 and from Southern Ontario, Canada. These are two international regions with universal  
22 healthcare, established ambulance/paramedic services, and electronic records for each pre-  
23 hospital emergency patient interaction. Comparative research to understand the variation  
24 between healthcare systems is critical to inform future improvements. In understanding the  
25 differences, the revealed complexity provides opportunities for multiple areas of health-systems  
26 learning. Though this type of research has been initiated in primary care [26] it has not been  
27 conducted internationally between ambulance services. A detailed understanding of patient  
28 pathways as they negotiate healthcare from the emergency 911/999 call through prehospital  
29 health services, with or without a hospital visit, is required. ACSCs therefore provide an  
30 excellent way to explore and trace similar conditions through the primary care and prehospital  
31 system.  
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39 Our objective was to map paramedic clinical impression codes to ACSCs and mental  
40 health conditions in two international regions (UK and Ontario, Canada) with universal  
41 healthcare but different contexts (e.g., policy, programs, resources, built environment), thereby  
42 laying groundwork for future cross-jurisdictional comparative primary care or prehospital  
43 research.  
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## 47 **Methods**

### 48 **Study Design**

49 The mapping was accomplished iteratively with two main phases: (a) identifying the  
50 common ACSCs shared between the two countries; and (b) identifying the respective clinical  
51 impression codes for each country that map to those shared ACSCs as well as to mental health  
52 conditions. The results of this study will be integral to subsequent international health services  
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3 research examining out-of-hospital emergency responses for ACSCs and mental health  
4 conditions.  
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### 8 **Setting and Participants**

9 A panel of experts from the UK-Canada Emergency Calls Data analysis and GEospatial  
10 mapping (EDGE) Consortium contributed to both phases. The EDGE Consortium was formed in  
11 2019, comprising academics from relevant disciplines, including but not limited to: primary care,  
12 paramedicine, rural health, health services and policy, biostatistics, and geography. Some  
13 members of the EDGE Consortium are also senior leaders of paramedic services and/or  
14 practicing primary care physicians (i.e., family doctors or general practitioners). For the first  
15 phase (identifying the list of common ACSCs), all 13 members of the EDGE consortium as of  
16 April 3rd, 2020, participated. The second phase (mapping clinical impression codes to ACSCs  
17 and mental health conditions), involved one paramedic and one primary care physician from  
18 each country.  
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### 27 **Patient and Public Involvement**

28 No patients were involved in this study.  
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### 32 **Data Sources**

33 Ambulance services under the National Health Service (NHS) in the UK record the  
34 paramedic's clinical impression in the 'ambulance electronic patient record system' and after  
35 patient assessment it is the main diagnostic source of paramedic clinical data.[6] Similarly,  
36 paramedic services in Ontario, Canada, have paramedics record their clinical impression after  
37 patient assessment using 'problem codes' in the 'ambulance call report'.[27] On first encounter  
38 with the patient, both a primary and secondary problem code can be documented as the main  
39 clinical impression, and then a final set of primary and secondary problem codes can be  
40 documented as the ultimate clinical diagnoses when transferring care of the patient to the  
41 receiving facility, when the interaction has been resolved, or when the patient has refused  
42 transport.[5,6] The initial secondary problem code and the set of final problem codes are  
43 optional, but an initial primary problem code must be recorded for each patient encounter. In  
44 both settings, these codes are from a pre-determined list provided by the respective governing  
45 bodies and are entered into a structured form. Though paramedics can choose which code to  
46 enter, they cannot change the actual codes themselves, and other areas of ambulance  
47 electronic health records may allow notations.  
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## Data Collection

Phase 1: The ACSCs used as health system indicators by each government were retrieved from institutional websites. In Ontario, the Canadian members of the EDGE consortium identified the Canadian Institute for Health Information [28] and Health Quality Ontario [29] as the most appropriate institutional sources for ACSCs used for health system indicators. In the UK, the NHS Institute for Innovation and Improvement was identified as the most appropriate source.[7,26]

Phase 2: The clinical impression codes common to all Ontario paramedic services were obtained from the Ontario Ministry of Health and Long-Term Care (a provincial governmental body) manual for completing ambulance call reports, under the heading 'problem codes'. [3] This ministry is responsible for ongoing review and updating of the clinical codes. For the UK, the list of clinical impression codes were obtained from the East Midlands Ambulance Service (a regional institutional body) electronic patient report template within the Medusa electronic medical record platform. These UK codes are used nationally and were developed by a multi-disciplinary panel of NHS clinicians.[30] These codes, both in Ontario and the UK, provide a common structure for clinicians to use within an ambulance electronic health record despite the multiple different care settings and contexts.

## Analysis

Phase 1: The ACSCs were first compared within each location (Ontario and UK) and then between locations. Within each location, the institutional lists of ACSCs were cross-referenced to determine if they contained the same conditions. All conditions were maintained, even if they only appeared on one list, but discrepancies were noted. Next, the lists for each location were compared against each other in a meeting with all EDGE Consortium members, aligning the conditions from each location by consensus. The final list of ACSCs was restricted to the conditions both locations had in common (i.e., shared ACSCs).

Phase 2: Using the shared ACSCs from Phase 1 and "mental health," paramedic clinical impression codes were matched to each condition. Within each location, a physician and paramedic independently matched the clinical impression codes to the conditions. Next, these results were compared for agreement. The paramedic and physician discussed any inconsistencies until they achieved consensus; the rationale for final codes selected is described in the results below. Where consensus could not be achieved, the

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3 paramedic/physician pair from the other country formed an arbitration panel to resolve  
4 disagreement.  
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## 8 **Results**

### 9 **Phase 1: ACSCs**

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11 The ACSC list from Health Quality Ontario [29] contained seven conditions: (a) angina;  
12 (b) asthma; (c) congestive heart failure (CHF) and pulmonary edema; (d) chronic obstructive  
13 pulmonary disease (COPD); (e) diabetes; (f) grand mal status and other epileptic convulsions;  
14 and, (g) hypertension. The Canadian Institute for Health Information list of ACSCs [28] had two  
15 groups: Group A had the same seven conditions as those from Healthy Quality Ontario listed  
16 above, and Group B was solely lower respiratory infections. Therefore, there was substantial  
17 agreement between the two institutional lists, and all eight conditions were maintained for the  
18 Ontario ACSC list (see Table 1).  
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24 The lists of ACSCs from UK institutional sources were much more extensive and  
25 included gynecological, dental, gastroenterological, upper respiratory, and vaccine preventable  
26 conditions. A King's Fund Report from 2012 [7] highlighted and clarified the NHS Institute for  
27 Innovation and Improvement's [26] definition of 19 ACSCs: (a) angina, (b) asthma, (c) cellulitis,  
28 (d) congestive heart failure, (e) convulsions and epilepsy, (f) chronic obstructive pulmonary  
29 disease, (g) dehydration and gastroenteritis, (h) dental conditions, (i) diabetes complications, (j)  
30 ear, nose and throat infections, (k) gangrene, (l) hypertension, (m) influenza and pneumonia, (n)  
31 iron-deficiency anaemia, (o) nutritional deficiency, (p) other vaccine preventable diseases, (q)  
32 pelvic inflammatory disease, (r) perforated/bleeding ulcer and (s) pyelonephritis (see Table  
33 1).[7]  
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39 When the two regional lists were compared by the EDGE Consortium members,  
40 agreement was readily reached that the following conditions were common ACSCs for both  
41 countries: (a) Diabetes; (b) COPD; (c) Asthma; (d) Angina; (e) Grand mal status and other  
42 epileptic convulsions or Convulsions and Epilepsy; (f) Heart Failure and Pulmonary edema; (g)  
43 HTN; and, (h) Lower respiratory or Influenza and Pneumonia. Terminology was slightly different  
44 for seizure related conditions and lower respiratory conditions. Notably, all ACSCs from the  
45 Ontario list were captured within the UK list and neither list included mental health conditions  
46 (see Table 1).  
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**Table 1: Ambulatory care sensitive conditions common to both Ontario, Canada and the United Kingdom**

Ontario ACSC List	UK ACSC List	Ontario/UK agreement
Diabetes	Diabetes complications	Agree
Chronic obstructive pulmonary disease	Chronic obstructive pulmonary disease	Agree
Asthma	Asthma	Agree
Angina	Angina	Agree
Grand mal status and other epileptic convulsions	Convulsions and epilepsy	Agree
Congestive heart failure and pulmonary edema	Congestive heart failure	Agree
Hypertension	Hypertension	Agree
	Cellulitis	No comparable ACSC in Ontario
	Dehydration and gastroenteritis	No comparable ACSC in Ontario
	Dental conditions	No comparable ACSC in Ontario
	Ear, nose and throat infections	No comparable ACSC in Ontario
	Gangrene	No comparable ACSC in Ontario
Lower Respiratory	Influenza and pneumonia	Agree
	Iron-deficiency anaemia	No comparable ACSC in Ontario
	Nutritional deficiency	No comparable ACSC in Ontario
	Other vaccine-preventable diseases	No comparable ACSC in Ontario
	Pelvic inflammatory disease	No comparable ACSC in Ontario
	Perforated/bleeding ulcer	No comparable ACSC in Ontario
	Pyelonephritis	No comparable ACSC in Ontario

Note: ACSC = Ambulatory Care Sensitive Condition

## Phase 2: Clinical Impression Codes Mapped to ACSCs and mental health

Clinical impression codes for paramedics in the UK were more extensive than those in Ontario (see Table 2 and Supplementary File 1). For example Ontario has three problem codes for respiratory conditions describing the aetiology and the general presenting issue or symptom, whereas the UK has five codes covering a mixture of causes, symptoms and diagnoses or diseases. For mental health, the Ontario clinical impression codes are extremely broad, including a whole medical discipline, while the UK codes cover both mechanisms and diagnoses.



