

Accepted Manuscript

British Journal of General Practice

Factors associated with potentially missed acute deterioration in primary care

Cecil, Elizabeth; Bottle , Alex ; Majeed, Azeem; Aylin, Paul

DOI: <https://doi.org/10.3399/BJGP.2020.0986>

To access the most recent version of this article, please click the DOI URL in the line above.

Received 14 November 2020

Revised 18 January 2021

Accepted 21 January 2021

© 2021 The Author(s). This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>). Published by British Journal of General Practice. For editorial process and policies, see: <https://bjgp.org/authors/bjgp-editorial-process-and-policies>

When citing this article please include the DOI provided above.

Author Accepted Manuscript

This is an 'author accepted manuscript': a manuscript that has been accepted for publication in British Journal of General Practice, but which has not yet undergone subediting, typesetting, or correction. Errors discovered and corrected during this process may materially alter the content of this manuscript, and the latest published version (the Version of Record) should be used in preference to any preceding versions

Factors associated with potentially missed acute deterioration in primary care

Elizabeth Cecil, Alex Bottle, Azeem Majeed, Paul Aylin.

Dr Elizabeth Cecil, PhD, Honorary Research Fellow, Department of Primary Care and Public Health, Imperial College London Charing Cross Campus, W6 8RP, UK, e.cecil@imperial.ac.uk, + 44 2075941838

Professor Alex Bottle, PhD, Professor of Medical Statistics, The Dr Foster Unit, Department of Primary Care and Public Health, 3 Dorset Rise, London EC4Y 8EN, robert.bottle@imperial.ac.uk.

Professor Azeem Majeed, MD, Professor of Primary Care and Public Health, Department of Primary Care and Public Health, Imperial College London, W6 8RP, UK, a.majeed@imperial.ac.uk.

Professor Paul Aylin, MBChB, FFPH, Professor of Epidemiology and Public Health, The Dr Foster Unit, Department of Primary Care and Public Health, 3 Dorset Rise, London EC4Y 8EN, p.aylin@imperial.ac.uk

Corresponding author: Elizabeth Cecil

KEY WORDS: Patient safety, Primary care, Health deterioration, Emergency hospital admissions

How this fits in

Failure to recognise serious illness (or patient deterioration) can contribute to avoidable harm to a patient. Little is known of determinants of missed deterioration in primary care. GP telephone and video consultations have increased substantially with the COVID-19 pandemic, but these forms of consultations have not been fully evaluated and may increase missed deterioration in primary care.

ABSTRACT

Background

In the UK, the majority of primary care contacts are uncomplicated. However, safety incidents resulting in patient harm occur, such as failure to recognise a patient's deterioration in health.

Aim

We aimed to determine patient and healthcare factors associated with potentially missed deterioration.

Design and Setting

A cohort of patients registered with English CPRD general practices between 01-04-2014 and 31-12-2017 with linked hospital data.

Methods

We defined a potentially missed deterioration as a patient, seen in primary care by a GP in the three days before hospitalisation, having a self-referred admission. We used generalised estimating equations to investigate factors associated with odds of a self-referred admission. We investigated all diagnoses and subsets of commonly reported missed conditions.

Results

There were 116,097 patients who contacted a GP three days prior to an emergency admission. Patients with sepsis or urinary tract infections were more likely to self-refer, adjusted odds ratio 1.10 95%CI(1.02-1.19) and 1.09 (1.04-1.14) respectively. GP appointment durations were associated with self-referral. On average, a 5-minute increase resulted in 10% decrease in odds of self-referred admissions, 0.90 (0.89-0.91). Patients having a telephone (compared with face-to-face) consultation 1.13 (1.09-1.16), previous health service use and health status were also associated with self-referred admission.

Conclusions

Differentiating deterioration from self-limiting conditions can be difficult for clinicians, particularly in patients with sepsis, UTI or with long-term conditions. Our findings supports the call for longer GP consultations and cautions reliance on telephone consultations in primary care; however, research is needed to understand the underlying mechanisms.

Abstract 249

Main text 2632

INTRODUCTION

In the UK, the National Health Service (NHS) general practitioners (GP) provide most first-contact healthcare,¹ with over 300 million primary care consultations annually within England alone.² The majority of contacts are harm free. However, some patients (around 2%) will experience a safety incident during their care.³ While some incidents are not preventable (e.g. unexpected complications during the provision of correct care) others such as failure to recognise serious illness (or patient deterioration) can contribute to avoidable harm.⁴

Investigations into determinants of missed deterioration in primary care are limited. A single study from the UK,⁵ investigating delayed escalation of care in deteriorating patients, focused on out-of-hours primary care provision, and did not link to data on other healthcare contacts.

Studies investigating diagnostic errors are more common, where the majority are considered to take place during patient assessment,⁶⁻⁸ and presence of comorbidity often contributed.

