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# Measuring the impact introducing NHS 111 online had on the NHS 111 telephone service and the wider NHS system

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Measuring the impact introducing NHS 111 online had on the NHS 111 telephone service and the wider NHS system

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Abstract

Objectives

The aim of this study was to explore what impact introducing the NHS 111 online service had on the number of phone calls to the NHS 111 telephone service and the NHS urgent care system.

Main outcome measures

Primary outcome: the number of triaged calls to the NHS 111 telephone service following the introduction of NHS 111 online. Secondary outcomes: Total calls to the NHS 111 telephone service, total number of emergency ambulance referrals or advice to contact 999, total number of advice to attend an Emergency Department or other urgent care treatment facility, and total number of advice to contact primary care.

Data

NHS 111 telephone and online contacts data were collected between Oct 2010 to Dec 2019 and Jan 2018 to Dec 2019 respectively. The NHS 111 Minimum Data Set was used for the NHS 111 telephone data and NHS Digital provided the NHS 111 Online data. There were 18 NHS 111 area codes included in the analysis.

Methods

Dose response interrupted time series was used to analyse the NHS 111 telephone and online data for each of the 18 NHS 111 area codes and a random effects meta-analysis was used to estimate the average effect of introducing the online service had on each outcome.

Conclusions

It was found that the NHS 111 online service has little impact on the number of triaged and total calls, suggesting that the workload for the NHS 111 telephone service has not increased or decreased as a result of introducing NHS 111 online. However, there was evidence to suggest an increase in the overall number of disposition recommendations (ambulance, Emergency Department and primary care) for NHS 111 telephone and online services combined following the introduction of the NHS 111 online service.
Strengths and limitations of this study

- This study is one of the first to look at how introducing NHS 111 online impacted the NHS 111 telephone service and the rest of the NHS urgent care services.
- A dose response interrupted time series model was used across 18 NHS 111 area code and used meta-analysis to estimate the average effect of introducing the online service.
- As NHS 111 online was rolled out rapidly as a national service, it was not possible to have any control area codes. Therefore, any effects seen cannot be assumed to be the direct result of introducing the new service or whether they would have happened anyway due to other factors impacting both the NHS 111 telephone service and the wider emergency and urgent care system.
- This evaluation was conducted at the early stages of implementation. Since COVID-19, public awareness and usage of the system may have changed.
- The data and results for outcome relating to the wider NHS urgent care services only consider recommendations for care and not actual care received.
Introduction

NHS 111 is a telephone advice and triage service for urgent but not life threatening conditions.[1] The NHS 111 service in England was set up in 2013 (previously NHS Direct) and aimed to improve patient access to urgent and emergency care services by directing the patient to the place most appropriate for their level of care need.[2] This service is available 24 hours a day, 7 days a week. Initial triage is conducted by non-clinical call assessors. Where necessary, additional clinical assessment is provided by healthcare professionals. This service receives a high volume of calls each year, but has had little impact on decreasing the demand for other NHS emergency and urgent care services.[3] Data from NHS England show that approximately 15,000,000 telephone calls to NHS 111 were answered in 2017/2018; this equates to around 46,000 a day.[4] This level of demand is also expected to continue to increase. For these calls, the proportions of final dispositions (recommendation on what to do next) are: 21% for ambulance dispatches or ED attendances, 60.7% recommended primary care dispositions and the remainder to attend another service or self-care.[5]

In 2017, NHS England introduced four pilot NHS 111 Online services as an alternative point of access for urgent care help. The online service allows users to use a web or “app” platform to enter their health problem and then answer a set of questions to get advice on what to do next. At the end of their session a list of local services is provided, if needed a call back from a clinician at the NHS111 telephone service can be requested or, where links allow, an appointment or call back from another service can be arranged.[6] In 2018, this service was expanded rapidly to cover the rest of England using a single platform based on the NHS Pathways triage system used by the NHS 111 telephone service that is accessed by a webpage or the NHS App. The purpose of introducing the NHS 111 Online system was to try to make the system easier and more accessible for users and to try to reduce the number of calls to the NHS 111 telephone service.[1] A new service may reduce demand for another service by redirecting activity, but there is also a risk that demand is increased, either by duplication of service use or creating new demand.

Aim

The aim of this study was to explore what impact introducing the NHS 111 online service had on the number of phone calls to the NHS 111 telephone service and the NHS urgent care system. A dose response interrupted time series was used to analyse the NHS 111 telephone and online data to explore these aims.
Methods

Outcomes

For this study, we looked at a number of outcomes. The primary outcome looked at what impact introducing the NHS 111 Online service had on the number of triaged calls to the existing NHS 111 telephone service. Triaged calls are defined as any call that is assessed using the NHS Pathways triage/assessment process to determine what the health problem is, whether it is urgent and provide a “disposition” advising what service is needed.[7] This excludes any calls which, for example, just provide health information with no assessment. The secondary outcomes were used to explore the impact of NHS 111 online on the total number of calls and the various dispositions that could impact on other services.

Outcomes affecting NHS 111 telephone service only:

- Triaged calls
- Total calls answered – including non-triaged calls for health information, those where the caller terminates before triage

Outcomes affecting the wider NHS urgent care system:

- Emergency ambulance referrals or advice to contact 999
- Advice to attend an Emergency Department or other urgent care treatment facility
- Advice to contact or attend primary care

The secondary outcomes, which looked at the impact NHS 111 online may have had on the wider NHS system, comprised of the combined dispositions from both the call and online data. For example, the outcome of emergency ambulance disposition is the combined number of 999 referrals from the telephone service and advice to contact 999 in the online data during the same time period.

Data Collection

NHS 111 telephone and online contacts data were collected between Oct 2010 to Dec 2019 and Jan 2018 to Dec 2019 respectively. The NHS 111 Minimum Data Set, Time Series to December 2019 was used for the NHS 111 telephone data and was accessed from [https://www.england.nhs.uk/statistics/statistical-work-areas/nhs-111-minimum-data-set/nhs-111-minimum-data-set-2019-20/](https://www.england.nhs.uk/statistics/statistical-work-areas/nhs-111-minimum-data-set/nhs-111-minimum-data-set-2019-20/) in January 2020.[8] NHS Digital provided the NHS 111 Online data. The telephone data was in the form of monthly counts at NHS 111 area code level, unlike the online data which was provided in the form of anonymous individual user sessions. Since the telephone data was at an aggregate level, all analyses were necessarily conducted at this “area code” level.

The NHS 111 telephone data was formed of records for 71 geographical “area codes”; some of these were subsequently split and merged into 38 different area codes. The NHS 111 Online records detailed the Clinical Commissioning Group (CCG) of the user, these mapped wholly into larger Sustainability and Transformation Partnership (STP) areas. The NHS 111 Online service was introduced at STP level with differing start dates.
Unfortunately, area codes and STPs are not co-terminus; area codes can be formed of multiple STPs and some STPs can be split over more than one area codes. This meant that not all NHS 111 area codes could be included in the analyses. In addition, for the interrupted time series analysis one full year of NHS 111 Online data was required, therefore any area codes where the online service had not been operating for at least a year were removed. For consistency, the telephone data was capped to 2 years prior to the introduction of the NHS 111 Online service. This meant each NHS 111 area code had a minimum of 36 months of data. This meant there were 18 NHS 111 area codes remaining for the analysis. A list of the 18 sites and their CCGs that were included are provided in the Appendix, Table 4.

As the telephone data provided for this study was at NHS 111 area code level, this limited what descriptive analyses could be presented for comparisons between the call and online population. The Yorkshire and Humber CUREd [9] data was used to compare the population characteristics of those who use online and those who called. However, the CUREd data was from 2016. It was unfortunate that Yorkshire and Humber was not one of the final 18 NHS 111 area codes used in the analyses. Yorkshire and Humber is a large region, which is made up of 22 CCGs, and the NHS 111 Online service became live at different times in these CCGs meaning we could not account for the time point of change in the interrupted times series models. However, this region was used for the descriptive analyses to enable a comparison between the NHS 111 online and telephone populations.

Statistical Analysis

Descriptive analyses were used to compare characteristics and the final dispositions for both online and telephone data populations alongside summaries of the characteristics of the online data population for the NHS 111 area codes included in this study.

Interrupted time series

To model the impact introducing the NHS 111 Online service may have had on the monthly number of calls, interrupted time series (ITS) was used. However, unlike conventional ITS, a dose response model was used. This meant instead of modelling the number of calls as a function of the time after the launch of the online service, it was modelled as a function of the number of online contacts that month. The dose response model provided an estimate of the reduction or increase in the number of telephone calls per online contact. Systematic components were also included in the model: an underlying time trend, a step change for when NHS 111 Online was introduced and ‘fixed’ seasonal effects (4 levels: Dec-Feb, Mar-May, June-Aug, Sept-Nov).

As each NHS 111 area code had different start dates for the introduction of NHS 111 Online, each area code was modelled separately and meta-analysis was used to determine the overall effect. Given there were 18 different NHS 111 area codes and a range of outcomes to model, the same model for each site and outcome was used, but different models were used as a sensitivity analysis.

The final model was determined by testing Poisson or Negative Binomial (NB) models and whether the model was an Autoregressive (AR) model on four NHS 111 area codes. These four NHS 111 area codes (Hertfordshire, Milton Keynes, North East and Nottinghamshire) were independently chosen prior to any analysis by two statisticians (RS & RJ). These sites were chosen as they represented areas with large to small numbers of calls.

To test whether an AR model was appropriate, the primary outcome was differenced to remove the general upwards trend (Appendix: Figure 8) and then the AutoCorrelation Function (ACF) and Partial
AutoCorrelation Function (PACF) plots were investigated. Following this, it was agreed that for all four area codes, an AR model was not needed but there may be some seasonality. However, it had already been pre-specified that seasonality would be included in the model and would be accounted for with the season variable.

The primary outcome variable was the number (count) of triaged calls to NHS 111 each month so both Poisson and NB were considered. As the output for the Poisson model showed the data was over dispersed, the NB model was chosen over the Poisson model. Again, the ACF and PACF plots for these models were investigated and it was confirmed an AR model was not needed (Appendix: Figure 9 & Figure 10).

The final model used for the analysis was:

$$\text{Number of calls} = \text{time} + \text{dose} + \text{step} + \text{season}, \quad (\text{linear})$$

Where the outcome is the number of calls to the NHS 111 telephone service each month, time as a linear variable 0,1,2,..., dose is the number of NHS 111 Online contacts for each month, step is a binary variable which is coded 0 before the introduction of NHS 111 Online and 1 afterwards and season is a fixed variable that represents the 4 seasons in the year.

**Sensitivity analyses**

Two further models were used for sensitivity analyses: an AR(1) model and a non-linear model with a non-linear term for time were used.

- **AR(1) Model:** Number of calls = time + dose + step + season, \quad (AR model)
- **Number of calls** = time + time^2 + dose + step + season. \quad (non – linear)

These models were applied to all sites and outcomes.