**Table 2: Paramedic Impression Codes in Ontario and the UK for Respiratory and Mental Health Conditions**

Category	Ontario Problem Codes	UK Clinical Impression Codes
Respiratory	21: Dyspnea 24: Respiratory Arrest 11: Obstruction (Partial/Complete)	COPD Other Respiratory Problem Chest Infection Choking Asthma Influenza
Mental Health	45: Behaviour / Psychiatric 81: Drug / Alcohol Overdose	Attempted Suicide Intentional Drug Overdose DOLS (Deprivation of Liberty Safeguards) Anxiety Psychosis Effects of Alcohol Social Problem Under MHA Section Accidental Overdose / Poisoning Depression Panic / Anxiety Attack Other Mental Health Problem Dementia Query Intoxicated

The physician and paramedic pair from Ontario each independently selected the clinical impression codes that best matched each condition based on their clinical expertise (see Supplementary File 2). The physician selected more codes in order to reflect the breadth of scope of conditions, though the paramedic had selected mainly one code. Agreement was reached that in actual practice, a single impression code would be chosen by paramedics to represent conditions encountered. A greater number of codes was likely to cause a low specificity in mapping of clinical conditions. For example, for chronic obstructive airways disease (COPD), the physician chose five separate codes to represent conditions that may have caused respiratory changes, that a paramedic could have observed attending to someone experiencing a COPD exacerbation; codes covered 'dyspnea', 'temporary loss of consciousness', and 'weakness/dizziness/unwell' were identified. The paramedic chose two codes: 'dyspnea' as the

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3 main code and 'respiratory arrest' as an alternate code. At the ensuing discussion, the common  
4 clinical circumstances requiring 911 calls were elucidated and discussed in detail. Extremes of  
5 presentation were considered, as well as the usual paramedic options for clinical impression  
6 and those that were most often used in reality. Consensus was reached that a code of 'dyspnea'  
7 would be the most specific in capturing people who called 911 for COPD.  
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11 The physician and paramedic pair from the East Midlands also each selected the clinical  
12 impression codes that best matched each condition based on their clinical expertise (see  
13 Supplementary File 2). Both physician and paramedic selected clinical impression codes  
14 independently, followed by a discussion of any differences. For example, for "angina" the  
15 paramedic only selected "cardiac chest pain" whereas the physician selected "cardiac chest  
16 pain", "ECG Confirmed ST Segment Elevated MI" and "Cardiac Problem". Similar to the  
17 selection in Ontario, the paramedic was more selective, and the physician was more inclusive.  
18 We agreed for the purpose of this exercise to be inclusive rather than exclusive. The UK  
19 paramedic and physician selected identical clinical impressions for all other conditions.  
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22 In both Ontario and the UK there was no clinical code found for hypertension. In Ontario,  
23 three of the ACSCs have the same code (dyspnea) whereas in the UK, each ACSC has a more  
24 unique descriptive code. The mental health codes were completely different between Ontario  
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## Discussion

This paper has successfully mapped clinical impression codes generated by paramedics attending to patients with ACSCs and mental health conditions in Canada and the UK. However, some interesting factors have emerged that researchers should be aware of when analyzing any paramedic clinical impression codes for primary care or prehospital research purposes. Hypertension, though classified as an ACSC, could not be distinguished specifically enough from any of the existing paramedic impression codes for either Canada or the UK. The codes, however, did contain clinical scenarios that might have included hypertension-induced emergencies, such as cerebrovascular accidents or heart failure. Therefore, although hypertension is very common in primary care and its complications lead to emergency situations, it cannot easily be detected in paramedic impression codes. However the issue of clinical misclassification is not limited only to this situation. Literature shows that ICD-10 codes used by clinicians often do not match the ACSC codes.[31] This can make it difficult for clinicians when trying to classify the presentation of the patient they just saw.

As noted in Table 1, there are many more paramedic impression codes in the UK compared to the Canadian codes in Ontario. The inconsistency in the two countries' codes resulted in the mapping process being more difficult, though it was achieved. Having too many or too few paramedic impression codes may result in paramedics not being able to choose the appropriate codes for certain conditions when in the clinical field. Therefore it is possible that some Canadian clinical impression codes may be undifferentiated between the clinical impressions, leading to lack of variability in the data. When Ontario chooses to revise their ACSC lists, they may consider looking at some of the UK codes to provide a greater breadth of conditions. However the UK has a much greater degree of granularity, combining diagnoses as well as symptoms and causes, which may be too detailed, leading to mis-classifications. Ultimately, both scenarios will render the identification of ACSCs retrospectively technically difficult and might warrant more consideration as ambulance services refine their data collection tools. The best scenario would be to have a unified system of paramedic impression codes that would be relevant for all countries and adopted internationally, allowing for ease of comparisons.

Although mental health was not an ACSC according to either country's institutional lists, our cross-country research team included it because it is a term that encompasses conditions that could be better managed through primary care but that often lead to emergency health system use, e.g. suicidal crisis as a result of chronic depressive disorder. It would be appropriate for mental health to be included whenever the institutions revise their ACSC lists in

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3 the future. It is important to note that mental health constituting an ACSC would not describe  
4 any acute psychotic presentations, but rather depression and other mood-related disorders that  
5 are commonly managed in general practice.  
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8 Inter-country comparison of ACSCs has occurred though focussing on the reduction of  
9 hospitalisations for these conditions.[32-33] However, this work has not used ambulance call  
10 data, which remains methodologically novel. The existing research literature has highlighted the  
11 importance of making appropriate comparisons, and ensuring that the ACSCs selected for study  
12 are appropriate for the demographics, epidemiological profile and primary care practices across  
13 countries, and that they are similar.[32] This paper has followed this caveat, as it is comparing  
14 similar countries that have similar ACSCs, and this work is designed to ensure future  
15 comparative inter-country work will be truly comparable due to the mapping work we have done.  
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20 Having any information about patient pathways is important in healthcare systems as we  
21 try to set up integrated care. As discussion around integrated care proceeds, understanding the  
22 unmet healthcare needs of patients with certain avoidable conditions is crucial in healthcare  
23 planning. These types of discussion are already happening at healthcare planning tables in the  
24 UK and Canada. Now that paramedic indicators for potentially avoidable calls have been  
25 identified in this paper, these discussions may fuel a series of quality improvement and research  
26 papers on these unique patient pathways. Indeed, for patients who have health issues that lead  
27 to a 999/911 call, but are not needed to be transported to the hospital, paramedic clinical  
28 impression codes are the only place this function of the healthcare system is captured, therefore  
29 they are a very important tool to use. This paper lays down important groundwork to allow future  
30 between-country comparisons to start, and to determine which health service practices may  
31 benefit our patient populations more or less, as we learn from each other's mistakes and  
32 successes.  
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### 43 **Limitations**

44 Though paramedic data can be linked to ACSCs, we cannot be absolutely sure that we  
45 have identified the conditions that have manifested as ACSCs. This study has uncovered how  
46 vague (Canada) or over-prescriptive (UK) some of the impression codes are. This will definitely  
47 affect the quality of any data analytical work that would ensue from any epidemiological  
48 examination of the paramedic data. Future work should focus on subsequent validation studies,  
49 such as a more rigorous Delphi method, followed by validation against actual administrative  
50 data that includes details about hospital visits and diagnostic codes further down the line of  
51 health system patient involvement. We also acknowledge that not all ACSCs require solely  
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3 community healthcare access in order to avoid hospitalisation. Some chronic disease  
4 complications simply cannot be prevented upstream and will need emergency department  
5 access and prehospital care in certain specific situations. However, in the field of pre-hospital  
6 care, the concept of ACSCs provides a relevant and interesting benchmark from which to  
7 launch enquiry into our practices of care and as such, is a suitable indicator.  
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## 11 12 **Conclusion**