We aimed to investigate factors related to self-referral to hospital, in acutely deteriorating patients who visited a GP, for all conditions and four commonly missed diagnoses in primary care,⁹ pulmonary embolism, urinary tract infection, ectopic pregnancies, and sepsis. Our use of primary-secondary care linked data is a novel approach to recognise potentially missed deterioration in primary care, (Figure 1).

METHODS

Study design

We conducted a population-based observational study investigating patient journeys through primary care to treatment in hospital.

Acute deterioration, the worsening of a patient's condition towards critical illness, was measured as an emergency hospital admission.

Data sources

The Clinical Practice Research Datalink (CPRD) is a validated, nationally representative primary care database of patient-level, longitudinal health records, covering 7% of the UK population.¹⁰ CPRD is linked to Hospital Episode Statistics (HES), containing inpatient and emergency department activity, in NHS hospitals in England.

Population

Our cohort consisted of patients who experienced a deterioration in health between 01-04-2014 and 31-12-2017 in England. A deterioration in health was defined as an emergency hospital admission (as opposed to an elective or planned admission), Box S1. We selected patients who had been

registered with a CPRD practice for at least a year. We excluded any admissions which were readmissions within three days of the index admission. We created sub-groups for patients admitted for four specific conditions that are (reportedly) commonly missed in primary care.⁹ ICD-10 codes identified emergency admissions for pulmonary embolism (PE), urinary tract infection or pyelonephritis (UTI), ectopic pregnancies, and sepsis. All codes used in this study are given in Table S9.

Primary care consultations

CPRD provides information on consultation type; staff; and clinical information from general practice. Consultations in CPRD represent occasions when a patient's electronic health record is opened. The duration is the length of time open.¹¹

We chose to investigate primary care consultations in the three days (0-2 days), before admission because a patient's acute deterioration is likely to be apparent within this time. We made the assumption that it would be possible to determine deterioration, even in a single consultation. If a patient had more than one visit, we investigated data in the last consultation before admission. We classified consultations as face-to-face or via telephone, and with a GP or nurse.

We calculated a patient's number of primary care consultations (excluding those within three days) during the 12 months leading up to the admission.

Hospital use in the 12 months before admission

The number of ED visits within the past year was categorised into (0, 1 and 2+). Previous admissions within 30 days were categorised into surgical and non-surgical. Emergency admissions and planned/elective admissions in the 12 months (excluding those within 30 days) before admission were categorised into 0 and 1+.

Patient demographic factors

We identified covariates from previous studies known to increase the risk of an emergency admission- age,¹² gender, morbidity and deprivation.¹³ The presence of long-term conditions was determined from coding in the patient's primary care records before the admission. Patients' socioeconomic status, based on residential postcode, was derived from linked Indices of Multiple Deprivation data (2015).¹⁴

Outcome

We focused on patients who consulted a GP, and excluded consultations with other healthcare professionals. A deteriorating patient who consults a GP can either have the deterioration

recognised and is referred (to ED, directly to hospital or other healthcare service); or the patient subsequently visits the ED as a self-referral.

Figure 1: Definition of GP potentially missed acute deterioration using primary and secondary care linked data

We define a potentially missed deterioration as a patient, seen in primary care by a GP in the three days before hospitalisation, having a self-referred admission (an emergency admission via ED and corresponding self-referred ED visit), Figure 1. Our primary outcome was self-referred admission.

Statistical Analysis

We applied logistic regression with generalized estimating equations, clustered by GP practice, assuming an exchangeable correlation structure. We carried out multivariable analyses (backwards selection) and a sensitivity analysis excluding consultations of <5 minutes (those more likely to have misclassified consultation types).

We used Stata version 15 (StataCorp, College Station, Texas, USA) for the analyses.

The study protocol was approved by the CPRD Independent Scientific Advisory Committee (ISAC). Protocol number: 18_095A.

RESULTS

In the 3,089,403 patients, registered at CPRD participating practices over the study period, there were 405,878 emergency admissions by 242,485 patients, registered with 280 general practices (564; 2,407; 5,383 and 15,015 admissions were for ectopic pregnancy, PE, sepsis, and UTI respectively). Most admissions were through the ED, 77%, (314,555/405,878), and 12% (47,835 /405,878) were via a GP. Of ED admissions 303,074 (96%) had a corresponding ED visit record.