As the Isle of Wight was an NHS 111 area code included in the analysis, due to its size with small call volumes and an atypical urgent care service configuration one further sensitivity analysis was conducted in which the Isle of Wight was excluded.

All three of these models used a log link function. For the linear and non-linear NB model the *glm.nb* function of the MASS package was used.[10] For the AR model the *tsglm* function of the tscount package was used.[11]

**Meta-analysis**

Forest plots were used to summarise the dose from the individual area analyses for all outcomes with estimates displayed as the incidence rate ratio per 1,000 online contacts. To combine the results from each area, a random effects meta-analysis was used to estimate the average effect of introducing the online service had on each outcome.[12] The between-area variance, $\tau^2$, was estimated using the DerSimonian-Laird method[13] and heterogeneity was evaluated using the $I^2$ statistic.[14] The results are presented as an overall estimate for each outcome alongside its associated 95% confidence interval and P-Value. Meta-analysis was conducted using the *metagen* function of the meta library.[15]

As above, the Meta-analysis was repeated for all sensitivity analyses and the overall estimate and 95% confidence interval for each model was displayed on a forest plot for comparison.
All analyses were conducted using R version 3.6.3 (R Core Team, 2020).[16]

**Ethics**

The University of Sheffield Research Ethics Committee granted ethical approval for the secondary use of routine data (Reference 031640).

The CUREd database [9] has approval from a National Health Service (NHS) Research and Ethics Committee, overseen by the NHS Health Research Authority’s Research Ethics Service, and from the NHS Health Research Authority (HRA).

**Public and Patient Involvement (PPI)**

PPI were involved prior to and throughout the wider project. However, there were no patient or public involvement in this part of the study.

**Results**

**Demographics**

Table 1 presents the population characteristics for those who contacted NHS 111 via the telephone service (2016) compared to the online service (2019) in Yorkshire and Humber. The largest difference in proportions between the two populations was for age. There was a higher proportion of the younger population using the online service compared to the telephone service with 61.1% of those aged between 16 and 34 using online service compared to 31.2% using the telephone. The results also suggest that the online service have a higher proportion being recommended a 999 ambulance compared to the telephone service, but have a smaller proportion recommended to contact primary care.

*Table 1: Characteristics of the NHS 111 telephone and online population for Yorkshire and Humber*

1 Online data were collected between Jan – Dec 2019
2 Telephone data were collected between Jan – Dec 2016

| Yorkshire and Humber | N Online¹ | %   | N Calls² | %   |
|----------------------|-----------|-----|----------|-----|
| N                    | 275538    | 100%| 1350280  | 100%|
| SEX                  |           |     |          |     |
| Female               | 186524    | 67.7%| 762741   | 56.5%|
| Male                 | 89014     | 32.3%| 585625   | 43.4%|
| Not known            | -         | -   | 587      | 0.0%|
| Not Specified        | -         | -   | 1327     | 0.1%|
| Total                | 275538    | 100%| 1350280  | 100%|
| AGE                  |           |     |          |     |
| [0,2)                | -         | -   | 138969   | 10.3%|

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| Yorkshire and Humber | N Online¹ | %   | N Calls ² | %   |
|----------------------|-----------|-----|-----------|-----|
| [2,16)               | 25636     | 9.3%| 188414    | 14.0%|
| [16,35)              | 168295    | 61.1%| 421536    | 31.2%|
| [35,75)              | 78823     | 28.6%| 415247    | 30.8%|
| [75,Inf)             | 2771      | 1%  | 186096    | 13.8%|
| NA                   | 13        | 0%  | 18        | 0.0% |
| Total                | 275538    | 100%| 1350280   | 100% |

| TIME OF DAY          |          |     |           |     |
|----------------------|----------|-----|-----------|-----|
| (Day: 08:00-19:59)   |          |     |           |     |
| Night                | 95224    | 34.6%| 423546    | 31.4%|
| Day                  | 180314   | 65.4%| 926734    | 68.6%|
| Total                | 275538   | 100%| 1350280   | 100% |

| WEEKEND/WEEK         |          |     |           |     |
|----------------------|----------|-----|-----------|-----|
| Week                 | 184712   | 67% | 774167    | 57.3%|
| Weekend              | 90826    | 33% | 576113    | 42.7%|
| Total                | 275538   | 100%| 1350280   | 100  |

| DISPOSITION          |          |     |           |     |
|----------------------|----------|-----|-----------|-----|
| 5.23 (Ambulance)     | 34571    | 14.81%| 135999    | 12.81%|
| 5.24 (A&E)           | 22678    | 9.71% | 101840    | 9.59% |
| 5.25 Primary Care    | 176210   | 75.48%| 824134    | 77.60%|
| Total                | 233459   | 100.00%| 1061973   | 100.00%|
Table 2: Characteristics of the NHS 111 online population split by the 18 NHS 111 area codes

Table 2 presents the characteristics of those who use NHS 111 online for each NHS 111 area code. The characteristic percentages tended to be similar for each area code.

| Site                  | N   | Female | Male | Total   | [2,16) | (16,35) | [35,75) | [75+] | NA | Total | Night | Day | Total | Week | Weekend | Total |
|-----------------------|-----|--------|------|---------|--------|---------|---------|-------|----|-------|-------|-----|-------|------|----------|-------|
| **North East**        | 142373 | 99088  | 43285 | 142373  | 15834  | 81521   | 43239   | 1775  | 4  | 142373 | 45105 | 97268 | 142373 | 91021 | 51352    | 142373 |
|                       |      | 69.6%  | 30.4% | 100%    | 11.1%  | 57.3%   | 30.4%   | 1.2%  |    |        | 31.7% | 68.3% | 100%   | 63.9% | 36.1%    | 100%   |
| **Lincolnshire**      | 26469 | 18302  | 8167  | 26469   | 2730   | 15387   | 7998    | 354   | -  | 26469  | 9809  | 16660 | 26469  | 16979 | 9490     | 26469  |
|                       |      | 69.1%  | 30.9% | 100%    | 10.3%  | 58.1%   | 30.2%   | 1.3%  |    |        | 37.1% | 62.9% | 100%   | 64.1% | 35.9%    | 100%   |
| **Nottinghamshire**   | 36263 | 25169  | 11094 | 36263   | 3089   | 23047   | 9761    | 366   | -  | 36263  | 13473 | 22790 | 36263  | 24143 | 13343    | 36263  |
|                       |      | 69.4%  | 30.6% | 100%    | 8.5%   | 63.6%   | 26.9%   | 1%    |    |        | 37.2% | 62.8% | 100%   | 66.6% | 33.4%    | 100%   |
| **Derbyshire**        | 39085 | 27356  | 11729 | 39085   | 3770   | 22934   | 11947   | 433   | 1  | 39085  | 14519 | 24566 | 39085  | 25742 | 13343    | 39085  |
|                       |      | 70%    | 30%   | 100%    | 9.6%   | 58.7%   | 30.6%   | 1.1%  |    |        | 37.1% | 62.9% | 100%   | 65.9% | 34.1%    | 100%   |
| **Isle of Wight**     | 4675  | 3088   | 1587  | 4675    | 550    | 2382    | 1649    | 92    | 2  | 4675   | 1662  | 3013  | 4675   | 3231  | 1444     | 4675   |
|                       |      | 66.1%  | 33.9% | 100%    | 11.8%  | 51%     | 35.3%   | 2%    |    |        | 35.6% | 64.4% | 100%   | 69.1% | 30.9%    | 100%   |
| **Inner North West**  | 12955 | 8247   | 4708  | 12955   | 524    | 9084    | 3255    | 90    | 2  | 12955  | 4298  | 8657  | 12955  | 9514  | 3441     | 12955  |
| London                |      | 63.7%  | 36.3% | 100%    | 4%     | 70.1%   | 25.1%   | 0.7%  |    |        | 33.2% | 66.8% | 100%   | 73.4% | 26.6%    | 100%   |
| **Hillingdon**        | 6498  | 4451   | 2047  | 6498    | 567    | 4020    | 1848    | 63    | -  | 6498   | 2514  | 3984  | 6498   | 4417  | 2081     | 6498   |
|                       |      | 68.5%  | 31.5% | 100%    | 8.7%   | 61.9%   | 28.4%   | 1%    |    |        | 38.7% | 61.3% | 100%   | 68%   | 32%      | 100%   |
| **Hertfordshire**     | 34320 | 23531  | 10789 | 34320   | 3607   | 19201   | 11091   | 421   | -  | 34320  | 12617 | 21703 | 34320  | 22035 | 12285    | 34320  |
|                       |      | 68.6%  | 31.4% | 100%    | 10.5%  | 55.9%   | 32.3%   | 1.2%  |    |        | 36.8% | 63.2% | 100%   | 64.2% | 35.8%    | 100%   |
| **Cambridgeshire**    | 30132 | 20268  | 9864  | 30132   | 3047   | 17378   | 9362    | 344   | 1  | 30132  | 11173 | 18959 | 30132  | 19249 | 10883    | 30132  |
| and Peterborough     |      | 67.3%  | 32.7% | 100%    | 10.1%  | 57.7%   | 31.1%   | 1.1%  |    |        | 37.1% | 62.9% | 100%   | 63.9% | 36.1%    | 100%   |
| **Northamptonshire**  | 26765 | 18398  | 8367  | 26765   | 2898   | 15259   | 8275    | 331   | 2  | 26765  | 9793  | 16972 | 26765  | 17271 | 9494     | 26765  |
|                       |      | 68.7%  | 31.3% | 100%    | 10.8%  | 57%     | 30.9%   | 1.2%  |    |        | 36.6% | 63.4% | 100%   | 64.5% | 35.5%    | 100%   |
| Site                                  | N      | Female | Male  | Total | [2,16) | (16,35) | (35,75) | (75+) | NA | Total | Night | Day | Total | Week | Weekend | Total |
|---------------------------------------|--------|--------|-------|-------|--------|---------|---------|-------|----|-------|-------|----|-------|------|---------|-------|
| Milton Keynes                         | 10368  | 7232   | 3136  | 10368 | 1065   | 6014    | 3201    | 87    | 1  | 10368 | 3707  | 6661| 10368 | 7123 | 3245    | 10368 |
| Leicestershire and Rutland            | 38235  | 26230  | 12005 | 38235 | 3740   | 22699   | 11356   | 438   | 2  | 38235 | 13761 | 24474| 38235 | 25118| 13117   | 38235 |
| Outer North West London               | 20100  | 13488  | 6612  | 20100 | 1651   | 12456   | 5768    | 224   | 1  | 20100 | 7838  | 12262| 20100 | 13634| 6466    | 20100 |
| North Central London                  | 30083  | 20103  | 9980  | 30083 | 1942   | 19623   | 8197    | 321   | -  | 30083 | 10943 | 19140| 30083 | 20957| 9126    | 30083 |
| South East London                     | 47243  | 32329  | 14914 | 47243 | 3357   | 30346   | 13183   | 353   | 4  | 47243 | 18118 | 29125| 47243 | 32416| 14827   | 47243 |
| Bristol, North Somerset & South Gloucestershire | 26046  | 17248  | 8797  | 26046 | 2054   | 15830   | 7903    | 258   | 1  | 26046 | 9910  | 16136| 26046 | 17298| 8748    | 26046 |
| Cornwall                              | 16786  | 11230  | 5556  | 16786 | 1916   | 8772    | 5790    | 307   | 1  | 16786 | 6383  | 10403| 16786 | 10551| 6235    | 16786 |
| Staffordshire                         | 36846  | 25378  | 11468 | 36846 | 4033   | 21114   | 11225   | 424   | -  | 36846 | 13588 | 23258| 36846 | 24189| 12657   | 36846 |
| Total                                 | 585242 | 401136 | 184106| 585242| 5642   | 347067  | 175048  | 6681  | 22 | 585242| 209211| 376031| 585242| 384888| 200354  | 585242 |

- **Sex**: Female, Male
- **Age Groups**: [2,16), (16,35), (35,75), (75+), NA
- **Time of Day**: (Day: 08:00–19:59)
- **Weekend/Week**: Total, Week, Weekend
Disposition comparison telephone vs. online data

Table 3 presents the dispositions of those who use NHS 111 online versus calls for each NHS 111 area code.