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14 Clinical impression codes generated by paramedics upon attending to acute call patients can be  
15 mapped to cover ACSCs and mental health conditions, both in the UK and in Ontario, Canada.  
16 This is an important first step in determining the numbers of ASCSs and mental health  
17 conditions that paramedics attend to, and in examining the clinical pathways of these individuals  
18 across the health system. This work lays the foundation for international comparative health  
19 services research on integrated pathways in primary care and EMS.  
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## 24 **Declarations**

### 25 26 **Ethics Approval and Consent to Participate**

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29 As this study did not have human participants and the co-authors mapped clinical impression  
30 codes (not patient data), ethical approval was not required.  
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### 32 33 **Availability of Data and Materials**

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35 Data sharing is not applicable to this article as no new data were created in this study.  
36

### 37 38 **Competing Interests**

39  
40 The authors declare that they have no competing interests.

### 41 42 **Funding**

43  
44 Not applicable.  
45

### 46 47 **Authors' contributions**

48  
49 GA, ANS, BM, RS, GW, RF, MP, RA, HM, and MG conceived of the study as a necessary step  
50 in the work of the EDGE consortium. GA and ANS served as the scientific advisors and led the  
51 study activities in Canada and the UK, respectively. GA, ANS, BM, RS, and MP collected the  
52 codes and data to be mapped. GA, ANS, BM, RS, and GW participated in the mapping and  
53 arbitration process. All authors contributed to the interpretation of the study results. GA, ANS,  
54 and MP drafted the manuscript. All authors provided critical comments on manuscript drafts,  
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## Supplementary File 1

**Table S1. Clinical Impression Codes available to paramedics in Ontario, Canada and the United Kingdom**

Ontario Problem Codes	UK Clinical Impression Codes
Vital Signs Absent	Injury Trauma
1: Cardiac/Medical	Gunshot
2: Traumatic	Abdominal Injury
Airway	Near Drowning
11: Obstruction	Explosive / Blast Injury
(Partial/Complete)	Stab Wound
Breathing	Limb Injury
21: Dyspnea	Penetrating Trauma
24: Respiratory Arrest	Head Injury
Circulation	Neck Injury
31: Hemorrhage	Smoke Inhalation
33: Hypotension	Diving Incident
34: Suspected sepsis	Fall Non - Injury
Neurological	Chest Injury
40: Traumatic Brain Injury	Thermal Injury
41: Stroke / TIA	Back Injury
42: Temporary Loss of	Carbon Monoxide Poisoning
Consciousness	Drowning
43: Altered Level of	Electrocution
Consciousness	Chemical Exposure
44: Headache	Multi-System Trauma
45: Behaviour / Psychiatric	Cold Exposure
45.01: Excited Delirium	CBRNE Incident
46: Active Seizure	Back Pain Non-Traumatic
47: Paralysis / Spinal Trauma	Unintentional Overdose
48: Confusion / Disorientation	Alleged Assault
49: Unconscious	Soft Tissue Injury
50: Post-ictal	Suspected Neck of Femur
Cardiac	Gastrointestinal
51: Ischemic	Acute Abdominal Problem
53: Palpitations	Constipation
54: Pulmonary Edema	Diarrhea & Vomiting
55: Post Arrest	Gastrointestinal Bleed
56: Cardiogenic Shock	Other Abdominal Problem
57: STEMI	Urinary
58: Hyperkalemia	Urinary Problem
Non-Traumatic	Urinary Tract Infection
60: Non Ischemic Chest Pain	Catheter Problem
61: Abdominal / Pelvic /	Allergic
Perineal / Rectal Pain	Allergic Reaction
62: Back Pain	Bite / Sting
	Neurological/stroke
	Faint
	Collapse Unknown Cause
	Collapse ? Cause

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4	Gastrointestinal	Convulsion
5	63: Nausea/ Vomiting/ Diarrhea	Other Neurological Problem
6	Musculoskeletal/Trauma	Febrile Convulsion
7	66: Musculoskeletal	Confusion
8	67: Trauma / Injury	Chronic Neurological Problem
9	Obstetrical/Gynecological	Headache
10	71: Obstetrical Emergency	Meningitis
11	72: Gynecological Emergency	Faint/Dizziness
12	73: Newborn / Neonatal	Obstetric or gynaecological
13	Endocrine/Toxicological	Ectopic Pregnancy
14	81: Drug / Alcohol Overdose	Other Gynae Problem
15	81.1: Suspected Opioid	Eclampsia
16	Overdose	Chronic Gynae Problem
17	82: Poisoning / Toxic Exposure	Other Obstetric Problem
18	83: Diabetic Emergency	New Born Infant
19	84: Allergic Reaction	Delivery Complication
20	85: Anaphylaxis	Antepartum Haemorrhage
21	86: Adrenal Crisis	Miscarriage
22	General and Minor	Postpartum Haemorrhage
23	87: Novel Medications	Pre-eclampsia
24	88: Home Medical Technology	In Labour
25	89: Lift Assist	PV Bleed
26	90: Inter-facility Transfer	Baby Delivered
27	91: Environmental Emergency	Non-specific
28	92: Weakness / Dizziness /	Other Medical Problem
29	Unwell	Unknown Problem
30	93: Treatment / Diagnosis &	Transport Only
31	Return	No Apparent Problem
32	94: Convalescent / Invalid /	Cardiovascular
33	Return Home	Arrhythmia / Palpitations
34	95: Infectious Disease	ECG Confirmed ST Segment
35	96: Organ Retrieval / Transfer	Elevated MI
36	98: Organ Recipient	Cardiac Problem
37	99: Other Medical / Trauma	Cardiac Arrest
38		DVT
39		Cardiac Chest Pain
40		AAA ([ruptured] abdominal aorti
41		aneurysm)
42		Ischaemic Limb
43		Heart Failure
44		Suspected PE
45		TIA
46		Stroke
47		Sickle Cell Crisis
48		Chest Pain Non-Cardiac
49		Respiratory
50		COPD
51		Other Respiratory Problem
52		Chest Infection
53		Choking
54		Asthma
55		Influenza
56		Psychosocial
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4	Attempted Suicide
5	Intentional Drug Overdose
6	DOLS (Deprivation of Liberty
7	Safeguards)
8	Anxiety
9	Psychosis
10	Effects of Alcohol
11	Social Problem
12	Under MHA Section
13	Accidental Overdose / Poisoning
14	Depression
15	Panic / Anxiety Attack
16	Other Mental Health Problem
17	Dementia
18	Query Intoxicated
19	ENT/ophthalmological
20	Dental Problem
21	Other ENT Problem
22	Eye Problem
23	Epistaxis
24	Infections
25	Sepsis
26	Pyrexia Unknown Origin
27	Other Infection
28	Hyperthermia
29	Palliative care/frailty
30	Palliative Terminal Care
31	Off Legs / Poor Mobility
32	Endocrine
33	Hyperglycaemia
34	Hypoglycaemia
35	Other Diabetic Problem
36	Endocrine Emergency
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## Supplementary File 2

Table S2. Paramedic Impression Codes Mapped to Ambulatory Care Sensitive Conditions

ACSC variable	Ontario Codes			UK Codes			Final Codes for Use	
	Paramedic-supplied	Physician-supplied	Combined/Corroborated	Paramedic-supplied	Physician-supplied	Combined/Corroborated	Ontario	UK
<b>Diabetes</b>	83: Diabetic Emergency <u>Alternate:</u> 41: Stroke/TIA 43: Altered Level of Consciousness 48: Confusion/Disorientation 49: Unconscious 63: Nausea/Vomiting/Diarrhea 92: Weakness/Dizziness/Unwell	83: Diabetic Emergency 42: Temporary Loss of Consciousness 63: Nausea/Vomiting/ Diarrhea 92: Weakness/Dizziness/Unwell	83: Diabetic Emergency	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	83: Diabetic Emergency	Hyperglycaemia Hypoglycaemia Other Diabetic Problem
<b>COPD</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/Dizziness/Unwell	21: Dyspnea	COPD	COPD	COPD	21: Dyspnea	COPD
<b>Asthma</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/	21: Dyspnea	Asthma	Asthma	Asthma	21: Dyspnea	Asthma