Contact with primary care in the three days before an emergency admission

Around one-in-three (127,197/405,878) patients had contact with primary care in the three days before admission; the majority (116,097) were with a GP, Table S1. The proportion of patients who self-referred varied across regions: South-West 12% (1,721/14,641) compared with 31% (4,189/13,639) in London, Table 1. Twenty percent of patients (23,232/116,097) had more than one contact in primary care (Table S2). The majority of patients (87%, 101,014/116,097) had face-to-face contact; 20% were telephone contacts (23,039) and 5% were OOH contacts (5,442). Primary care

consultations lasted for a median of 9 minutes (interquartile range [3, 18]). Of patients who had face-to-face contact with a GP, 10% (10,483/101,014) also had a coded 'Telephone encounter'.

Health service use in the year before emergency admission

In 20% of admissions (22,596/116,097), the patient had a previous admission within 30 days, Table 2. Patients who self-referred had, on average, higher primary care consultation, ED visit and emergency admission rates in the previous year.

Determinants of GP potentially missed deterioration

Women admitted to hospital as an emergency with ectopic pregnancy had lower odds of self-referred admission, compared with other conditions, adjusted odds ratio (OR): 0.59, 95%CI(0.37-0.94), Table 3. Patients admitted with sepsis or UTI were more likely to self-refer: 1.10 (1.02-1.19) and 1.09 (1.04-1.14) respectively. Older patients were slightly less likely to self-refer, OR: (0.99 (0.99 to 1.00)) with 10-year age increase. Patients with a GP-reported comorbidity were more likely to self-refer, 1.06 (1.03-1.09). GP consultation factors associated with self-referral were: number of consultations in 3 days before admission; type of consultation; duration; and gender.

Patients who consulted with a female GP were 4% less likely to self-refer (0.96 (0.94 to 0.98)). Patients who had a telephone (compared with face-to-face) consultation were more likely to self-refer, 1.13 (1.09-1.16). With a 5-minute increase in GP consultation length, there was a 10% decrease in adjusted odds of self-referred admission, 0.90 (0.89-0.91). Previous health service use was associated with self-referral: previous admission, (1.09 (1.04-1.15)) or procedure (1.06 (1.02-1.11)), within 30 days; or having visited ED (1.19 (1.16-1.22)) last year. Previous GP consultation rate was not associated with a self-referred admission.

Sensitivity analysis

Thirty-four percent (39,010/116,097) of GP consultations lasted less than 5 minutes. Adjusted odds ratios were similar after excluding these short consultations, Table S3.

Specific conditions

One in five women (106/564) admitted as an emergency for ectopic pregnancy had contact with a GP in 3 days before admission. While 35% (849/2,407), 29% (1,546/5,383) and 34% (5,057/15,015) had contact with a GP before admission in patients with PE, sepsis, and UTI respectively.

Thirteen percent (15/106) of women with ectopic pregnancy self-referred, while 25%, 27% (410/1,546), and 25% (1,273/5,057) of patients with PE, sepsis and UTI respectively.

Consultation duration was consistently shorter in patients who self-referred across all conditions. A 5-minute increase in consultation time was associated with a 11% (0.89 (0.81-0.98)), 9% (0.91 (0.85-

0.96) and 7% (0.93 (0.91-0.96) decrease in odds of self-referral in patients with PE, sepsis and UTI respectively. For patients with PE there was no evidence other factors were associated, including a procedure within 30 days. Previous hospital use was positively associated with self-referral in patients with Sepsis, while previous primary care use was negatively associated with patients with UTI (0.93 (0.91-0.96).

DISCUSSION

Summary

One in three patients had contact in primary care in the three days before admission. In patients who saw a GP, the proportion of potentially missed deterioration (self-referred) varied across regions; age groups; conditions; and patient's health status. Patients who self-referred had significantly shorter primary care consultation time. Patients with sepsis or UTI (compared with other conditions) were 10% and 9%, respectively, more likely to self-refer. GP appointment times were negatively associated with a self-referral. Previous health service use and telephone consultations were also associated with a self-referred admission.

An investigation of patient safety incident reports in England and Wales found failures to recognise signs of clinical deterioration, resulting in delayed management, was a major factor in serious harm-related incidences in primary care.¹⁵ Recognition of clinical deterioration and immediate management of the condition, includes referral to secondary care. To our knowledge, this is the first study to investigate factors relating to GP referral in deteriorating patients using linked primary and secondary care data.

Strengths and limitations

The size of our cohort, at almost 250,000 patients means findings are unlikely to be due to chance. However, there may be inherent biases. For example, selection bias due to inclusion/exclusion criteria means our study may not represent a more mobile population. There are small numbers for rare conditions: for example, of 106 women with ectopic pregnancy who had contact with a GP, only 14 had a self-referred admission.

Our study is reliant on coding by GP practice and hospital staff and subject to biases of misclassification and missing data. GPs must remember to change consultation type when administrative tasks are performed, for example, entering test results of a patient who is not present. A study using video recording of 229 GP consultations found consultation duration ranged between 2 and 30 minutes.¹⁶ We assumed that administrative tasks would take less than 5 minutes

per patient. The omission of GP consultations of less than 5 minutes (sensitivity analysis) had little impact on estimated associations.