Table 3: Disposition comparison for NHS 111 telephone and online contacts for the 18 NHS 111 area codes (Jan – Dec 2019).

| NHS 111 Area code | Disposition | Call N | %  | Online N | %  | NHS 111 Area code | Call N | %  | Online N | %  |
|-------------------|-------------|--------|----|----------|----|-------------------|--------|----|----------|----|
| North East        | 5.23 (Ambulance) | 128500 | 22.23% | 19610 | 16.79% | Northamptonshire | 28460 | 17.92% | 3934 | 17.65% |
|                   | 5.24 (A&E)    | 78262  | 13.54% | 14646 | 12.54% |                    | 19123 | 12.04% | 2959 | 13.28% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 371186 | 64.22% | 82539 | 70.67% |                    | 111275 | 70.05% | 15395 | 69.07% |
| Total             |              | 577948 | 100.00% | 116795 | 100.00% |                    | 158858 | 100.00% | 22288 | 100.00% |
| Lincolnshire      | 5.23 (Ambulance) | 28940 | 21.58% | 3901 | 18.09% | Milton Keynes     | 9005 | 17.89% | 1581 | 19.03% |
|                   | 5.24 (A&E)    | 11793  | 8.80% | 2495 | 11.57% |                    | 5163 | 10.26% | 1064 | 12.81% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 93347 | 69.62% | 15172 | 70.34% |                    | 36175 | 71.86% | 5664 | 68.17% |
| Total             |              | 134080 | 100.00% | 21568 | 100.00% |                    | 50343 | 100.00% | 8309 | 100.00% |
| Nottinghamshire   | 5.23 (Ambulance) | 40777 | 21.08% | 5386 | 18.42% | Leicestershire and Rutland | 43298 | 18.42% | 5826 | 18.42% |
|                   | 5.24 (A&E)    | 22479  | 11.62% | 3639 | 12.45% |                    | 20389 | 8.67% | 3685 | 11.65% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 130182 | 67.30% | 20213 | 71.86% |                    | 171359 | 72.90% | 22122 | 69.93% |
| Total             |              | 193438 | 100.00% | 29238 | 100.00% |                    | 235046 | 100.00% | 31633 | 100.00% |
| Derbyshire        | 5.23 (Ambulance) | 42481 | 18.45% | 5500 | 17.82% | Outer North West London | 29515 | 17.82% | 3062 | 19.27% |
|                   | 5.24 (A&E)    | 19818  | 8.61% | 3712 | 11.56% |                    | 22197 | 13.40% | 1789 | 11.26% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 167943 | 72.94% | 22885 | 71.30% |                    | 113947 | 68.78% | 11042 | 69.48% |
| Total             |              | 230242 | 100.00% | 32097 | 100.00% |                    | 165659 | 100.00% | 15893 | 100.00% |
| Isle of Wight     | 5.23 (Ambulance) | 10881 | 18.76% | 695 | 19.06% | North Central London | 37331 | 18.20% | 4188 | 17.70% |
|                   | 5.24 (A&E)    | 8560  | 14.76% | 457 | 12.53% |                    | 28086 | 13.69% | 2886 | 12.20% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 38550 | 66.48% | 2495 | 68.41% |                    | 139748 | 68.11% | 16587 | 70.10% |
|                          | Inner North West London | South East London | Bristol, North Somerset & South Gloucestershire | Cornwall | Staffordshire |
|--------------------------|-------------------------|-------------------|-----------------------------------------------|----------|---------------|
| Total                    | 57991 100.00%           | 3647 100.00%      | 205165 100.00%                                | 23661 100.00% |
| **5.23 (Ambulance)**     | 13345 17.02%            | 37089 12.20%      | 36412 11.97%                                  | 6423 16.95% |
| **5.24 (A&E)**           | 10816 13.79%            | 1930 10.91%       | 4497 11.87%                                   |          |
| **5.25a (Contact Primary care) & 5.25b (Speak to Primary care)** | 54264 69.19% | 230600 75.83% | 26972 71.18% |          |
| Total                    | 78425 100.00%           | 10151 100.00%     | 304101 100.00%                                | 37892 100.00% |
| **5.25a (Contact Primary care) & 5.25b (Speak to Primary care)** | 54264 69.19% | 230600 75.83% | 304101 100.00% |          |
| **Total**                | 52985 100.00%           | 5323 100.00%      | 24207 100.00%                                 |          |
| **Total**                | 214609 100.00%          | 28488 100.00%     | 87363 100.00%                                 | 13601 100.00% |
| **5.23 (Ambulance)**     | 13345 17.02%            | 37089 12.20%      | 36412 11.97%                                  | 6423 16.95% |
| **5.24 (A&E)**           | 10816 13.79%            | 1930 10.91%       | 4497 11.87%                                   |          |
| **5.25a (Contact Primary care) & 5.25b (Speak to Primary care)** | 54264 69.19% | 230600 75.83% | 304101 100.00% |          |
| **Total**                | 52985 100.00%           | 5323 100.00%      | 24207 100.00%                                 |          |
| **Total**                | 214609 100.00%          | 28488 100.00%     | 87363 100.00%                                 | 13601 100.00% |
| **5.23 (Ambulance)**     | 27582 12.85%            | 1001 18.81%       | 16904 19.35%                                  | 2505 18.42% |
| **5.24 (A&E)**           | 20206 9.42%             | 581 10.91%        | 5997 6.86%                                    | 1542 11.34% |
| **5.25a (Contact Primary care) & 5.25b (Speak to Primary care)** | 36630 69.13% | 135925 67.26% | 19159 70.28% |          |
| **Total**                | 52985 100.00%           | 5323 100.00%      | 24207 100.00%                                 |          |
| **Total**                | 214609 100.00%          | 28488 100.00%     | 87363 100.00%                                 | 13601 100.00% |
| **5.23 (Ambulance)**     | 27582 12.85%            | 1001 18.81%       | 16904 19.35%                                  | 2505 18.42% |
| **5.24 (A&E)**           | 20206 9.42%             | 581 10.91%        | 5997 6.86%                                    | 1542 11.34% |
| **5.25a (Contact Primary care) & 5.25b (Speak to Primary care)** | 36630 69.13% | 135925 67.26% | 19159 70.28% |          |
| **Total**                | 52985 100.00%           | 5323 100.00%      | 24207 100.00%                                 |          |
| **Total**                | 214609 100.00%          | 28488 100.00%     | 87363 100.00%                                 | 13601 100.00% |
| **5.23 (Ambulance)**     | 30481 18.47%            | 4002 16.53%       | 36875 17.46%                                  | 20905 100.00% |
| **5.24 (A&E)**           | 18670 11.31%            | 3483 12.57%       | 5997 6.86%                                    | 1542 11.34% |
| **5.25a (Contact Primary care) & 5.25b (Speak to Primary care)** | 115909 70.22% | 64462 73.79% | 19159 70.28% |          |
| **Total**                | 165060 100.00%          | 24207 100.00%     | 87363 100.00%                                 | 13601 100.00% |
| **Total**                | 211150 100.00%          | 30364 100.00%     | 87363 100.00%                                 | 13601 100.00% |
Triaged calls

Figure 1 presents LOESS (locally estimated scatterplot smoothing) plots for the primary outcome, triaged calls, for the four NHS 111 area codes in which the model was developed. Triaged calls excludes calls that were abandoned and those that were not triaged.

Figure 1: LOESS plots of the number of triaged calls and online contacts the four test NHS 111 area codes
blue - Triaged NHS 111 telephone; red - online NHS 111 contacts

Figure 2 presents the plots for the ITS model for the four NHS 111 area codes using the primary analysis method (linear negative binomial with no AR(1)).

Figure 2: ITS plots for the four test sites. Solid line – ITS model; dashed line – null model (no intervention); solid dots – triaged NHS 111 telephone; hollow dots – online NHS 111 contacts.

The results of the meta-analysis of triaged 111 NHS calls are given below. The analysis is for the primary analysis method for each site and then for each sensitivity analysis overall.

Figure 3A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The x-axis is showing the incidence rate ratio per 1,000 online contacts. The overall incidence rate ratio per 1,000 online contacts is 1.013 (95% CI: 0.996 to 1.029, P=0.127). This means that on average for every 1,000 online contacts, the number of calls to the NHS 111 telephone service that are triaged has increased by 1.3% (95% CI: -0.4% to 2.9%). However, this result is not statistically significant.

Figure 3B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Excluding the Isle of Wight has little effect on the estimate. Including a non-linear term for time has increased the standard error and lowered the estimates, but the overall conclusion remains the same. The AR(1) model provides similar incidence rate estimates and confidence intervals.

Figure 3: Forest plots showing the effect of introducing the NHS 111 online service on the number of triaged calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: I² = 71.5% (95% CI: 54.1% to 82.3%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
**Total calls**

Total calls is all calls offered to NHS 111 reflecting how many people attempted to contact the service. Figure 4A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.008 (95% CI: 0.992 to 1.025, P=0.313). This means that on average for every 1,000 online contacts, the number of calls to NHS 111 has increased by 0.8% (95% CI: -0.8% to 2.5%). However, this result is not significant.

Figure 4B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Excluding the Isle of Wight has little effect on the estimate. Including a non-linear term for time has increased the standard error and decreased the incidence rate ratio, there is now a 3-4% decrease in calls be 1,000 online contacts, but the overall conclusion remains the same. The AR(1) model provides similar incidence rate estimates and confidence intervals.

*Figure 4: Forest plots showing the effect of introducing the NHS 111 online service on the total number of calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: I² = 68.0% (95% CI: 47.7% to 80.4%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.*
Emergency Ambulance dispositions

One of the dispositions at the end of a 111 contact is referral to or to call 999 for an emergency ambulance response. The outcome for this analysis is the number of 999 ambulance dispositions for both NHS 111 telephone and online. Figure 5A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.067 (95% CI: 1.035 to 1.100, P<0.001). This means that on average for every 1,000 online contacts, the number of recommendations for ambulance response has increased by 6.7% (95% CI: 3.5% to 10.0%). This result is considered a statistically significant effect, suggesting that on average the online 111 service could cause an increase in the number of ambulance dispatches overall if online users follow this advice.