		Dizziness/Unwell						
<b>Angina</b>	51: Ischemic <u>Alternate:</u> 53: Palpitations 55: Post Arrest 56: Cardiogenic Shock 57: STEMI 61: Abdominal/ Pelvic/Perineal/ Rectal Pain	21: Dyspnea 51: Ischemic 92: Weakness/ Dizziness/Unwell	51: Ischemic	Cardiac Chest Pain	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain	51: Ischemic 57: STEMI	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain
<b>Grand Mal and other epileptic convulsions</b>	46: Active Seizure <u>Alternate:</u> 42: Temporary Loss of Consciousness 43: Altered Level of Consciousness 48: Confusion /Disorientation 49: Unconscious 50: Post-ictal	46: Active Seizure 50: Post-ictal 42: Temporary Loss of Consciousness 44: Headache 45: Behaviour/ Psychiatric 48: Confusion/ Disorientation 89: Lift Assist 92: Weakness/ Dizziness/Unwell	46: Active Seizure 50: Post-ictal	Convulsion Epilepsy	Convulsion Epilepsy	Convulsion Epilepsy	46: Active Seizure 50: Post-ictal	Convulsion Epilepsy
<b>HF and Pulm Edema</b>	54: Pulmonary Edema <u>Alternate:</u> 24: Respiratory Arrest 51: Ischemic 55: Post Arrest 56: Cardiogenic Shock 57: STEMI	21: Dyspnea 54: Pulmonary Edema 60: Non Ischemic Chest Pain 92: Weakness/ Dizziness/ Unwell	54: Pulmonary Edema	Heart Failure	Heart Failure	Heart Failure	54: Pulmonary Edema	Heart Failure

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<b>Hypertension</b>	99: Other Medical/ Trauma <u>Alternate:</u> 41: Stroke/TIA 44: Headache 51: Ischemic 53: Palpitations 54: Pulmonary Edema 57: STEMI	44: Headache 92: Weakness/ Dizziness/ Unwell 99: Other Medical/Trauma	No code available	None	None	No code available	No code available	No code available
<b>Lower Respiratory</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 33: Hypotension 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/ Dizziness/ Unwell	21: Dyspnea	Chest infection	Chest infection	Chest Infection	21: Dyspnea	Chest Infection
<b>Mental Health - anxiety, depression, panic attack</b>	45: Behaviour/ Psychiatric <u>Alternate:</u> 43: Altered Level of Consciousness 53: Palpitations	21: Dyspnea 45: Behaviour/ Psychiatric 42: Temporary Loss of Consciousness 44: Headache 48: Confusion/ Disorientation 60: Non Ischemic Chest Pain 63: Nausea/ Vomiting/ Diarrhea 92: Weakness/ Dizziness/ Unwell	45: Behaviour/ Psychiatric	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	45: Behaviour/ Psychiatric 81: Intentional drug overdose	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack



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		89: Lift Assist 45.01 Excited Delirium						
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Notes: COPD = chronic obstructive pulmonary disease; ECG = electrocardiogram; MI = myocardial infarction; ST Elevation = elevation of the ST segment on an electrocardiogram; STEMI = ST elevation myocardial infarction; TIA = transient ischemic attack

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# BMJ Open

## Development of Indicators for Avoidable Emergency Medical Service Calls by Mapping Paramedic Clinical Impression Codes to Ambulatory Care Sensitive Conditions and Mental Health Conditions in the UK and Canada

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Secondary Subject Heading:	Emergency medicine, General practice / Family practice, Health policy
Keywords:	Primary Health Care, ACCIDENT & EMERGENCY MEDICINE, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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3 **Development of Indicators for Avoidable Emergency Medical Service Calls by Mapping**  
4 **Paramedic Clinical Impression Codes to Ambulatory Care Sensitive Conditions and**  
5 **Mental Health Conditions in the UK and Canada**  
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8 G. Agarwal, A. N. Siriwardena, B. McLeod, R. Spaight, G. Whitley, R. Ferron, M. Pirrie, R.  
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## Abstract

**Objective:** Paramedic assessment data has not been used for research on avoidable calls. Paramedic impression codes are designated by paramedics upon responding to a 911/999 medical emergency after an assessment of the presenting condition. Ambulatory Care Sensitive Conditions (ACSCs) are non-acute health conditions not needing hospital admission when properly managed. This study aimed to map the paramedic impression codes to ACSCs and mental health conditions for use in future research on avoidable 911/999 calls.

**Design:** Mapping paramedic impression codes to existing definitions of ambulatory care sensitive conditions (ACSCs) and mental health conditions.

**Setting:** East Midlands Region, UK and Southern Ontario, Canada

**Participants:** Expert panel from the UK-Canada Emergency Calls Data analysis and GEospatial mapping (EDGE) Consortium

**Results:** Mapping was iterative first identifying the common ACSCs shared between the two countries then identifying the respective clinical impression codes for each country that mapped to those shared ACSCs as well as to mental health conditions. Experts from the UK-Canada Emergency Calls Data analysis and GEospatial mapping (EDGE) Consortium contributed to both phases and were able to independently match the codes and then compare results. Clinical impression codes for paramedics in the UK were more extensive than those in Ontario. The mapping revealed some interesting inconsistencies between paramedic impression codes, but also demonstrated that it was possible.

**Conclusion:** This is an important first step in determining the numbers of ASCSs and mental health conditions that paramedics attend to, and in examining the clinical pathways of these individuals across the health system. This work lays the foundation for international comparative health services research on integrated pathways in primary care and emergency medical services.

## Strengths and Limitations of this Study

- Clinical impression codes available to paramedics in their mandatory reporting forms are an underutilized source of health system data and were mapped to ambulatory care sensitive conditions (ACSCs) and mental health conditions using a novel method.
- The mapping was conducted for both the UK and Ontario, Canada contexts, supporting future inter-country comparisons between these regions with similar healthcare systems but varying policies and resources.

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3 • Though paramedic data can be linked to ACSCs using the mapping from this study, it  
4 cannot be absolutely certain that the conditions with these codes are manifestations of  
5 ACSCs.  
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8 • The mapping was only completed for ACSCs as defined by the UK and Ontario, Canada  
9 healthcare systems and the mapping method would need to be repeated for other  
10 countries to permit their inclusion in future international studies.  
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## Introduction

Paramedic assessment data are often used in pre-hospital research [1,2], but rarely for research on avoidable calls.[1] Paramedic impression codes are designated by paramedics during a 911/999 medical emergency response after completing a patient assessment.[3,4] This is critical information for primary care research, capturing the hitherto unknown clinical 'pathway' of a patient, namely: (a) the clinical situation *between* the primary care setting and the emergency department (ED), or (b) details of clinical cases assessed by paramedics but *not* transported to hospital. Importantly, the latter scenario typically comprises lower acuity calls contributing to emergency health system burden that may be better addressed by primary care.[1]

Ambulatory Care Sensitive Conditions (ACSCs) are non-acute health conditions not requiring hospital admission when properly managed or prevented by accessible primary care in the community.[5] ACSCs are routinely monitored and are quality indicators for primary, community, and hospital care.[6] While there are some ACSC complications that cannot be prevented, in the majority of cases they can usually be successfully managed within the community; however, ACSCs are still placing significant demand on hospitals.[7–9] Canadian data demonstrate that, excluding physician costs, ED visits for unmanaged ACSCs average \$280 CDN[9] and hospitalizations \$5700 CDN.[9] Recent studies indicate that ACSCs may also be contributing to the rise in 911/999 calls for emergency medical services.[1, 10, 11] UK 999 calls have been rising by 7% each year [12], whilst 911 calls in Ontario increased by 4.2% [13], outpacing population growth. To address this burden and reduce avoidable calls for ACSCs, community paramedicine or alternative paramedicine models are being developed and implemented.[1] However, literature examining ACSCs and 911/999 calls has used dispatch data [14], ED visits via ambulance [15], and patient self-reported reasons for calling.[12] Research has found that dispatch data does not correspond closely with paramedic clinical impression [16], suggesting that dispatch data is not representative of the true nature of the call after the paramedic has completed their assessment. Increasingly, prehospital research studies are utilising clinical impressions for this reason.[1, 17]

Next, ED visit research may underestimate the burden of ACSCs on 911/999 because 16-38% of patients are not transported to ED [17–19] and these non-transportations may be primarily for low-acuity conditions.[18, 19] Lastly, self-report data may suffer from bias in who can be contacted, self-selection bias, recall bias, social desirability bias, and errors due to incorrect responses (e.g. poor health literacy). Therefore, being able to identify ACSCs from paramedic impression codes in administrative datasets would be valuable for health system research; for