Our study assumes that a patient who visits a GP yet self-refers to hospital as an emergency has, potentially, had their deterioration missed. There are challenges in defining and measuring missed diagnoses in primary care. Disease is often self-limiting, yet in certain serious conditions, such as meningitis, disease progression can be rapid. Primary care clinicians need to weigh up the conundrum of over- versus under-diagnosis.¹⁷ Research has found, diagnostic errors are often preceded by common symptoms and common, relatively benign initial diagnoses.¹⁸ Consultations are likely to be accompanied by safety-netting advice, and the subsequent 'telephone encounters', we found, recorded in health records of deteriorating patients may suggest that patients are being monitored. Notably, we found that patients who had both face-to-face and telephone consultations were less likely to self-refer than those who only had one type of consultation. More research is needed to investigate these contacts further.

We found the proportion of patients who self-referred to hospital, following contact with a GP, was highly variable between regions. GP practice factors, for example, access,^{19 20} or the hospital policy on recording the method of admission, may explain this variation. Our use of a multilevel model clustering by GP practice means that we investigated within practice variation; therefore, GP practice factors, such access, will be controlled for. However, the behaviours of individual GPs are not.

Comparison with existing literature

Our emergency admission rates, Box S1, in all valid patients registered with CPRD partnered practices are comparable to previous studies.²¹⁻²³ GP consultation rates in our cohort are slightly higher than previously reported rates.²⁴ However, it is not surprising as the cohort only includes patients with an emergency admission over the study period, and patients may be generally sicker than the general population.

Although the effect size was small, we found, after adjusting for confounders, that older patients were less likely to self-refer (1% less likely with each 10-year increase in age). Previous work, investigating factors associated with risk of delayed escalation in OOH primary care⁵ found a positive association between age and delayed escalation. This study did not control for GP diagnosed morbid conditions, which may explain the difference from our findings.

Surgery is known to be a strong predictor of emergency hospital admission, particularly for certain conditions such as PE. After surgery, patients will be discharged back to primary care with follow-up

consultations within outpatients. A clear plan from the discharging surgical team must be conveyed to both GPs and patients if they are to be truly efficient at spotting deterioration.

We found surgery was a strong predictor of self-referred admissions for all conditions but not for PE. There may be an issue with power, not enough observations to establish an association, or it may suggest that GPs and patients are watchful for the complications of surgery but missing other conditions not related to surgery.

Implications for Research and practice

On average a GP consultation in the UK lasts 10 minutes,²⁵ yet there has been a call for 15-minute consultations, to allow for 'improved decision making and case management'.²⁶ We found patients who had longer consultations with their GP are less likely to have a subsequent self-referred admission. This could imply that GPs with more time to assess their patients are more likely to recognise the deterioration and refer the patient for secondary care. However, our findings need to be interpreted with caution. This may be an example of reverse causation. A GP who recognises acute deterioration in a patient will either refer the patient directly to hospital or call the ED to warn that the patient is on their way. The act of contacting a hospital will add time to the consultation and could explain the described association. Further research is required to understand the mechanisms. Increasing consultation time may also decrease GP workload overall.¹¹ Certainly, increasing consultation time would allow GPs more time to engage with the national early warning scores (NEWS),²⁷ a structured way of communicating the severity of a patient's clinical condition, which supports recognition of patient deterioration (particularly sepsis) in the community and can be used to improve the process of care and prioritise the sickest patients.²⁸ The limited coding of vital signs we found implies that, over our study period, NEWS was not routinely being calculated in English GP practices.

Telephone consultations were also associated with an increased risk of potentially missed deterioration. Video consultations were rarely used during our study period. Although the safety of online consulting has been questioned,²⁹ there have been changes to GP appointments because of coronavirus (COVID-19) and most are now by phone or video call.^{30 31} Our findings suggest that the increase to alternative consultation modes in general practice should be carefully investigated for any unintended consequences.

CONCLUSION

Differentiating deterioration from self-limiting conditions can be difficult for clinicians, particularly for patients with sepsis or UTI or with GP recorded long term conditions. The negative association between GP consultation duration and self-referral suggests that addressing shortages in the primary care workforce and allowing primary care clinicians more time to assess patients could help improve patient safety and clinical outcomes. Finally, the expansion of telephone and video consultations needs careful assessment of any unintended negative consequences.