Figure 5B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Again, excluding the Isle of Wight has little effect on the estimate. The non-linear model also has little effect on the estimate and confidence intervals, the estimates have decreased slightly. Similarly for the AR(1) model.

Figure 5: Forest plots showing the effect of introducing the NHS 111 online service on the number of ambulance call outs. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: I² = 89.8% (95% CI: 85.4% to 92.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
ED attendances

Another disposition at the end of a 111 contact is recommendation to attend ED. The outcome for this analysis is the number of ED recommendations for both NHS 111 telephone and online. Figure 6A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.050 (95% CI: 1.010 to 1.092, P=0.014). This means that on average for every 1,000 online contacts, the number of recommendations to attend has increased by 5% (95% CI: 1.0% to 9.2%). This result is considered a statistically significant effect, suggesting that on average the online 111 service has caused an increase in the number ED recommendations overall.

Figure 6B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Again, excluding the Isle of Wight has little effect on the estimate. Similarly for the AR(1) model. The non-linear model changes the direction of the effect, however this result is no longer significant (P=0.110).

Figure 6: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to attend ED. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: I^2 = 94.4% (95% CI: 92.4% to 95.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Contact with primary care

Primary care dispositions at the end of a 111 contact can suggest users either contact or attend different services within different timeframes. This includes GP services but also, for example, pharmacy or dentist (community care). The analysis for this section looks at primary care only.

The outcome for this analysis focuses on the number of primary care only recommendations for both NHS 111 telephone and online. Figure 7A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.051 (95% CI: 1.027 to 1.076, P<0.001). This means that on average for every 1,000 online contacts, the number of primary care only recommendations has increased by 5.1% (95% CI: 2.7% to 7.6%). This result is considered a statistically significant effect, suggesting that on average the online 111 service has caused an increase in the number primary care only recommendations overall.

Figure 7B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Again, excluding the Isle of Wight has little effect on the estimate. Similarly for the non-linear model and the AR(1) model. The non-linear model has slightly smaller estimates but is no longer statistically significant (P=0.168).

Figure 7: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to contact primary care. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 84.3\%$ (95% CI: 76.4% to 89.5%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Discussion

Introducing the NHS 111 Online service added another point of access for urgent and emergency care in the NHS. The online service operates in addition to the existing telephone service, not replacing it, hence creating two sources of access. Both these services can direct users to services in the emergency and urgent care system, unless the health problem is suitable for self-care. Interrupted time series analysis was conducted to assess changes in activity following the introduction of NHS 111 Online using a dose response model where the “dose” is the number of contacts with the NHS 111 Online service.

The primary outcome was investigating the impact introducing the online service potentially had on the NHS 111 telephone service. The results indicate that overall, the online service had little impact on the number of total and triaged calls, this suggests that the workload for NHS 111 may not have increased or decreased since introducing NHS 111 Online. This in turn also suggests there has not been a substantial shift to using the online service instead of the telephone service. However, this finding was not consistent as there were four sites that showed a reduction in triaged calls. This could indicate for these areas that it is possible there may have been a shift away from the telephone service to the online service.

For the secondary outcomes which looked at the wider NHS urgent care system, the results from the combined activity from the NHS 111 telephone service and online service suggested that there was an increase in the overall number of recommendations to contact or attend those services following the introduction of the NHS 111 Online service. On the surface, the results suggest there was an overall increase in demand for emergency and urgent care services, which is not surprising. For the 18 sites we included in our analyses, there were almost 600,000 contacts with the NHS 111 Online service with no visible shift away from the telephone service and nationally there were over 2 million contacts during 2019. It has been shown previously, that introducing new services and access points for emergency and urgent care, such as NHS Direct, NHS 111 and Walk in Centres, have created an increase and therefore new demand for services.[17–19] Following from this, it is entirely plausible that introducing this new online service could produce the same effect. However, the findings from the previous research were based on actual utilisation of other services in the emergency and urgent care system. For this analysis, it was only possible to show the recommendations about services to contact or attend and so potential increases in service utilisation. This estimated potential service use increase would only hold true if all recommendations were acted upon and if those who used NHS 111 Online subsequently accessed a service they would not have used without a recommendation from the online service.

There is also the possibility that that any changes in demand may have been influenced by other external factors. Meta-analysis was used to produce an overall summary measure of effect from the 18 sites included in the analyses. However, the forest plots show there is considerable variation between different NHS 111 area codes, this could suggest there are local differences, for example service availability and the amount of integration between services, therefore the effect of introducing NHS 111 Online may unlikely be consistent in different health economies.

Strengths and Limitations

There are a few limitations of these analyses to be discussed. Firstly, as NHS 111 Online was rolled out rapidly as a national service, it was not possible to use an experimental design with control area codes.
This means any effects seen cannot be assumed to be the direct result of introducing the new service or whether they would have happened anyway due to other factors impacting on both the NHS 111 telephone service and the wider emergency and urgent care system.

Secondly, as we had to use the telephone service NHS 111 minimum dataset aggregated data rather than patient level data, this meant we were only able to successfully match 18 of the 38 potential NHS 111 area codes to NHS 111 Online data, therefore, we have not been able to establish a national estimate of impact. However, for the 18 NHS 111 area codes included in the analysis we are confident that they are representative of different geographical areas, activity volume and provider types across England to make reasonable inferences.

Thirdly, as this evaluation of NHS 111 Online was conducted during the early stage of implementation, it had only been operational for 12 – 18 months in the sites we have used, we have estimated system impact based on the “dose”, in terms of contacts with the new service, present at that time. Analysing the data at a later stage when the service becomes more widely understood by the public, contacts may increase and it is possible the impact may change, therefore any subsequent assessment of impact could be more robust.

Finally, as previously discussed, the data and results only considers recommendations for care and not actual care received. This might be quite different and will be dependent on how people use the service making it difficult to estimate how much new demand there may be.

Further work

The work from the study has opened up a number of potential areas to conduct further work. Exploring the patient level comparisons further of the characteristics of the two NHS 111 populations (Telephone and Online) and the relationships between characteristics. This has the potential to help identify patients who are most likely to benefit from using the two types of service and provide information that would help patients choose which service to use.

As discussed in the limitations, we were only able to determine recommendations to other services, not what happened. Further work is required to explore the dispositions further to determine whether NHS 111 has had an impact on the wider services. To do this linked data would be required to follow the patient pathway and unfortunately, this linkage is currently not possible as NHS 111 Online have no individual patient identifiers. An example of using NHS 111 telephone linked data is the work by Lewis et al.[20]

In the results, there was evidence of inconsistencies between different NHS 111 area codes, some seeing decreases and others seeing increases, further work could explore whether the differences in impact on the 111 telephone service between areas are due to different populations, available services, policies or other factors.

Evaluating the services early in the introduction does have the potential to have unstable results. Repeating the analysis at a later stage once the systems have settled and matured and the population are more familiar with the purpose and use would help provide a more clear picture. Analysing the data at a later date could also provide the opportunity to include all the NHS111 area codes as the introduction stage could be ignored in the analysis. This could be even more important now following the COVID-19 pandemic where the NHS 111 systems saw huge increases in demand for the telephone service and the NHS 111 online service was rapidly developed to include a COVID-19 specific triage
pathway to help deal with the demand. With the publicity the NHS 111 telephone and online services received during the start of the pandemic, it would be of interest to see whether population behaviour of using these services has changed since the pandemic started.

Conclusion

The results show that younger people are more likely to use NHS 111 online compared to older people. It was also found that the NHS 111 online service has little impact on the number of triaged and total calls, suggesting that the workload for NHS 111 has not increased or decreased as a result of introducing NHS 111 online. There was evidence that the introduction of NHS 111 online increased the overall number of disposition recommendations (ambulance, Emergency Department and primary care) of the NHS 111 telephone and NHS online services combined. However, as these are recommendations it is not possible to say whether this will have increased the workload for the rest of the urgent care system services. It will be important to further monitor impact as contacts with the NHS111 online service increase and avoid creating large volumes of new demand in a system that is already under serious pressure.

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## Appendix

### Table 4: NHS 111 Area code and CCG list

| Code                                | CCG                                                       |
|-------------------------------------|-----------------------------------------------------------|
| **North East-111AA1**              |                                                           |
|                                    | NHS Darlington CCG                                        |
|                                    | NHS Durham Dales, Easington and Sedgefield CCG            |
|                                    | NHS Hartlepool and Stockton-on-Tees CCG                   |
|                                    | NHS Newcastle Gateshead CCG                               |
|                                    | NHS North Durham CCG                                      |
|                                    | NHS North Tyneside CCG                                    |
|                                    | NHS Northumberland CCG                                    |
|                                    | NHS South Tees CCG                                        |
|                                    | NHS South Tyneside CCG                                    |
|                                    | NHS Sunderland CCG                                        |
| **Lincolnshire-111AA2**            |                                                           |
|                                    | NHS Lincolnshire East CCG                                 |
|                                    | NHS Lincolnshire West CCG                                 |
|                                    | NHS South Lincolnshire CCG                                |
|                                    | NHS South West Lincolnshire CCG                           |
| **Nottinghamshire-111AA4**         | NHS Mansfield and Ashfield CCG                            |
|                                    | NHS Newark and Sherwood CCG                               |
|                                    | NHS Nottingham City CCG                                   |
|                                    | NHS Nottingham North and East CCG                         |
|                                    | NHS Nottingham West CCG                                   |
|                                    | NHS Rushcliffe CCG                                         |
| **Derbyshire-111AA5**              | NHS Derby and Derbyshire CCG                              |
|                                    | NHS Erewash CCG                                            |
|                                    | NHS Hardwick CCG                                           |
|                                    | NHS North Derbyshire CCG                                  |
|                                    | NHS Southern Derbyshire CCG                               |
| **Isle of Wight-111AA6**           | NHS Isle of Wight CCG                                     |
| Inner North West London-111AA7 | NHS Central London (Westminster) CCG  |
|                               | NHS Hammersmith and Fulham CCG       |
|                               | NHS West London CCG                  |
| Hillingdon-111AA9             | NHS Hillingdon CCG                  |
| Hertfordshire-111AB2          | NHS East and North Hertfordshire CCG |
|                               | NHS Herts Valleys CCG               |
| Cambridgeshire and Peterborough-111AC5 | NHS Cambridgeshire and Peterborough CCG |
| Northamptonshire111AC6        | NHS Corby CCG                        |
|                               | NHS Nene CCG                         |
| Milton Keynes-111AC7          | NHS Milton Keynes CCG                |
| Leicestershire and Rutland-111AC8 | NHS East Leicestershire and Rutland CCG |
|                               | NHS Leicester City CCG               |
|                               | NHS West Leicestershire CCG          |
| Outer North West London-111AD4 | NHS Brent CCG                        |
|                               | NHS Ealing CCG                       |
|                               | NHS Harrow CCG                       |
|                               | NHS Hounslow CCG                     |
| North Central London-111AD5   | NHS Barnet CCG                       |
|                               | NHS Camden CCG                       |
|                               | NHS Enfield CCG                      |
|                               | NHS Haringey CCG                     |
|                               | NHS Islington CCG                    |
| South East London-111AD7      | NHS Bexley CCG                       |
|                               | NHS Bromley CCG                      |
|                               | NHS Greenwich CCG                    |
|                               | NHS Lambeth CCG                      |
|                               | NHS Lewisham CCG                     |
|                               | NHS Southwark CCG                    |
| Location                        | CCG Name                                |
|--------------------------------|-----------------------------------------|
| **Bristol, North Somerset & South Gloucestershire-111AE7** | NHS Bristol, North Somerset and South Gloucestershire CCG |
| **Cornwall-111AF1**             | NHS Kernow CCG                          |
| **Staffordshire-111AF4**        | NHS Cannock Chase CCG                   |
|                                 | NHS East Staffordshire CCG              |
|                                 | NHS North Staffordshire CCG             |
|                                 | NHS South East Staffordshire and Seisdon Peninsula CCG |
|                                 | NHS Stafford and Surrounds CCG          |
|                                 | NHS Stoke on Trent CCG                  |
Figure 8: Model fit: Difference plot of four test sites
Model fit: ACF