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3 example, studies on the differential rates in 911/999 non-transport for ACSC and non-ACSC  
4 calls, and potential primary care interventions.  
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6 Although mental health conditions are not traditionally considered ACSCs, they have  
7 similar characteristics and health system implications. Specifically, the majority of depressive  
8 and mood-related disorder cases can be better managed in primary care and community  
9 settings [20,21], avoiding visits to the ED.[22] However, mental health conditions represent 4%  
10 of ED visits [23] based on hospital discharge data, and 8-11% of 911/999 calls [24,25], based  
11 on dispatch data. As with ACSCs, these data sources provide some indication but do not  
12 accurately represent the true prevalence of mental health conditions in the pre-hospital  
13 emergency environment; instead, this would be better captured using paramedic clinical  
14 impression codes - a gap in the current literature.  
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20 This study focused on paramedic impression codes from the East Midlands Region, UK  
21 and from Southern Ontario, Canada. These are two international regions with universal  
22 healthcare, established ambulance/paramedic services, and electronic records for each pre-  
23 hospital emergency patient interaction. Comparative research to understand the variation  
24 between healthcare systems is critical to inform future improvements. In understanding the  
25 differences, the revealed complexity provides opportunities for multiple areas of health-systems  
26 learning. Though this type of research has been initiated in primary care [26] it has not been  
27 conducted internationally between ambulance services. A detailed understanding of patient  
28 pathways as they negotiate healthcare from the emergency 911/999 call through prehospital  
29 health services, with or without a hospital visit, is required. ACSCs therefore provide an  
30 excellent way to explore and trace similar conditions through the primary care and prehospital  
31 system.  
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39 Our objective was to map paramedic clinical impression codes to ACSCs and mental  
40 health conditions in two international regions (UK and Ontario, Canada) with universal  
41 healthcare but different contexts (e.g., policy, programs, resources, built environment), thereby  
42 laying groundwork for future cross-jurisdictional comparative primary care or prehospital  
43 research.  
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## 47 **Methods**

### 48 **Study Design**

49 The mapping was accomplished iteratively with two main phases: (a) identifying the  
50 common ACSCs shared between the two countries; and (b) identifying the respective clinical  
51 impression codes for each country that map to those shared ACSCs as well as to mental health  
52 conditions. The results of this study will be integral to subsequent international health services  
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3 research examining out-of-hospital emergency responses for ACSCs and mental health  
4 conditions.  
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### 8 **Setting and Participants**

9 A panel of experts from the UK-Canada Emergency Calls Data analysis and GEospatial  
10 mapping (EDGE) Consortium contributed to both phases. The EDGE Consortium was formed in  
11 2019, comprising academics from relevant disciplines, including but not limited to: primary care,  
12 paramedicine, rural health, health services and policy, biostatistics, and geography. Some  
13 members of the EDGE Consortium are also senior leaders of paramedic services and/or  
14 practicing primary care physicians (i.e., family doctors or general practitioners). For the first  
15 phase (identifying the list of common ACSCs), all 13 members of the EDGE consortium as of  
16 April 3rd, 2020, participated. The second phase (mapping clinical impression codes to ACSCs  
17 and mental health conditions), involved one paramedic and one primary care physician from  
18 each country.  
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### 27 **Patient and Public Involvement**

28 No patients were involved in this study.  
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### 32 **Data Sources**

33 Ambulance services under the National Health Service (NHS) in the UK record the  
34 paramedic's clinical impression in the 'ambulance electronic patient record system' and after  
35 patient assessment it is the main diagnostic source of paramedic clinical data.[6] Similarly,  
36 paramedic services in Ontario, Canada, have paramedics record their clinical impression after  
37 patient assessment using 'problem codes' in the 'ambulance call report'.[27] On first encounter  
38 with the patient, both a primary and secondary problem code can be documented as the main  
39 clinical impression, and then a final set of primary and secondary problem codes can be  
40 documented as the ultimate clinical diagnoses when transferring care of the patient to the  
41 receiving facility, when the interaction has been resolved, or when the patient has refused  
42 transport.[5,6] The initial secondary problem code and the set of final problem codes are  
43 optional, but an initial primary problem code must be recorded for each patient encounter. In  
44 both settings, these codes are from a pre-determined list provided by the respective governing  
45 bodies and are entered into a structured form. Though paramedics can choose which code to  
46 enter, they cannot change the actual codes themselves, and other areas of ambulance  
47 electronic health records may allow notations.  
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## Data Collection

Phase 1: The ACSCs used as health system indicators by each government were retrieved from institutional websites. In Ontario, the Canadian members of the EDGE consortium identified the Canadian Institute for Health Information [28] and Health Quality Ontario [29] as the most appropriate institutional sources for ACSCs used for health system indicators. In the UK, the NHS Institute for Innovation and Improvement was identified as the most appropriate source.[7,26]

Phase 2: The clinical impression codes common to all Ontario paramedic services were obtained from the Ontario Ministry of Health and Long-Term Care (a provincial governmental body) manual for completing ambulance call reports, under the heading 'problem codes'. [3] This ministry is responsible for ongoing review and updating of the clinical codes. For the UK, the list of clinical impression codes were obtained from the East Midlands Ambulance Service (a regional institutional body) electronic patient report template within the Medusa electronic medical record platform. These UK codes are used nationally and were developed by a multi-disciplinary panel of NHS clinicians.[30] These codes, both in Ontario and the UK, provide a common structure for clinicians to use within an ambulance electronic health record despite the multiple different care settings and contexts.

## Analysis

Phase 1: The ACSCs were first compared within each location (Ontario and UK) and then between locations. Within each location, the institutional lists of ACSCs were cross-referenced to determine if they contained the same conditions. All conditions were maintained, even if they only appeared on one list, but discrepancies were noted. Next, the lists for each location were compared against each other in a meeting with all EDGE Consortium members, aligning the conditions from each location by consensus. The final list of ACSCs was restricted to the conditions both locations had in common (i.e., shared ACSCs).

Phase 2: Using the shared ACSCs from Phase 1 and "mental health," paramedic clinical impression codes were matched to each condition. Within each location, a physician and paramedic independently matched the clinical impression codes to the conditions. Next, these results were compared for agreement. The paramedic and physician discussed any inconsistencies until they achieved consensus; the rationale for final codes selected is described in the results below. Where consensus could not be achieved, the

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3 paramedic/physician pair from the other country formed an arbitration panel to resolve  
4 disagreement.  
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## 8 **Results**

### 9 **Phase 1: ACSCs**

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11 The ACSC list from Health Quality Ontario [29] contained seven conditions: (a) angina;  
12 (b) asthma; (c) congestive heart failure (CHF) and pulmonary edema; (d) chronic obstructive  
13 pulmonary disease (COPD); (e) diabetes; (f) grand mal status and other epileptic convulsions;  
14 and, (g) hypertension. The Canadian Institute for Health Information list of ACSCs [28] had two  
15 groups: Group A had the same seven conditions as those from Healthy Quality Ontario listed  
16 above, and Group B was solely lower respiratory infections. Therefore, there was substantial  
17 agreement between the two institutional lists, and all eight conditions were maintained for the  
18 Ontario ACSC list (see Table 1).  
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24 The lists of ACSCs from UK institutional sources were much more extensive and  
25 included gynecological, dental, gastroenterological, upper respiratory, and vaccine preventable  
26 conditions. A King's Fund Report from 2012 [7] highlighted and clarified the NHS Institute for  
27 Innovation and Improvement's [26] definition of 19 ACSCs: (a) angina, (b) asthma, (c) cellulitis,  
28 (d) congestive heart failure, (e) convulsions and epilepsy, (f) chronic obstructive pulmonary  
29 disease, (g) dehydration and gastroenteritis, (h) dental conditions, (i) diabetes complications, (j)  
30 ear, nose and throat infections, (k) gangrene, (l) hypertension, (m) influenza and pneumonia, (n)  
31 iron-deficiency anaemia, (o) nutritional deficiency, (p) other vaccine preventable diseases, (q)  
32 pelvic inflammatory disease, (r) perforated/bleeding ulcer and (s) pyelonephritis (see Table  
33 1).[7]  
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39 When the two regional lists were compared by the EDGE Consortium members,  
40 agreement was readily reached that the following conditions were common ACSCs for both  
41 countries: (a) Diabetes; (b) COPD; (c) Asthma; (d) Angina; (e) Grand mal status and other  
42 epileptic convulsions or Convulsions and Epilepsy; (f) Heart Failure and Pulmonary edema; (g)  
43 HTN; and, (h) Lower respiratory or Influenza and Pneumonia. Terminology was slightly different  
44 for seizure related conditions and lower respiratory conditions. Notably, all ACSCs from the  
45 Ontario list were captured within the UK list and neither list included mental health conditions  
46 (see Table 1).  
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**Table 1: Ambulatory care sensitive conditions common to both Ontario, Canada and the United Kingdom**