REFERENCES

1. Marshall M. A Precious Jewel — The Role of General Practice in the English NHS. *N Engl J Med* 2015;372(10):893-97. doi: 10.1056/NEJMp1411429
2. NHS Digital. Appointments in General Practice, October 2018 2018 [Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/oct-2018> accessed 01/12/2020].
3. Panesar SS, deSilva D, Carson-Stevens A, et al. How safe is primary care? A systematic review. *BMJ Qual Saf* 2016;25(7):544-53. doi: 10.1136/bmjqs-2015-004178
4. Avery AJ, Sheehan C, Bell B, et al. Incidence, nature and causes of avoidable significant harm in primary care in England: retrospective case note review. *BMJ Qual Saf* 2020;bmjqs-2020-011405. doi: 10.1136/bmjqs-2020-011405
5. Hayward GN, Vincent C, Lasserson DS. Predicting clinical deterioration after initial assessment in out-of-hours primary care: a retrospective service evaluation. *Br J Gen Pract* 2017;67(654):e78-e85. doi: 10.3399/bjgp16X687961 [published Online First: 2016/11/09]
6. Schiff GD, Hasan O, Kim S, et al. Diagnostic error in medicine: Analysis of 583 physician-reported errors. *Arch Gen Intern Med* 2009;169(20):1881-87. doi: 10.1001/archinternmed.2009.333
7. Singh H, Giardina TD, Meyer AND, et al. Types and Origins of Diagnostic Errors in Primary Care Settings. *JAMA Intern Med* 2013;173(6):418-25. doi: 10.1001/jamainternmed.2013.2777
8. Newman-Toker DE, Schaffer AC, Yu-Moe CW, et al. Serious misdiagnosis-related harms in malpractice claims: The "Big Three" - vascular events, infections, and cancers. *Diagnosis (Berl)* 2019;6(3):227-40. doi: 10.1515/dx-2019-0019 [published Online First: 2019/09/20]
9. Wallace E, Lowry J, Smith SM, et al. The epidemiology of malpractice claims in primary care: a systematic review. *BMJ Open* 2013;3(7) doi: 10.1136/bmjopen-2013-002929
10. Herrett E, Gallagher AM, Bhaskaran K, et al. Data Resource Profile: Clinical Practice Research Datalink (CPRD). *Int J Epidemiol* 2015 doi: 10.1093/ije/dyv098
11. Stevens S, Bankhead C, Mukhtar T, et al. Patient-level and practice-level factors associated with consultation duration: a cross-sectional analysis of over one million consultations in English primary care. *BMJ Open* 2017;7(11):e018261. doi: 10.1136/bmjopen-2017-018261
12. Blunt I, Bardsley M, Dixon J. Trends in Emergency Admissions in England 2004–2009: Nuffield Trust, 2010.

13. Heyderman RS, Ben-Shlomo Y, Brennan CA, et al. The incidence and mortality for meningococcal disease associated with area deprivation: an ecological study of hospital episode statistics. *Arch Dis Child* 2004;89(11):1064-68. doi: 10.1136/adc.2003.036004
14. National Statistics: English Indices of Deprivation 2015 [Available from: <https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015> accessed 01/12/2020].
15. Carson-Stevens A, Hibbert P, Williams H, et al. Characterising the nature of primary care patient safety incident reports in the England and Wales National Reporting and Learning System: a mixed-methods agenda-setting study for general practice. Southampton UK: NIHR Journals Library, 2016.
16. Salisbury C, Procter S, Stewart K, et al. The content of general practice consultations: cross-sectional study based on video recordings. *Br J Gen Pract* 2013;63(616):e751-e59. doi: 10.3399/bjgp13X674431
17. Zwaan L, Singh H. The challenges in defining and measuring diagnostic error. *Diagnosis (Berl)*, 2015:97.
18. Ely JW, Kaldjian LC, D'Alessandro DM. Diagnostic errors in primary care: lessons learned. *J Am Board Fam Med* 2012;25(1):87-97. doi: 10.3122/jabfm.2012.01.110174 [published Online First: 2012/01/06]
19. Cecil E, Bottle A, Sharland M, et al. Impact of UK Primary Care Policy Reforms on Short-Stay Unplanned Hospital Admissions for Children With Primary Care–Sensitive Conditions. *Ann Fam Med* 2015;13(3):214-20. doi: 10.1370/afm.1786
20. Cowling TE, Soljak MA, Bell D, et al. Emergency hospital admissions via accident and emergency departments in England: time trend, conceptual framework and policy implications. *J R Soc Med* 2014;107(11):432-38. doi: 10.1177/0141076814542669
21. Deeny S, Thorlby R, Steventon A. Reducing emergency admissions: unlocking the potential of people to better manage their long-term conditions. In: Health Foundation, ed. Briefing: , 2018.
22. Aylin P, Bottle A, Kirkwood G, et al. Trends in hospital admissions for pulmonary embolism in England: 1996/7 to 2005/6. *Clin Med* 2008;8(4):388-92. doi: 10.7861/clinmedicine.8-4-388
23. Bardsley M, Blunt I, Davies S, et al. Is secondary preventive care improving? Observational study of 10-year trends in emergency admissions for conditions amenable to ambulatory care. *BMJ Open* 2013;3(1):e002007. doi: 10.1136/bmjopen-2012-002007
24. Hobbs FDR, Bankhead C, Mukhtar T, et al. Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007–2013. *Lancet* 2016;387(10035):2323-30. doi: 10.1016/S0140-6736(16)00620-6
25. Irving G, Neves AL, Dambha-Miller H, et al. International variations in primary care physician consultation time: a systematic review of 67 countries. *BMJ Open* 2017;7(10):e017902. doi: 10.1136/bmjopen-2017-017902
26. BMA. Safe working in general practice, 2016.
27. Brangan E, Banks J, Brant H, et al. Using the National Early Warning Score (NEWS) outside acute hospital settings: a qualitative study of staff experiences in the West of England. *BMJ Open* 2018;8(10):e022528. doi: 10.1136/bmjopen-2018-022528 [published Online First: 2018/10/29]
28. Scott LJ, Redmond NM, Tavaré A, et al. Association between National Early Warning Scores in primary care and clinical outcomes: an observational study in UK primary and secondary care. *Br J Gen Pract* 2020;70(695):e374-e80. doi: 10.3399/bjgp20X709337