Figure 9: ACF plots of the four test sites

Model fit: PACF

Figure 10: PACF plots of the four test sites
Figure 1: LOESS plots of the number of triaged calls and online contacts the four test NHS 111 area codes
blue - Triaged NHS 111 telephone; red - online NHS 111 contacts

453x340mm (87 x 87 DPI)
Figure 2: ITS plots for the four test sites. Solid line – ITS model; dashed line – null model (no intervention); solid dots – triaged NHS 111 telephone; hollow dots – online NHS 111 contacts.

175x131mm (220 x 220 DPI)
Figure 3: Forest plots showing the effect of introducing the NHS 111 online service on the number of triaged calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 71.5\%$ (95% CI: 54.1% to 82.3%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.

159x159mm (120 x 120 DPI)
Figure 4: Forest plots showing the effect of introducing the NHS 111 online service on the total number of calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 68.0\%$ (95% CI: 47.7% to 80.4%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.

159x159mm (120 x 120 DPI)
Figure 5: Forest plots showing the effect of introducing the NHS 111 online service on the number of ambulance call outs. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 89.8\%$ (95% CI: 85.4% to 92.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Figure 6: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to attend ED. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 94.4\%$ (95% CI: 92.4% to 95.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Figure 7: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to contact primary care. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 84.3\%$ (95% CI: 76.4% to 89.5%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.

159x159mm (120 x 120 DPI)
Figure 8: Model fit: Difference plot of four test sites

182x136mm (220 x 220 DPI)
Figure 9: ACF plots of the four test sites

Hertfordshire

Milton Keynes

North East

Nottinghamshire

Figure 9: ACF plots of the four test sites

179x134mm (220 x 220 DPI)
Figure 10: PACF plots of the four test sites

185x139mm (220 x 220 DPI)
Measuring the impact introducing NHS 111 online had on the NHS 111 telephone service and the wider NHS urgent care system: an observational study

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Measuring the impact introducing NHS 111 online had on the NHS 111 telephone service and the wider NHS urgent care system: an observational study

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Abstract

Objectives

To explore what impact introducing the NHS 111 online service had on the number of phone calls to the NHS 111 telephone service and the NHS urgent care system.

Design

Observational study using a dose response interrupted time series model and random effects meta-analysis to estimate the average effect.

Setting and participants

NHS 111 telephone and online contacts for 18 NHS 111 area codes in England. NHS 111 telephone and online contacts data were collected between Oct 2010 to Dec 2019 and Jan 2018 to Dec 2019 respectively.

Primary and secondary outcome measures

Primary outcome: the number of triaged calls to the NHS 111 telephone service following the introduction of NHS 111 online. Secondary outcomes: Total calls to the NHS 111 telephone service, total number of emergency ambulance referrals or advice to contact 999, total number of advice to attend an Emergency Department or other urgent care treatment facility, and total number of advice to contact primary care.

Results

For triaged calls, the overall incidence rate ratio (IRR) per 1,000 online contacts was 1.013 (95% CI: 0.996 to 1.029, P=0.127). For total calls, the overall IRR per 1,000 online contacts was 1.008 (95% CI: 0.992 to 1.025, P=0.313). For emergency ambulance referrals or advice to contact 999, the overall IRR per 1,000 online contacts was 1.067 (95% CI: 1.035 to 1.100, P<0.001). For advice to attend an Emergency Department or other urgent care treatment facility, the overall IRR per 1,000 online contacts is 1.050 (95% CI: 1.010 to 1.092, P=0.014). And finally, for those advised to contact primary care, the overall IRR per 1,000 online contacts is 1.051 (95% CI: 1.027 to 1.076, P<0.001).

Conclusions

It was found that the NHS 111 online service has little impact on the number of triaged and total calls, suggesting that the workload for the NHS 111 telephone service has not increased or decreased as a result of introducing NHS 111 online. However, there was evidence to suggest an increase in the overall number of disposition recommendations (ambulance, Emergency Department and primary care) for NHS 111 telephone and online services combined following the introduction of the NHS 111 online service.
Strengths and limitations of this study

- This study is one of the first to look at how introducing NHS 111 online impacted the NHS 111 telephone service and the rest of the NHS urgent care services.
- A dose response interrupted time series model was used across 18 NHS 111 area code and used meta-analysis to estimate the average effect of introducing the online service.
- As NHS 111 online was rolled out rapidly as a national service, it was not possible to have any control area codes. Therefore, any effects seen cannot be assumed to be the direct result of introducing the new service or whether they would have happened anyway due to other factors impacting both the NHS 111 telephone service and the wider emergency and urgent care system.
- This evaluation was conducted at the early stages of implementation. Since COVID-19, public awareness and usage of the system may have changed.
- The data and results for outcome relating to the wider NHS urgent care services only consider recommendations for care and not actual care received.
Introduction

NHS 111 is a telephone advice and triage service for urgent but not life threatening conditions.[1] The NHS 111 service in England was set up in 2013 (previously NHS Direct) and aimed to improve patient access to urgent and emergency care services by directing the patient to the place most appropriate for their level of care need.[2] This service is available 24 hours a day, 7 days a week. Initial triage is conducted by non-clinical call assessors. Where necessary, additional clinical assessment is provided by healthcare professionals. This service receives a high volume of calls each year, but has had little impact on decreasing the demand for other NHS emergency and urgent care services.[3] Data from NHS England show that approximately 15,000,000 telephone calls to NHS 111 were answered in 2017/2018; this equates to around 46,000 a day[4]. This level of demand is also expected to continue to increase. For these calls, the proportions of final dispositions (recommendation on what to do next) are: 21% for ambulance dispatches or ED attendances, 60.7% recommended primary care dispositions and the remainder to attend another service or self-care.[5]

In 2017, NHS England introduced four pilot NHS 111 Online services as an alternative point of access for urgent care help. The online service allows users to use a web or “app” platform to enter their health problem and then answer a set of questions to get advice on what to do next. At the end of their session a list of local services is provided, if needed a call back from a clinician at the NHS 111 telephone service can be requested or, where links allow, an appointment or call back from another service can be arranged.[6] In 2018, this service was expanded rapidly to cover the rest of England using a single platform based on the NHS Pathways triage system used by the NHS 111 telephone service that is accessed by a webpage or the NHS App. The purpose of introducing the NHS 111 Online system was to try to make the system easier and more accessible for users and to try to reduce the number of calls to the NHS 111 telephone service.[1] A new service may reduce demand for another service by redirecting activity, but there is also a risk that demand is increased, either by duplication of service use or creating new demand.

Aim

This work is part of a larger mixed-methods study ‘Impact of NHS 111 Online on the NHS 111 telephone service and urgent care system: a mixed-methods study’ which is published in the NIHR Health Services and Delivery Research journal.[7] The larger study used both quantitative and qualitative methods to explore what impact introducing NHS 111 Online had on the NHS 111 telephone service and the urgent care system. This article presents in greater detail the quantitative methods and analysis. Specifically, to investigate what impact introducing the NHS 111 online service had on the number of phone calls to the NHS 111 telephone service and the NHS urgent care system using a dose response interrupted time series model.
Methods

Outcomes

Primary outcome:
For this study, we looked at a number of outcomes. The primary outcome looked at what impact introducing the NHS 111 Online service had on the number of triaged calls to the existing NHS 111 telephone service. Triaged calls are defined as any call that is assessed using the NHS Pathways triage/assessment process to determine what the health problem is, whether it is urgent and provide a “disposition” advising what service is needed.[8] This excludes any calls which, for example, just provide health information with no assessment.

Secondary outcomes:
The secondary outcomes were used to explore the impact of NHS 111 online on the total number of calls and the various dispositions that could impact on other services.

Outcomes affecting NHS 111 telephone service only:
- Total calls answered – including non-triaged calls for health information, those where the caller terminates before triage

Outcomes affecting the wider NHS urgent care system:
- Emergency ambulance referrals or advice to contact 999
- Advice to attend an Emergency Department or other urgent care treatment facility
- Advice to contact or attend primary care

The secondary outcomes, which looked at the impact NHS 111 online may have had on the wider NHS system, comprised of the combined dispositions from both the call and online data. For example, the outcome of emergency ambulance disposition is the combined number of 999 referrals from the telephone service and advice to contact 999 in the online data during the same time period.

Data Collection
NHS 111 telephone and online contacts data were collected between Oct 2010 to Dec 2019 and Jan 2018 to Dec 2019 respectively. The NHS 111 Minimum Data Set, Time Series to December 2019 was used for the NHS 111 telephone data and was accessed from (https://www.england.nhs.uk/statistics/statistical-work-areas/nhs-111-minimum-data-set/nhs-111-minimum-data-set-2019-20/) in January 2020.[9] NHS Digital provided the NHS 111 Online data. The telephone data was in the form of monthly counts at NHS 111 area code level, unlike the online data which was provided in the form of anonymous individual user sessions. Since the telephone data was at an aggregate level, all analyses were necessarily conducted at this “area code” level.

Due to the level of the data, the NHS 111 telephone data was formed of records for 71 geographical “area codes” and the online data was made up of STPs (Sustainability and Transformation Partnership) and CCGs (Clinical Commissioning Group) which could be mapped to 38 NHS 111 area codes (The remaining telephone data NHS 111 area codes were old codes that have been subsequently merged
into some of the newer area codes). These area codes are made up of STPs which in turn are made up of CCGs. Unfortunately, area codes and STPs are not co-terminus; area codes can be formed of multiple STPs and some STPs can be split over more than one area codes. Given that the online 111 service was introduced at STP level, this meant that not all NHS 111 area codes could be included in the analyses.