Ontario ACSC List	UK ACSC List	Ontario/UK agreement
Diabetes	Diabetes complications	Agree
Chronic obstructive pulmonary disease	Chronic obstructive pulmonary disease	Agree
Asthma	Asthma	Agree
Angina	Angina	Agree
Grand mal status and other epileptic convulsions	Convulsions and epilepsy	Agree
Congestive heart failure and pulmonary edema	Congestive heart failure	Agree
Hypertension	Hypertension	Agree
	Cellulitis	No comparable ACSC in Ontario
	Dehydration and gastroenteritis	No comparable ACSC in Ontario
	Dental conditions	No comparable ACSC in Ontario
	Ear, nose and throat infections	No comparable ACSC in Ontario
	Gangrene	No comparable ACSC in Ontario
Lower Respiratory	Influenza and pneumonia	Agree
	Iron-deficiency anaemia	No comparable ACSC in Ontario
	Nutritional deficiency	No comparable ACSC in Ontario
	Other vaccine-preventable diseases	No comparable ACSC in Ontario
	Pelvic inflammatory disease	No comparable ACSC in Ontario
	Perforated/bleeding ulcer	No comparable ACSC in Ontario
	Pyelonephritis	No comparable ACSC in Ontario

Note: ACSC = Ambulatory Care Sensitive Condition

## Phase 2: Clinical Impression Codes Mapped to ACSCs and mental health

Clinical impression codes for paramedics in the UK were more extensive than those in Ontario (see Table 2 and Supplementary File 1). For example Ontario has three problem codes for respiratory conditions describing the aetiology and the general presenting issue or symptom, whereas the UK has five codes covering a mixture of causes, symptoms and diagnoses or diseases. For mental health, the Ontario clinical impression codes are extremely broad, including a whole medical discipline, while the UK codes cover both mechanisms and diagnoses.

**Table 2: Paramedic Impression Codes in Ontario and the UK for Respiratory and Mental Health Conditions**

Category	Ontario Problem Codes	UK Clinical Impression Codes
Respiratory	21: Dyspnea 24: Respiratory Arrest 11: Obstruction (Partial/Complete)	COPD Other Respiratory Problem Chest Infection Choking Asthma Influenza
Mental Health	45: Behaviour / Psychiatric 81: Drug / Alcohol Overdose	Attempted Suicide Intentional Drug Overdose DOLS (Deprivation of Liberty Safeguards) Anxiety Psychosis Effects of Alcohol Social Problem Under MHA Section Accidental Overdose / Poisoning Depression Panic / Anxiety Attack Other Mental Health Problem Dementia Query Intoxicated

The physician and paramedic pair from Ontario each independently selected the clinical impression codes that best matched each condition based on their clinical expertise (see Supplementary File 2). The physician selected more codes in order to reflect the breadth of scope of conditions, though the paramedic had selected mainly one code. Agreement was reached that in actual practice, a single impression code would be chosen by paramedics to represent conditions encountered. A greater number of codes was likely to cause a low specificity in mapping of clinical conditions. For example, for chronic obstructive airways disease (COPD), the physician chose five separate codes to represent conditions that may have caused respiratory changes, that a paramedic could have observed attending to someone experiencing a COPD exacerbation; codes covered 'dyspnea', 'temporary loss of consciousness', and 'weakness/dizziness/unwell' were identified. The paramedic chose two codes: 'dyspnea' as the

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3 main code and 'respiratory arrest' as an alternate code. At the ensuing discussion, the common  
4 clinical circumstances requiring 911 calls were elucidated and discussed in detail. Extremes of  
5 presentation were considered, as well as the usual paramedic options for clinical impression  
6 and those that were most often used in reality. Consensus was reached that a code of 'dyspnea'  
7 would be the most specific in capturing people who called 911 for COPD.  
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11 The physician and paramedic pair from the East Midlands also each selected the clinical  
12 impression codes that best matched each condition based on their clinical expertise (see  
13 Supplementary File 2). Both physician and paramedic selected clinical impression codes  
14 independently, followed by a discussion of any differences. For example, for "angina" the  
15 paramedic only selected "cardiac chest pain" whereas the physician selected "cardiac chest  
16 pain", "ECG Confirmed ST Segment Elevated MI" and "Cardiac Problem". Similar to the  
17 selection in Ontario, the paramedic was more selective, and the physician was more inclusive.  
18 We agreed for the purpose of this exercise to be inclusive rather than exclusive. The UK  
19 paramedic and physician selected identical clinical impressions for all other conditions.  
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22 In both Ontario and the UK there was no clinical code found for hypertension. In Ontario,  
23 three of the ACSCs have the same code (dyspnea) whereas in the UK, each ACSC has a more  
24 unique descriptive code. The mental health codes were completely different between Ontario  
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## Discussion

This paper has successfully mapped clinical impression codes generated by paramedics attending to patients with ACSCs and mental health conditions in Canada and the UK. However, some interesting factors have emerged that researchers should be aware of when analyzing any paramedic clinical impression codes for primary care or prehospital research purposes. Hypertension, though classified as an ACSC, could not be distinguished specifically enough from any of the existing paramedic impression codes for either Canada or the UK. The codes, however, did contain clinical scenarios that might have included hypertension-induced emergencies, such as cerebrovascular accidents or heart failure. Therefore, although hypertension is very common in primary care and its complications lead to emergency situations, it cannot easily be detected in paramedic impression codes. However the issue of clinical misclassification is not limited only to this situation. Literature shows that ICD-10 codes used by clinicians often do not match the ACSC codes.[31] This can make it difficult for clinicians when trying to classify the presentation of the patient they just saw.

As noted in Table 1, there are many more paramedic impression codes in the UK compared to the Canadian codes in Ontario. The inconsistency in the two countries' codes resulted in the mapping process being more difficult, though it was achieved. Having too many or too few paramedic impression codes may result in paramedics not being able to choose the appropriate codes for certain conditions when in the clinical field. Therefore it is possible that some Canadian clinical impression codes may be undifferentiated between the clinical impressions, leading to lack of variability in the data. When Ontario chooses to revise their ACSC lists, they may consider looking at some of the UK codes to provide a greater breadth of conditions. However the UK has a much greater degree of granularity, combining diagnoses as well as symptoms and causes, which may be too detailed, leading to mis-classifications. Ultimately, both scenarios will render the identification of ACSCs retrospectively technically difficult and might warrant more consideration as ambulance services refine their data collection tools. The best scenario would be to have a unified system of paramedic impression codes that would be relevant for all countries and adopted internationally, allowing for ease of comparisons.

Although mental health was not an ACSC according to either country's institutional lists, our cross-country research team included it because it is a term that encompasses conditions that could be better managed through primary care but that often lead to emergency health system use, e.g. suicidal crisis as a result of chronic depressive disorder. It would be appropriate for mental health to be included whenever the institutions revise their ACSC lists in



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3 the future. It is important to note that mental health constituting an ACSC would not describe  
4 any acute psychotic presentations, but rather depression and other mood-related disorders that  
5 are commonly managed in general practice.  
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8 Inter-country comparison of ACSCs has occurred though focussing on the reduction of  
9 hospitalisations for these conditions.[32-33] However, this work has not used ambulance call  
10 data, which remains methodologically novel. The existing research literature has highlighted the  
11 importance of making appropriate comparisons, and ensuring that the ACSCs selected for study  
12 are appropriate for the demographics, epidemiological profile and primary care practices across  
13 countries, and that they are similar.[32] This paper has followed this caveat, as it is comparing  
14 similar countries that have similar ACSCs, and this work is designed to ensure future  
15 comparative inter-country work will be truly comparable due to the mapping work we have done.  
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20 Having any information about patient pathways is important in healthcare systems as we  
21 try to set up integrated care. As discussion around integrated care proceeds, understanding the  
22 unmet healthcare needs of patients with certain avoidable conditions is crucial in healthcare  
23 planning. These types of discussion are already happening at healthcare planning tables in the  
24 UK and Canada. Now that paramedic indicators for potentially avoidable calls have been  
25 identified in this paper, these discussions may fuel a series of quality improvement and research  
26 papers on these unique patient pathways. Indeed, for patients who have health issues that lead  
27 to a 999/911 call, but are not needed to be transported to the hospital, paramedic clinical  
28 impression codes are the only place this function of the healthcare system is captured, therefore  
29 they are a very important tool to use. This paper lays down important groundwork to allow future  
30 between-country comparisons to start, and to determine which health service practices may  
31 benefit our patient populations more or less, as we learn from each other's mistakes and  
32 successes.  
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### 43 **Limitations**