29. Peters L, Greenfield G, Majeed A, et al. The impact of private online video consulting in primary care. *J R Soc Med* 2018;111(5):162-66. doi: 10.1177/0141076818761383 [published Online First: 2018/03/01]
30. Royal College of General Practitioners. Principles for supporting high quality consultations by video in general practice during COVID-19, 2020. 2015 [Available from: <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/C0479-principles-of-safe-video-consulting-in-general-practice-updated-29-may.pdf> accessed 01/12/2020]
31. Peek N, Sujan M, Scott P. Digital health and care in pandemic times: impact of COVID-19. *BMJ Health Care Inform* 2020;27(1):e100166. doi: 10.1136/bmjhci-2020-100166

Abbreviations

CPRD	Clinical Practice Research Datalink
ED	Emergency department
GP	General practitioner
HES	hospital Episode Statistics
IMD	Indices of Multiple Deprivation
NHS	National health service
OOH	Out-of-hours
OR	Odds ratio
UTI	Urinary tract infections

ACKNOWLEDGEMENTS

We thank Dr Ailsa McKay & Dr Roger Newson, Department of Primary Care and Public Health, Imperial College London, for the development of a Read code list to select patients with comorbid conditions. We also thank the members of the Project's Research Partners Group, particularly Helen Miller, for their support with the study design and interpretation of the findings.

This work uses data provided by patients and collected by the NHS as part of their care and support. Using patient data is vital to improve health and care for everyone. There is huge potential to make better use of information from people's patient records, to understand more about disease, develop new treatments, monitor safety, and plan NHS services. Patient data should be kept safe and secure, to protect everyone's privacy, and it's important that there are safeguards to make sure that it is stored and used responsibly. Everyone should be able to find out about how patient data is used.

DECLARATIONS

Ethics approval

We obtained ethical and scientific approval for the use of CPRD for our study from the Independent Scientific Advisory Committee Protocol number: 18_095R.

Consent for publication

Not applicable

Availability of data and material

The datasets analysed during the current study are not publicly available as access is subject to approval. We will consider (via the corresponding author) requests for data sharing on an individual basis, however we will be governed in respect of data sharing by the data owners (CPRD) and any requests to share will be subject to their permission, and to the approval of ethics committees overseeing the use of these data sources.

Competing interests

EC has nothing to disclose. AB and PA report grants from Dr Foster, outside the submitted work. AM is supported by the NIHR under the Applied Research Collaboration (ARC) programme for North West London.

Funding

This work was supported through the National Institute of Health Research (NIHR) Imperial Patient Safety Translational Research Centre, (PSTRC) programme grant (PSTRC-2016-004). The NIHR Imperial Patient Safety Translational Centre is a partnership between the Imperial College Healthcare NHS Trust and Imperial College London. The Dr Foster Unit is an academic unit in the Department of Primary Care and Public Health, within the School of Public Health, Imperial College London. The unit receives research funding from Dr Foster Intelligence, an independent health service research organisation (a wholly owned subsidiary of Telstra). The Department of Primary Care & Public Health at Imperial College London is grateful for support from the NW London NIHR Applied Research Collaboration and the Imperial NIHR Biomedical Research Centre. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the NIHR, MRC, CCF, NETSCC, the HSR programme or the Department of Health. None of the funders had any role in the conception, design, analysis or reporting of this study.