In addition, for the interrupted time series analysis one full year of NHS 111 Online data was required, therefore any area codes where the online service had not been operating for at least a year were removed. For consistency, the telephone data was capped to 2 years prior to the introduction of the NHS 111 Online service. This meant each NHS 111 area code had a minimum of 36 months of data. In total there were 18 NHS 111 area codes remaining for the analysis. A list of the 18 sites and their CCGs that were included are provided in the Appendix Table 1.

As the telephone data provided for this study was at NHS 111 area code level, this limited what descriptive analyses could be presented for comparisons between the call and online population. The Yorkshire and Humber CUREd [10] data was used to compare the population characteristics of those who use online and those who called. However, the CUREd data was from 2016. It was unfortunate that Yorkshire and Humber was not one of the final 18 NHS 111 area codes used in the analyses. Yorkshire and Humber is a large region, which is made up of 22 CCGs, and the NHS 111 Online service became live at different times in these CCGs meaning we could not account for the time point of change in the interrupted times series models. However, this region was used for the descriptive analyses to enable a comparison between the NHS 111 online and telephone populations.

**Statistical Analysis**

Descriptive analyses were used to compare characteristics and the final dispositions for both online and telephone data populations alongside summaries of the characteristics of the online data population for the NHS 111 area codes included in this study.

**Interrupted time series**

To model the impact introducing the NHS 111 Online service may have had on the monthly number of calls, interrupted time series (ITS) was used. However, unlike conventional ITS, a dose response model was used. This meant instead of modelling the number of calls as a function of the time after the launch of the online service, it was modelled as a function of the number of online contacts that month. The dose response model allows for the number of online contacts, which may impact on the number of telephone calls, to be taken into account. The dose response model provided an estimate of the reduction or increase in the number of telephone calls per online contact.

Systematic components were also included in the model: an underlying time trend, a step change for when NHS 111 Online was introduced and ‘fixed’ seasonal effects (4 levels: Dec-Feb, Mar-May, June-Aug, Sept-Nov).

As each NHS 111 area code had different start dates for the introduction of NHS 111 Online, each area code was modelled separately and meta-analysis was used to determine the overall effect. Given there were 18 different NHS 111 area codes and a range of outcomes to model, the same model for each site and outcome was used, but different models were used as a sensitivity analysis.

The final model was determined by testing Poisson or Negative Binomial (NB) models and whether the model was an Autoregressive (AR) model on four NHS 111 area codes. These four NHS 111 area codes (Hertfordshire, Milton Keynes, North East and Nottinghamshire) were independently chosen.
prior to any analysis by two statisticians (RS & RJ). These sites were chosen as they represented areas with large to small numbers of calls.

To test whether an AR model was appropriate, the primary outcome was differenced to remove the general upwards trend (Appendix Figure 1) and then the AutoCorrelation Function (ACF) and Partial AutoCorrelation Function (PACF) plots were investigated. Following this, it was agreed that for all four area codes, an AR model was not needed but there may be some seasonality. However, it had already been pre-specified that seasonality would be included in the model and would be accounted for with the season variable.

The primary outcome variable was the number (count) of triaged calls to NHS 111 each month so both Poisson and NB models were considered. As the output for the Poisson model showed the data was over dispersed, the NB model was chosen over the Poisson model. Again, the ACF and PACF plots for these models were investigated and it was confirmed an AR model was not needed (Appendix Figure 2 & Figure 3).

The final model used for the analysis was:

\[ \text{Number of calls} = \text{time} + \text{dose} + \text{step} + \text{season}, \quad \text{(linear)} \]

Where the outcome is the number of calls to the NHS 111 telephone service each month, time is a linear variable 0,1,2,..., dose is the number of NHS 111 Online contacts for each month, step is a binary variable which is coded 0 before the introduction of NHS 111 Online and 1 afterwards and season is a fixed variable that represents the 4 seasons in the year.

**Sensitivity analyses**

Two further models were used for sensitivity analyses: an AR(1) model and a non-linear model with a non-linear term for time were used.

\[ \text{AR(1) Model: Number of calls} = \text{time} + \text{dose} + \text{step} + \text{season}, \quad \text{(AR model)} \]

\[ \text{Number of calls} = \text{time} + \text{time}^2 + \text{dose} + \text{step} + \text{season}. \quad \text{(non – linear)} \]

These models were applied to all sites and outcomes.

As the Isle of Wight was an NHS 111 area code included in the analysis, due to its size with small call volumes and an atypical urgent care service configuration one further sensitivity analysis was conducted in which the Isle of Wight was excluded.

All three of these models used a log link function. For the linear and non-linear NB model the \textit{glm.nb} function of the MASS package was used.[11] For the AR model the \textit{tsglm} function of the tscount package was used.[12]

**Meta-analysis**

Forest plots were used to summarise the dose from the individual area analyses for all outcomes with estimates displayed as the incidence rate ratio per 1,000 online contacts. To combine the results from each area, a random effects meta-analysis was used to estimate the average effect of introducing the online service on each outcome.[13] The between-area variance, \( \tau^2 \), was estimated using the DerSimonian-Laird method[14] and the proportion of total variability due to between-area heterogeneity was evaluated using the I² statistic.[15] The results are presented as an overall estimate
for each outcome alongside its associated 95% confidence interval and P-Value. Meta-analysis was conducted using the metagen function of the meta library.[16]

As above, the Meta-analysis was repeated for all sensitivity analyses and the overall estimate and 95% confidence interval for each model was displayed on a forest plot for comparison.

All analyses were conducted using R version 3.6.3 (R Core Team, 2020).[17]

**Ethics**

The University of Sheffield Research Ethics Committee granted ethical approval for the secondary use of routine data (Reference 031640).

The CUREd database [10] has approval from a National Health Service (NHS) Research and Ethics Committee, overseen by the NHS Health Research Authority’s Research Ethics Service, and from the NHS Health Research Authority (HRA).

**Public and Patient Involvement (PPI)**

PPI were involved prior to and throughout the wider project. However, there were no patient or public involvement in this part of the study.

**Results**

**Demographics**

Table 1 presents the population characteristics for those who contacted NHS 111 via the telephone service (2016) compared to the online service (2019) in Yorkshire and Humber. The largest difference in proportions between the two populations was for age. There was a higher proportion of the younger population using the online service compared to the telephone service with 61.1% of those aged between 16 and 34 using online service compared to 31.2% using the telephone. The results also suggest that the online service have a higher proportion being recommended a 999 ambulance compared to the telephone service, but have a smaller proportion recommended to contact primary care.

**Table 1: Characteristics of the NHS 111 telephone and online population for Yorkshire and Humber**

1 Online data were collected between Jan – Dec 2019

2 Telephone data were collected between Jan – Dec 2016

| Yorkshire and Humber | N Online ¹ | % | N Calls ² | % |
|----------------------|-----------|---|-----------|---|
| N                    | 275538    | 100% | 1350280  | 100% |
| **SEX**              |           |     |           |     |
| Female               | 186524    | 67.7% | 762741  | 56.5% |
| Male                 | 89014     | 32.3% | 585625  | 43.4% |
| Not known            | -         | - | 587  | 0.0% |
| Not Specified        | -         | - | 1327  | 0.1% |
| Yorkshire and Humber | N Online\(^1\) | %    | N Calls \(^2\) | %    |
|----------------------|--------------|------|----------------|------|
| Total                | 275538       | 100% | 1350280        | 100% |
| **AGE**              |              |      |                |      |
| (0,2)                | -            | -    | 138969         | 10.3%|
| [2,16)               | 25636        | 9.3% | 188414         | 14.0%|
| [16,35)              | 168295       | 61.1%| 421536         | 31.2%|
| [35,75)              | 78823        | 28.6%| 415247         | 30.8%|
| [75,Inf)             | 2771         | 1%   | 186096         | 13.8%|
| NA                   | 13           | 0%   | 18             | 0.0% |
| Total                | 275538       | 100% | 1350280        | 100% |
| **TIME OF DAY**      |              |      |                |      |
| (Day: 08:00-19:59)   |              |      |                |      |
| Night                | 95224        | 34.6%| 423546         | 31.4%|
| Day                  | 180314       | 65.4%| 926734         | 68.6%|
| Total                | 275538       | 100% | 1350280        | 100% |
| **WEEKEND/WEEK**     |              |      |                |      |
| Week                 | 184712       | 67%  | 774167         | 57.3%|
| Weekend              | 90826        | 33%  | 576113         | 42.7%|
| Total                | 275538       | 100% | 1350280        | 100% |
| **DISPOSITION**      |              |      |                |      |
| 5.23 (Ambulance)     | 34571        | 14.81%| 135999        | 12.81%|
| 5.24 (ED)            | 22678        | 9.71% | 101840        | 9.59% |
| 5.25 Primary Care    | 176210       | 75.48%| 824134        | 77.60%|
| Total                | 233459       | 100.00%| 1061973      | 100.00%|
Online demographics by NHS 111 area code

Table 2 presents the characteristics of those who use NHS 111 online for each NHS 111 area code. The characteristic percentages tended to be similar for each area code. Of those using NHS 111 online, a higher proportion were female, most of the online users were in the younger age categories with very small proportions in the 75+ group, and a larger proportion of contacts were made in the day.

Table 2: Characteristics of the NHS 111 online population split by the 18 NHS 111 area codes