44 Though paramedic data can be linked to ACSCs, we cannot be absolutely sure that we  
45 have identified the conditions that have manifested as ACSCs. This study has uncovered how  
46 vague (Canada) or over-prescriptive (UK) some of the impression codes are. This will definitely  
47 affect the quality of any data analytical work that would ensue from any epidemiological  
48 examination of the paramedic data. Future work should focus on subsequent validation studies,  
49 such as a more rigorous Delphi method, followed by validation against actual administrative  
50 data that includes details about hospital visits and diagnostic codes further down the line of  
51 health system patient involvement. We also acknowledge that not all ACSCs require solely  
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3 community healthcare access in order to avoid hospitalisation. Some chronic disease  
4 complications simply cannot be prevented upstream and will need emergency department  
5 access and prehospital care in certain specific situations. However, in the field of pre-hospital  
6 care, the concept of ACSCs provides a relevant and interesting benchmark from which to  
7 launch enquiry into our practices of care and as such, is a suitable indicator.  
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## 11 12 **Conclusion**

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14 Clinical impression codes generated by paramedics upon attending to acute call patients can be  
15 mapped to cover ACSCs and mental health conditions, both in the UK and in Ontario, Canada.  
16 This is an important first step in determining the numbers of ASCSs and mental health  
17 conditions that paramedics attend to, and in examining the clinical pathways of these individuals  
18 across the health system. This work lays the foundation for international comparative health  
19 services research on integrated pathways in primary care and EMS.  
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## 24 **Declarations**

### 25 26 **Ethics Approval and Consent to Participate**

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29 As this study did not have human participants and the co-authors mapped clinical impression  
30 codes (not patient data), ethical approval was not required.  
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### 32 33 **Availability of Data and Materials**

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35 Data sharing is not applicable to this article as no new data were created in this study.  
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### 37 38 **Competing Interests**

39  
40 The authors declare that they have no competing interests.

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43  
44 Not applicable.  
45

### 46 47 **Authors' contributions**

48  
49 GA, ANS, BM, RS, GW, RF, MP, RA, HM, and MG conceived of the study as a necessary step  
50 in the work of the EDGE consortium. GA and ANS served as the scientific advisors and led the  
51 study activities in Canada and the UK, respectively. GA, ANS, BM, RS, and MP collected the  
52 codes and data to be mapped. GA, ANS, BM, RS, and GW participated in the mapping and  
53 arbitration process. All authors contributed to the interpretation of the study results. GA, ANS,  
54 and MP drafted the manuscript. All authors provided critical comments on manuscript drafts,  
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## Supplementary File 1

**Table S1. Clinical Impression Codes available to paramedics in Ontario, Canada and the United Kingdom**

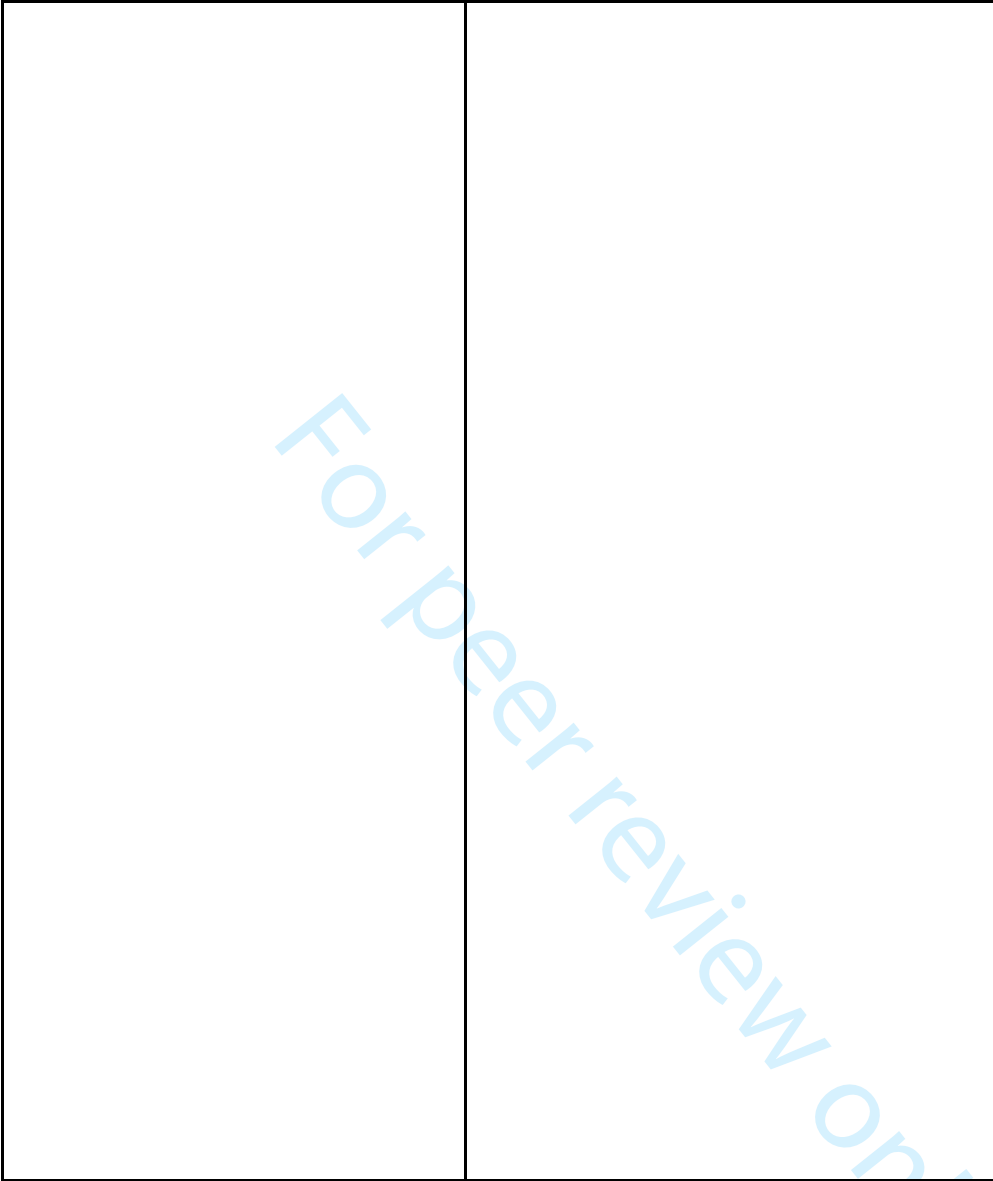
Ontario Problem Codes	UK Clinical Impression Codes
Vital Signs Absent	Injury Trauma
1: Cardiac/Medical	Gunshot
2: Traumatic	Abdominal Injury
Airway	Near Drowning
11: Obstruction	Explosive / Blast Injury
(Partial/Complete)	Stab Wound
Breathing	Limb Injury
21: Dyspnea	Penetrating Trauma
24: Respiratory Arrest	Head Injury
Circulation	Neck Injury
31: Hemorrhage	Smoke Inhalation
33: Hypotension	Diving Incident
34: Suspected sepsis	Fall Non - Injury
Neurological	Chest Injury
40: Traumatic Brain Injury	Thermal Injury
41: Stroke / TIA	Back Injury
42: Temporary Loss of	Carbon Monoxide Poisoning
Consciousness	Drowning
43: Altered Level of	Electrocution
Consciousness	Chemical Exposure
44: Headache	Multi-System Trauma
45: Behaviour / Psychiatric	Cold Exposure
45.01: Excited Delirium	CBRNE Incident
46: Active Seizure	Back Pain Non-Traumatic
47: Paralysis / Spinal Trauma	Unintentional Overdose
48: Confusion / Disorientation	Alleged Assault
49: Unconscious	Soft Tissue Injury
50: Post-ictal	Suspected Neck of Femur
Cardiac	Gastrointestinal
51: Ischemic	Acute Abdominal Problem
53: Palpitations	Constipation
54: Pulmonary Edema	Diarrhea & Vomiting
55: Post Arrest	Gastrointestinal Bleed
56: Cardiogenic Shock	Other Abdominal Problem
57: STEMI	Urinary
58: Hyperkalemia	Urinary Problem
Non-Traumatic	Urinary Tract Infection
60: Non Ischemic Chest Pain	Catheter Problem
61: Abdominal / Pelvic /	Allergic
Perineal / Rectal Pain	Allergic Reaction
62: Back Pain	Bite / Sting
	Neurological/stroke
	Faint
	Collapse Unknown Cause
	Collapse ? Cause