Authors' contributions

EC and PA conceived the research. EC carried out the literature search and drafted the protocol. All authors contributed to protocol development. EC applied for study approval, carried out the analysis and AB provided statistical advice. All authors took part in interpreting the findings. All authors commented on and helped to revise drafts of the paper. All authors approved the final manuscript

as submitted. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

EC had full access to all the data in the study and takes full responsibility for the integrity of the data and the accuracy of the data analysis, and the final responsibility for the decision to submit for publication.

Accepted Manuscript – BJGP – BJGP.2020.0986

Table 1: Patient and condition characteristics of emergency admissions to hospital between April 2014 and March 2017 by patients' GP engagement and admission referral

	Self-referred ^a	Other	Total
	No. (%)	No. (%)	
All UPAs	24,953 (21)	91,144 (79)	116,097
Ectopic pregnancy	14 (13)	92 (87)	106
Pulmonary Embolism	161 (19)	688 (81)	849
Sepsis	410 (27)	1,136 (73)	1546
UTI	1,273 (25)	3,784 (75)	5057
Gender			
Male	11,105 (21)	40,699 (79)	51804
Female	13,847 (22)	50,443 (78)	64290
Deprivation level ^b			
Least deprived fifth: 1	4,988 (19)	21,005 (81)	25993
2	4,923 (21)	18,341 (79)	23264
3	5,242 (21)	19,316 (79)	24558
4	5,213 (24)	16,667 (76)	21880
Most deprived fifth: 5	4,575 (22)	15,783 (78)	20358
GP recorded comorbidity			
No comorbidity	4,431 (20)	17,746 (80)	22,177
Comorbidity 1	5,404 (22)	19,395 (78)	24,799
Comorbidity 2+	15,118 (22)	54,003 (78)	69,121
Region			
East Midlands	3 (8)	37 (93)	40
East of England	2,427 (25)	7,314 (75)	9741
London	4,189 (31)	9,450 (69)	13639
North East	309 (11)	2,417 (89)	2726
North West	3,991 (23)	13,734 (77)	17725
South Central	2,891 (17)	14,362 (83)	17253
South East Coast	6,484 (29)	15,639 (71)	22123
South West	1,721 (12)	12,920 (88)	14641
West Midlands	2,599 (16)	13,195 (84)	15794
Yorkshire	339 (14)	2,076 (86)	2415
	Median [IQR]^c	Median [IQR]^c	Median [IQR]^c
	67 [42-81]	66 [41-81]	66 [41-81]

The table displays row percentages. These data are on 116,097 emergency admissions by 90,193 patients who had consultation with a GP between April 2014 and March 2017.

a) Self-referred admission is defined as an admission via ED and a corresponding ED record with a referral source of self-referred b) Indices of multiple deprivation population weighted fifths c) Interquartile range

Table 2: ED contact & prior health contacts, in patients who consulted a GP in the three days before an emergency admission to hospital for all diagnoses and commonly missed conditions, by admission referral

	Self-referred ^a N=24,953	Other referred N=91,144	Total • N=116,097
	Number (%)	Number (%)	Number (%)
ED visits (3-365 days)			
0 visits	9,628 (18)	43,370 (82)	52,998
1 visit	6,032 (22)	21,859 (78)	27,891
2+ visits	9,293 (26)	25,915 (74)	35,208
A previous hospital admission <30 days			
For a surgical procedure	2,274 (24)	7,079 (76)	9,353
Non-surgical admission	3,279 (25)	9,964 (75)	13,243
Previous hospital admission (30-365 days)			
Elective 1+	6,696 (22)	23,111 (78)	29,807
Emergency 1+	9,992 (24)	32,516 (76)	42,508
	Mean no. (95% CI)	Median [IQR]	Mean no. (95% CI)
Primary care consultations (3-365 days)			
GP consultations	9 [4, 17]	8 [4, 15]	8 [4, 16]
Nurse consultations	2 [0, 4]	2 [0, 4]	2 [0, 4]
Face-to-face consultations	11 [5, 19]	10 [5, 18]	10 [5, 18]
Telephone consultations	0 [0, 2]	0 [0, 2]	0 [0, 2]

Numbers and rates are for 116,097 emergency admissions by 90,193 patients who had consultation with a GP between April 2014 and March 2017

a) A self-referred admission is defined as an admission via ED and a corresponding ED record with a referral source of self-referred

Table 3: Crude and adjusted odds ratios comparing odds of a self-referred admission in patients who visited a GP in 3 days before emergency admission