| Site                  | N     | Female | Male | Total | (2,16) | (16,35) | (35,75) | (75+) | NA | Total | Night | Day | Total | Week | Weekend | Total |
|-----------------------|-------|--------|------|-------|--------|---------|---------|-------|----|-------|-------|-----|-------|------|---------|-------|
| North East            | 142373| 99088  | 43285| 142373| 15834  | 81521   | 43239   | 1775  | 4  | 142373| 45105 | 97268| 142373| 91021| 51352   | 142373|
| Lincolnshire          | 26469 | 18302  | 8167 | 26469 | 2730   | 15387   | 7998    | 354   | -  | 26469 | 9089  | 16660| 26469 | 16979| 9490    | 26469 |
| Nottinghamshire       | 36263 | 25169  | 11094| 36263 | 3089   | 23047   | 9761    | 366   | -  | 36263 | 13473 | 22790| 36263 | 24143| 12120   | 36263 |
| Derbyshire             | 39085 | 27356  | 11729| 39085 | 3770   | 22934   | 11947   | 433   | 1  | 39085 | 14519 | 24566| 39085 | 25742| 13343   | 39085 |
| Isle of Wight         | 4675  | 3088   | 1587 | 4675  | 550    | 2382    | 1649    | 92    | 2  | 4675  | 1662  | 3013 | 4675  | 3231 | 1444    | 4675  |
| Inner North West      | 12955 | 8247   | 4708 | 12955 | 524    | 9084    | 3255    | 90    | 2  | 12955 | 4298  | 8657 | 12955 | 9514 | 3441    | 12955 |
| London                | 12955 | 8247   | 4708 | 12955 | 524    | 9084    | 3255    | 90    | 2  | 12955 | 4298  | 8657 | 12955 | 9514 | 3441    | 12955 |
| Hertfordshire         | 34320 | 23531  | 10789| 34320 | 3607   | 19201   | 11091   | 421   | -  | 34320 | 12617 | 21703| 34320 | 22035| 12285   | 34320 |
| Cambridgeshire and Peterborough | 30132 | 20268  | 9864 | 30132 | 3047   | 17378   | 9362    | 344   | 1  | 30132 | 11173 | 18959| 30132 | 19249| 10883   | 30132 |
| Northamptonshire      | 26765 | 18398  | 8367 | 26765 | 2898   | 15259   | 8275    | 331   | 2  | 26765 | 9793  | 16972| 26765 | 17271| 9494    | 26765 |
| Site                              | N   | Female | Male | Total | [2,16) | [16,35) | [35,75) | [75+] | NA | Total | Night | Day | Total | Week | Weekend | Total |
|----------------------------------|-----|--------|------|-------|--------|---------|---------|-------|----|-------|-------|-----|-------|------|---------|-------|
| Milton Keynes                    | 10368 | 7232  | 3136 | 10368 | 1065   | 6014    | 3201    | 87     | 1  | 10368 | 3707  | 6661 | 10368 | 7123 | 3245    | 10368 |
| Leicestershire and Rutland       | 38235 | 26230 | 12005 | 38235 | 3740   | 22699   | 11356   | 438    | 2  | 38235 | 13761 | 24474| 38235 | 25118| 13117   | 38235 |
| Outer North West London          | 20100 | 13488 | 6612 | 20100 | 1651   | 12456   | 5768    | 224    | 1  | 20100 | 7838  | 12262| 20100 | 13634| 6466    | 20100 |
| North Central London             | 30083 | 20103 | 9980 | 30083 | 1942   | 19623   | 8197    | 321    | -  | 30083 | 10943 | 19140| 30083 | 20957| 9126    | 30083 |
| South East London                | 47243 | 32329 | 14914 | 47243 | 3357   | 30346   | 13183   | 353    | 4  | 47243 | 18118 | 29125| 47243 | 32416| 14827   | 47243 |
| Bristol, North Somerset & South Gloucestershire | 26046 | 17248 | 8798 | 26046 | 2054   | 15830   | 7903    | 258    | 1  | 26046 | 9910  | 16136| 26046 | 17298| 8748    | 26046 |
| Cornwall                         | 16786 | 11230 | 5556 | 16786 | 1916   | 8772    | 5790    | 307    | 1  | 16786 | 6383  | 10403| 16786 | 10551| 6235    | 16786 |
| Staffordshire                    | 36846 | 25378 | 11468 | 36846 | 4083   | 21114   | 11225   | 424    | -  | 36846 | 13588 | 23258| 36846 | 24189| 12657   | 36846 |
| Total                            | 585242| 401136 | 184106 | 585242 | 56424  | 347067  | 175048  | 6681   | 22 | 585242| 209211| 376031| 585242 | 384888| 200354  | 585242 |

- Sex: Male, Female
- Age: [2,16), [16,35), [35,75), [75+]
- Time of Day: Night (00:00-07:59), Day (08:00-19:59)
- NA: Not Available
- Total:
  - Night: 36.6%, Day: 63.4%
  - Week: 64.5%, Weekend: 35.5%
- Site:
  - Milton Keynes
  - Leicestershire and Rutland
  - Outer North West London
  - North Central London
  - South East London
  - Bristol, North Somerset & South Gloucestershire
  - Cornwall
  - Staffordshire
  - Total
Disposition comparison telephone vs. online data

Table 3 presents the dispositions of those who use NHS 111 online versus calls for each NHS 111 area code. The proportion of dispositions for calls versus online are fairly similar.

Table 3: Disposition comparison for NHS 111 telephone and online contacts for the 18 NHS 111 area codes (Jan – Dec 2019).

| NHS 111 Area code | Disposition | Call N | %     | Online N | %     | NHS 111 Area code | Call N | %     | Online N | %     |
|-------------------|-------------|--------|--------|----------|--------|-------------------|--------|--------|----------|--------|
| North East        | 5.23 (Ambulance) | 128500 | 22.23% | 19610    | 16.79% | Northamptonshire   | 28460  | 17.92% | 3934     | 17.65% |
|                   | 5.24 (ED)   | 78262  | 13.54% | 14646    | 12.54% |                   | 19123  | 12.04% | 2959     | 13.28% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 371186 | 64.22% | 82539    | 70.67% |                   | 111275 | 70.05% | 15395    | 69.07% |
|                   | Total       | 577948 | 100.00% | 116795   | 100.00% |                   | 158858 | 100.00% | 22288    | 100.00% |
| Lincolnshire      | 5.23 (Ambulance) | 28940  | 21.58% | 3901     | 18.09% | Milton Keynes      | 9005   | 17.89% | 1581     | 19.03% |
|                   | 5.24 (ED)   | 11793  | 8.80%  | 2495     | 11.57% |                   | 5163   | 12.26% | 1064     | 12.81% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 93347  | 69.62% | 15172    | 70.34% |                   | 36175  | 71.86% | 5664     | 68.17% |
|                   | Total       | 134080 | 100.00% | 21568    | 100.00% |                   | 50343  | 100.00% | 8309     | 100.00% |
| Nottinghamshire   | 5.23 (Ambulance) | 40777  | 21.08% | 5386     | 18.42% | Leicestershire and Rutland | 43298  | 18.42% | 5826     | 18.42% |
|                   | 5.24 (ED)   | 22479  | 11.62% | 3639     | 12.45% |                   | 20389  | 8.67%  | 3685     | 11.65% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 130182 | 67.30% | 20213    | 72.90% |                   | 171359 | 72.90% | 22122    | 69.93% |
|                   | Total       | 193438 | 100.00% | 29238    | 100.00% |                   | 235046 | 100.00% | 31633    | 100.00% |
| Derbyshire         | 5.23 (Ambulance) | 42481  | 18.45% | 5500     | 17.14% | Outer North West London | 29515  | 17.82% | 3062     | 19.27% |
|                   | 5.24 (ED)   | 19818  | 8.61%  | 3712     | 11.56% |                   | 22197  | 13.40% | 1789     | 11.26% |
|                   | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | 167943 | 72.94% | 22885    | 71.30% |                   | 113947 | 68.78% | 11042    | 69.48% |
|                   | Total       | 230242 | 100.00% | 32097    | 100.00% |                   | 165659 | 100.00% | 15893    | 100.00% |
| Isle of Wight      | 5.23 (Ambulance) | 10881  | 18.76% | 695      | 19.06% | North Central London | 37331  | 18.20% | 4188     | 17.70% |
|                   | 5.24 (ED)   | 8560   | 14.76% | 457      | 12.53% |                   | 28086  | 13.69% | 2886     | 12.20% |

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| Region                      | 5.23 (Ambulance) | 5.24 (ED) | 5.25a (Contact Primary care) & 5.25b (Speak to Primary care) | Total |
|-----------------------------|------------------|-----------|---------------------------------------------------------------|-------|
| Inner North West London     |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 13345            | 10816     | 54264                                         | 78425 |
| 5.24 (ED)                   | 1930             | 1292      | 6929                                          | 10151 |
| Total                       |                  |           |                                               |       |
| South East London           |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 37089            | 36412     | 230600                                        | 304101|
| 5.24 (ED)                   | 6423             | 4497      | 26972                                         | 37892 |
| Total                       |                  |           |                                               |       |
| Hillingdon                  |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 9387             | 6968      | 36630                                         | 52985 |
| 5.24 (ED)                   | 1001             | 581       | 3741                                          | 5323  |
| Total                       |                  |           |                                               |       |
| Bristol, North Somerset & South Gloucestershire |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 39989            | 26174     | 135925                                        | 202088|
| 5.24 (ED)                   | 3495             | 2457      | 14953                                         | 20905 |
| Total                       |                  |           |                                               |       |
| Hertfordshire               |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 27582            | 2026      | 166821                                        | 214609|
| 5.24 (ED)                   | 5845             | 3484      | 19159                                         | 28488 |
| Total                       |                  |           |                                               |       |
| Cornwall                    |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 16904            | 5997      | 64462                                         | 87363 |
| 5.24 (ED)                   | 2505             | 1542      | 9554                                          | 13601 |
| Total                       |                  |           |                                               |       |
| Cambridgeshire and Peterborough |              |           |                                                               |       |
| 5.23 (Ambulance)            | 30481            | 18670     | 115909                                        | 165060|
| 5.24 (ED)                   | 4002             | 3043      | 17162                                         | 24207 |
| Total                       |                  |           |                                               |       |
| Staffordshire               |                  |           |                                                               |       |
| 5.23 (Ambulance)            | 36875            | 18394     | 150281                                        | 211150|
| 5.24 (ED)                   | 5535             | 3326      | 21503                                         | 30364 |
| Total                       |                  |           |                                               |       |
**Triaged calls**

Figure 1 presents LOESS (locally estimated scatterplot smoothing) plots for the primary outcome, triaged calls, for the four NHS 111 area codes in which the model was developed. Triaged calls excludes calls that were abandoned and those that were not triaged. The general trend in all four sites is similar, with the number of triaged calls increasing over time.

*Figure 1: LOESS plots of the number of triaged calls and online contacts for the four test NHS 111 area codes blue - Triaged NHS 111 telephone; red - online NHS 111 contacts*

Figure 2 presents the plots for the ITS model for the four NHS 111 area codes using the primary analysis method (linear negative binomial with no AR(1)).

*Figure 2: ITS plots for the four test sites. Solid line – ITS model; dashed line – null model (no intervention); solid dots – triaged NHS 111 telephone; hollow dots – online NHS 111 contacts.*

The results of the meta-analysis of triaged 111 NHS calls are given in Figure 3. The analysis is for the primary analysis method for each site and then for each sensitivity analysis overall.

Figure 3A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The x-axis is showing the incidence rate ratio per 1,000 online contacts. The overall incidence rate ratio per 1,000 online contacts is 1.013 (95% CI: 0.996 to 1.029, P=0.127). This means that on average for every 1,000 online contacts, the number of calls to the NHS 111 telephone service that are triaged has increased by 1.3% (95% CI: -0.4% to 2.9%). However, this result is not statistically significant.

Figure 3B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Excluding the Isle of Wight has little effect on the estimate. Including a non-linear term for time has increased the standard error and lowered the estimates, but the overall conclusion remains the same. The AR(1) model provides similar incidence rate estimates and confidence intervals.
Total calls

Total calls is all calls offered to NHS 111 reflecting how many people attempted to contact the service. Figure 4A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.008 (95% CI: 0.992 to 1.025, P=0.313). This means that on average for every 1,000 online contacts, the number of calls to NHS 111 has increased by 0.8% (95% CI: -0.8% to 2.5%). However, this result is not significant.