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4	Gastrointestinal	Convulsion
5	63: Nausea/ Vomiting/ Diarrhea	Other Neurological Problem
6	Musculoskeletal/Trauma	Febrile Convulsion
7	66: Musculoskeletal	Confusion
8	67: Trauma / Injury	Chronic Neurological Problem
9	Obstetrical/Gynecological	Headache
10	71: Obstetrical Emergency	Meningitis
11	72: Gynecological Emergency	Faint/Dizziness
12	73: Newborn / Neonatal	Obstetric or gynaecological
13	Endocrine/Toxicological	Ectopic Pregnancy
14	81: Drug / Alcohol Overdose	Other Gynae Problem
15	81.1: Suspected Opioid	Eclampsia
16	Overdose	Chronic Gynae Problem
17	82: Poisoning / Toxic Exposure	Other Obstetric Problem
18	83: Diabetic Emergency	New Born Infant
19	84: Allergic Reaction	Delivery Complication
20	85: Anaphylaxis	Antepartum Haemorrhage
21	86: Adrenal Crisis	Miscarriage
22	General and Minor	Postpartum Haemorrhage
23	87: Novel Medications	Pre-eclampsia
24	88: Home Medical Technology	In Labour
25	89: Lift Assist	PV Bleed
26	90: Inter-facility Transfer	Baby Delivered
27	91: Environmental Emergency	Non-specific
28	92: Weakness / Dizziness /	Other Medical Problem
29	Unwell	Unknown Problem
30	93: Treatment / Diagnosis &	Transport Only
31	Return	No Apparent Problem
32	94: Convalescent / Invalid /	Cardiovascular
33	Return Home	Arrhythmia / Palpitations
34	95: Infectious Disease	ECG Confirmed ST Segment
35	96: Organ Retrieval / Transfer	Elevated MI
36	98: Organ Recipient	Cardiac Problem
37	99: Other Medical / Trauma	Cardiac Arrest
38		DVT
39		Cardiac Chest Pain
40		AAA ([ruptured] abdominal aorti
41		aneurysm)
42		Ischaemic Limb
43		Heart Failure
44		Suspected PE
45		TIA
46		Stroke
47		Sickle Cell Crisis
48		Chest Pain Non-Cardiac
49		Respiratory
50		COPD
51		Other Respiratory Problem
52		Chest Infection
53		Choking
54		Asthma
55		Influenza
56		Psychosocial
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4	Attempted Suicide
5	Intentional Drug Overdose
6	DOLS (Deprivation of Liberty
7	Safeguards)
8	Anxiety
9	Psychosis
10	Effects of Alcohol
11	Social Problem
12	Under MHA Section
13	Accidental Overdose / Poisoning
14	Depression
15	Panic / Anxiety Attack
16	Other Mental Health Problem
17	Dementia
18	Query Intoxicated
19	ENT/ophthalmological
20	Dental Problem
21	Other ENT Problem
22	Eye Problem
23	Epistaxis
24	Infections
25	Sepsis
26	Pyrexia Unknown Origin
27	Other Infection
28	Hyperthermia
29	Palliative care/frailty
30	Palliative Terminal Care
31	Off Legs / Poor Mobility
32	Endocrine
33	Hyperglycaemia
34	Hypoglycaemia
35	Other Diabetic Problem
36	Endocrine Emergency
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## Supplementary File 2

Table S2. Paramedic Impression Codes Mapped to Ambulatory Care Sensitive Conditions

ACSC variable	Ontario Codes			UK Codes			Final Codes for Use	
	Paramedic-supplied	Physician-supplied	Combined/Corroborated	Paramedic-supplied	Physician-supplied	Combined/Corroborated	Ontario	UK
<b>Diabetes</b>	83: Diabetic Emergency <u>Alternate:</u> 41: Stroke/TIA 43: Altered Level of Consciousness 48: Confusion/Disorientation 49: Unconscious 63: Nausea/Vomiting/Diarrhea 92: Weakness/Dizziness/Unwell	83: Diabetic Emergency 42: Temporary Loss of Consciousness 63: Nausea/Vomiting/ Diarrhea 92: Weakness/Dizziness/Unwell	83: Diabetic Emergency	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	Hyperglycaemia Hypoglycaemia Other Diabetic Problem	83: Diabetic Emergency	Hyperglycaemia Hypoglycaemia Other Diabetic Problem
<b>COPD</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/Dizziness/Unwell	21: Dyspnea	COPD	COPD	COPD	21: Dyspnea	COPD
<b>Asthma</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/	21: Dyspnea	Asthma	Asthma	Asthma	21: Dyspnea	Asthma

		Dizziness/Unwell						
<b>Angina</b>	51: Ischemic <u>Alternate:</u> 53: Palpitations 55: Post Arrest 56: Cardiogenic Shock 57: STEMI 61: Abdominal/ Pelvic/Perineal/ Rectal Pain	21: Dyspnea 51: Ischemic 92: Weakness/ Dizziness/Unwell	51: Ischemic	Cardiac Chest Pain	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain	51: Ischemic 57: STEMI	ECG Confirmed ST Segment Elevated MI Cardiac Problem Cardiac Chest Pain
<b>Grand Mal and other epileptic convulsions</b>	46: Active Seizure <u>Alternate:</u> 42: Temporary Loss of Consciousness 43: Altered Level of Consciousness 48: Confusion /Disorientation 49: Unconscious 50: Post-ictal	46: Active Seizure 50: Post-ictal 42: Temporary Loss of Consciousness 44: Headache 45: Behaviour/ Psychiatric 48: Confusion/ Disorientation 89: Lift Assist 92: Weakness/ Dizziness/Unwell	46: Active Seizure 50: Post-ictal	Convulsion Epilepsy	Convulsion Epilepsy	Convulsion Epilepsy	46: Active Seizure 50: Post-ictal	Convulsion Epilepsy
<b>HF and Pulm Edema</b>	54: Pulmonary Edema <u>Alternate:</u> 24: Respiratory Arrest 51: Ischemic 55: Post Arrest 56: Cardiogenic Shock 57: STEMI	21: Dyspnea 54: Pulmonary Edema 60: Non Ischemic Chest Pain 92: Weakness/ Dizziness/ Unwell	54: Pulmonary Edema	Heart Failure	Heart Failure	Heart Failure	54: Pulmonary Edema	Heart Failure

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<b>Hypertension</b>	99: Other Medical/ Trauma <u>Alternate:</u> 41: Stroke/TIA 44: Headache 51: Ischemic 53: Palpitations 54: Pulmonary Edema 57: STEMI	44: Headache 92: Weakness/ Dizziness/ Unwell 99: Other Medical/Trauma	No code available	None	None	No code available	No code available	No code available
<b>Lower Respiratory</b>	21: Dyspnea <u>Alternate:</u> 24: Respiratory Arrest	21: Dyspnea 33: Hypotension 42: Temporary Loss of Consciousness 60: Non Ischemic Chest Pain 92: Weakness/ Dizziness/ Unwell	21: Dyspnea	Chest infection	Chest infection	Chest Infection	21: Dyspnea	Chest Infection
<b>Mental Health - anxiety, depression, panic attack</b>	45: Behaviour/ Psychiatric <u>Alternate:</u> 43: Altered Level of Consciousness 53: Palpitations	21: Dyspnea 45: Behaviour/ Psychiatric 42: Temporary Loss of Consciousness 44: Headache 48: Confusion/ Disorientation 60: Non Ischemic Chest Pain 63: Nausea/ Vomiting/ Diarrhea 92: Weakness/ Dizziness/ Unwell	45: Behaviour/ Psychiatric	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack	45: Behaviour/ Psychiatric 81: Intentional drug overdose	Attempted Suicide Intentional Drug Overdose Anxiety Psychosis Depression Panic / Anxiety Attack

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		89: Lift Assist 45.01 Excited Delirium						
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Notes: COPD = chronic obstructive pulmonary disease; ECG = electrocardiogram; MI = myocardial infarction; ST Elevation = elevation of the ST segment on an electrocardiogram; STEMI = ST elevation myocardial infarction; TIA = transient ischemic attack

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