	Unadjusted N=116,097		Adjusted N=116,097	
	OR (95%CI)		OR (95%CI)	
Admission diagnosis				
Ectopic	0.57 (0.36 to 0.90)	*	0.59 (0.37 to 0.94)	*
Sepsis	1.15 (1.06 to 1.24)	**	1.09 (1.01 to 1.18)	*
Pulmonary Embolism	0.88 (0.78 to 1.00)			
UTI	1.14 (1.09 to 1.19)	***	1.09 (1.04 to 1.14)	***
All other	<i>Reference</i>		<i>Reference</i>	
Patient factors				
Gender (women vs men)	1.00 (0.98 to 1.02)			
Age (10-year increase)	1.01 (1.01 to 1.02)	***	0.99 (0.99 to 1.00)	***
Indices of Multiple Deprivation				
Most vs least deprived	1.02 (0.98 to 1.06)			
GP reported comorbidity				
None	<i>Reference</i>		<i>Reference</i>	
1 recorded comorbidity	1.09 (1.05 to 1.12)		1.07 (1.03 to 1.11)	**
2+ recorded comorbidities	1.10 (1.07 to 1.12)		1.05 (1.01 to 1.08)	*
Health Service use in deteriorating patient within 3 days				
No. of GP Consultations	0.91 (0.88 to 0.93)	***	0.91 (0.89 to 0.93)	***
Consultation type				
Face-to-Face	<i>Reference</i>		<i>Reference</i>	
Telephone consultation	1.26 (1.22 to 1.30)	***	1.14 (1.11 to 1.18)	***
Face-to-Face&Telephone	0.90 (0.86 to 0.94)	***	0.89 (0.85 to 0.92)	**
GP consultation duration (5-minute increase)				
	0.89 (0.89 to 0.90)		0.90 (0.89 to 0.91)	***
Female GP	0.93 (0.91 to 0.98)	***	0.96 (0.94 to 0.98)	***
Also seen by a nurse	0.84 (0.80 to 0.87)	***	0.89 (0.85 to 0.92)	***
Health Service use - previous 12 months				
No. of GP consultations (3-365 days)	1.01 (1.01 to 1.01)	***		
Admission in previous 3-<30 days				
None	<i>Reference</i>		<i>Reference</i>	
Surgical	1.16 (1.12 to 1.20)		1.07 (1.04 to 1.11)	**
Non-surgical	1.16 (1.13 to 1.20)	***	1.03 (1.00 to 1.06)	*
ED visits previous (3-365 days)				
0	<i>Reference</i>		<i>Reference</i>	
1	1.14 (1.11 to 1.17)	***	1.13 (1.10 to 1.16)	***
2	1.31 (1.28 to 1.34)	***	1.29 (1.25 to 1.33)	***
Previous admissions (30-<365 days)				
Elective (1+vs0)	1.05 (1.02 to 1.07)			
Emergency (1+vs0)	1.13 (1.12 to 1.16)		0.94 (0.91 to 0.96)	***

Logistic model using generalised estimating equations, clustering by GP practice, for 116,097 emergency admissions by 90,193 patients.

Figure 1: Definition of GP potentially missed acute deterioration using primary and secondary care linked data

Accepted Manuscript – BJGP – BJGP.2020.0986

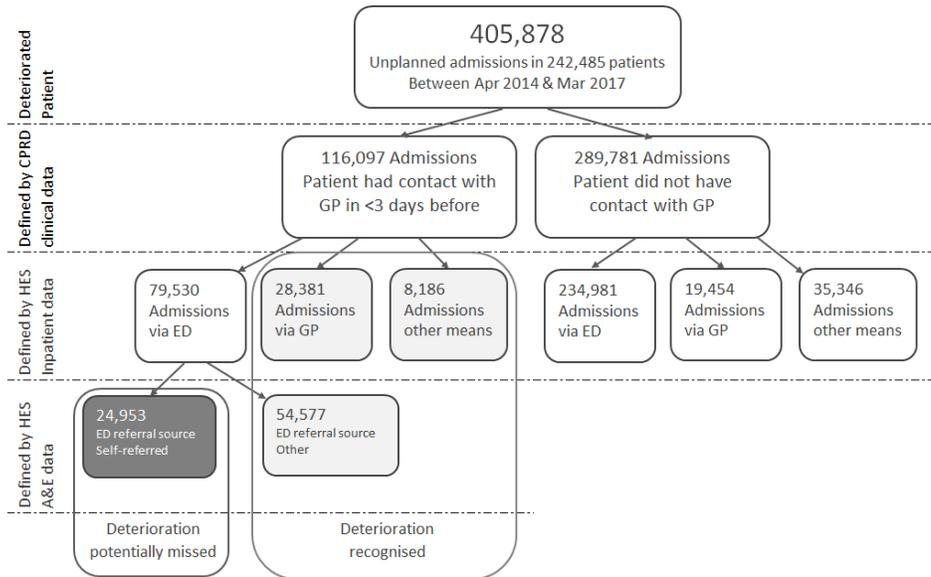


Figure 1: Definition of GP potentially missed acute deterioration using primary and secondary care linked data

384x229mm (72 x 72 DPI)