Figure 4B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Excluding the Isle of Wight has little effect on the estimate. Including a non-linear term for time has increased the standard error and decreased the incidence rate ratio, there is now a 3-4% decrease in calls per 1,000 online contacts, but the overall conclusion remains the same. The AR(1) model provides similar incidence rate estimates and confidence intervals.

Figure 4: Forest plots showing the effect of introducing the NHS 111 online service on the total number of calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: I² = 68.0% (95% CI: 47.7% to 80.4%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Emergency Ambulance dispositions

One of the dispositions at the end of a 111 contact is referral to or to call 999 for an emergency ambulance response. The outcome for this analysis is the number of 999 ambulance dispositions for both NHS 111 telephone and online. Figure 5A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.067 (95% CI: 1.035 to 1.100, P<0.001). This means that on average for every 1,000 online contacts, the number of recommendations for ambulance response has increased by 6.7% (95% CI: 3.5% to 10.0%). This result is considered a statistically significant effect, suggesting that on average the online 111 service could cause an increase in the number of ambulance dispatches overall if online users follow this advice.

Figure 5B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Again, excluding the Isle of Wight has little effect on the estimate. The non-linear model also has little effect on the estimate and confidence intervals, the estimates have decreased slightly. Similarly for the AR(1) model.

Figure 5: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations for ambulance call outs. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: I² = 89.8% (95% CI: 85.4% to 92.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
ED attendances

Another disposition at the end of a 111 contact is recommendation to attend ED. The outcome for this analysis is the number of ED recommendations for both NHS 111 telephone and online. Figure 6A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.050 (95% CI: 1.010 to 1.092, P=0.014). This means that on average for every 1,000 online contacts, the number of recommendations to attend has increased by 5% (95% CI: 1.0% to 9.2%). This result is considered a statistically significant effect, suggesting that on average the online 111 service has caused an increase in the number of ED recommendations overall.

Figure 6B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Again, excluding the Isle of Wight has little effect on the estimate. Similarly for the AR(1) model. The non-linear model changes the direction of the effect, however this result is no longer significant (P=0.110).

Figure 6: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to attend ED. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 94.4\%$ (95% CI: 92.4% to 95.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Contact with primary care

Primary care dispositions at the end of a 111 contact can suggest users either contact or attend different services within different timeframes. This includes GP services but also, for example, pharmacy or dentist (community care). The analysis for this section looks at primary care only.

The outcome for this analysis focuses on the number of primary care only recommendations for both NHS 111 telephone and online. Figure 7A shows the forest plot of results for the primary analysis, for each NHS 111 area code and overall. The overall incidence rate ratio per 1,000 online contacts is 1.051 (95% CI: 1.027 to 1.076, P<0.001). This means that on average for every 1,000 online contacts, the number of primary care only recommendations has increased by 5.1% (95% CI: 2.7% to 7.6%). This result is considered a statistically significant effect, suggesting that on average the online 111 service has caused an increase in the number primary care only recommendations overall.

Figure 7B presents the forest plot for the overall results of the main analysis method and various sensitivity analyses. Again, excluding the Isle of Wight has little effect on the estimate. Similarly for the non-linear model and the AR(1) model. The non-linear model has slightly smaller estimates but is no longer statistically significant (P=0.168).

Figure 7: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to contact primary care. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 84.3\%$ (95% CI: 76.4% to 89.5%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Discussion

Introducing the NHS 111 Online service added another point of access for urgent and emergency care in the NHS. The online service operates in addition to the existing telephone service, not replacing it, hence creating two sources of access. Both these services can direct users to services in the emergency and urgent care system, unless the health problem is suitable for self-care. Interrupted time series analysis was conducted to assess changes in activity following the introduction of NHS 111 Online using a dose response model where the “dose” is the number of contacts with the NHS 111 Online service.

The demographic data showed that the largest difference in population characteristics of the telephone and online users was that a larger proportion of younger people used the online service.

The primary outcome was investigating the impact introducing the online service potentially had on the NHS 111 telephone service. The results indicate that overall, the online service had little impact on the number of total and triaged calls, this suggests that the workload for the NHS 111 telephone service may not have increased or decreased since introducing NHS 111 Online. This in turn also suggests there has not been a substantial shift to using the online service instead of the telephone service. However, this finding was not consistent as there were four sites that showed a reduction in triaged calls. This could indicate for these areas that there may have been a shift away from the telephone service to the online service.

For the secondary outcomes which looked at the wider NHS urgent care system, the results from the combined activity from the NHS 111 telephone service and online service suggested that there was an increase in the overall number of recommendations to contact or attend those services following the introduction of the NHS 111 Online service. On the surface, the results suggest there was an overall increase in demand for emergency and urgent care services, which is not surprising. For the 18 sites we included in our analyses, there were almost 600,000 contacts with the NHS 111 Online service with no visible shift away from the telephone service and nationally there were over 2 million contacts during 2019. It has been shown previously, that introducing new services and access points for emergency and urgent care, such as NHS Direct, NHS 111 and Walk in Centres, have created an increase and therefore new demand for services.[18–20] Following from this, it is entirely plausible that introducing this new online service could produce the same effect. However, the findings from the previous research were based on actual utilisation of other services in the emergency and urgent care system. For this analysis, it was only possible to show the recommendations about services to contact or attend and so potential increases in service utilisation. This estimated potential service use increase would only hold true if all recommendations were acted upon and if those who used NHS 111 Online subsequently accessed a service they would not have used without a recommendation from the online service.

There is also the possibility that that any changes in demand may have been influenced by other external factors. Meta-analysis was used to produce an overall summary measure of effect from the 18 sites included in the analyses. However, the forest plots show there is considerable variation between different NHS 111 area codes, this could suggest there are local differences, for example service availability and the amount of integration between services, therefore the effect of introducing NHS 111 Online maybe inconsistent in different health economies.

Strengths and Limitations

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There are a few limitations of these analyses to be discussed. Firstly, as NHS 111 Online was rolled out rapidly as a national service, it was not possible to use an experimental design with control area codes. This means any effects seen cannot be assumed to be the direct result of introducing the new service or whether they would have happened anyway due to other factors impacting on both the NHS 111 telephone service and the wider emergency and urgent care system.

Secondly, as we had to use the telephone service NHS 111 minimum dataset aggregated data rather than patient level data, this meant we were only able to successfully match 18 of the 38 potential NHS 111 area codes to NHS 111 Online data, therefore, we have not been able to establish a national estimate of impact. However, for the 18 NHS 111 area codes included in the analysis we are confident that they are representative of different geographical areas, activity volume and provider types across England to make reasonable inferences.

Thirdly, as this evaluation of NHS 111 Online was conducted during the early stage of implementation, it had only been operational for 12 – 18 months in the sites we have used, we have estimated system impact based on the “dose”, in terms of contacts with the new service, present at that time. Analysing the data at a later stage when the service becomes more widely understood by the public, contacts may increase and it is possible the impact may change, therefore any subsequent assessment of impact could be more robust.

Finally, as previously discussed, the data and results only considers recommendations for care and not actual care received. This might be quite different and will be dependent on how people use the service making it difficult to estimate how much new demand there may be.

Further work

The work from the study has opened up a number of potential areas to conduct further work. Exploring the patient level comparisons further of the characteristics of the two NHS 111 populations (Telephone and Online) and the relationships between characteristics. This has the potential to help identify patients who are most likely to benefit from using the two types of service and provide information that would help patients choose which service to use.

As discussed in the limitations, we were only able to determine recommendations to other services, not what happened. Further work is required to explore the dispositions further to determine whether NHS 111 has had an impact on the wider services. To do this linked data would be required to follow the patient pathway and unfortunately, this linkage is currently not possible as NHS 111 Online have no individual patient identifiers. An example of using NHS 111 telephone linked data is the work by Lewis et al.[21]

In the results, there was evidence of inconsistencies between different NHS 111 area codes, some seeing decreases and others seeing increases, further work could explore whether the differences in impact on the 111 telephone service between areas are due to different populations, available services, policies or other factors.

Evaluating the services early in the introduction does have the potential to have unstable results. Repeating the analysis at a later stage once the systems have settled and matured and the population are more familiar with the purpose and use would help provide a more clear picture. Analysing the data at a later date could also provide the opportunity to include all the NHS 111 area codes as the introduction stage could be ignored in the analysis. This could be even more important now following
the COVID-19 pandemic where the NHS 111 systems saw huge increases in demand for the telephone service and the NHS 111 online service was rapidly developed to include a COVID-19 specific triage pathway to help deal with the demand. With the publicity the NHS 111 telephone and online services received during the start of the pandemic, it would be of interest to see whether population behaviour of using these services has changed since the pandemic started.

Conclusion

The results show that younger people are more likely to use NHS 111 online compared to older people. It was also found that the NHS 111 online service has little impact on the number of triaged and total calls, suggesting that the workload for NHS 111 has not increased or decreased as a result of introducing NHS 111 online. There was evidence that the introduction of NHS 111 online increased the overall number of disposition recommendations (ambulance, Emergency Department and primary care) of the NHS 111 telephone and NHS online services combined. However, as these are recommendations it is not possible to say whether this will have increased the workload for the rest of the urgent care system services. It will be important to further monitor impact as contacts with the NHS 111 online service increase and avoid creating large volumes of new demand in a system that is already under serious pressure.
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Contributorship statement

JT conceived the study. JT performed the background searches. TS curated the data. RMS, RMJ and JN designed the analysis plan. RMS and RMJ performed the statistical analysis of the data and interpretation of the results. RMS drafted the initial manuscript and all authors contributed to its revision.

Statement

This report presents independent research commissioned by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, MRC, CCF, NETSCC, the Health Services and Delivery Research programme or the Department of Health.

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Competing interest

The authors declares that there are no conflicts of interest.

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Data sharing statement

The NHS 111 Minimum Data Set, Time Series to December 2019 (Microsoft Excel file) was the source of the NHS 111 telephone data for the evaluation period. This file is freely and openly available from the publisher’s (NHS England) website [https://www.england.nhs.uk/statistics/statistical-work-areas/nhs-111-minimum-data-set/nhs-111-minimum-data-set-2019-20/] (accessed January 2020).

NHS Digital provided a bespoke extract (comma separated values text file) as the source for the NHS 111 Online data. Data may be obtained from a third party and are not publicly available, enquiries for this data should be directed to the data provider: NHS Digital.
The CUREd Research Database, hosted by The University of Sheffield, provided a bespoke extract (comma separated values text file) as the source for patient-level NHS 111 telephone service data. Data may be obtained from a third party and are not publicly available, enquiries for this data should be directed to the data provider: The CUREd Research Database [https://www.sheffield.ac.uk/scharr/research/centres/cure/projects/cured-how-access-data].
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Figure 1: LOESS plots of the number of triaged calls and online contacts the four test NHS 111 area codes
blue - Triaged NHS 111 telephone; red - online NHS 111 contacts

453x340mm (87 x 87 DPI)
Figure 2: ITS plots for the four test sites. Solid line – ITS model; dashed line – null model (no intervention); solid dots – triaged NHS 111 telephone; hollow dots – online NHS 111 contacts.

175x131mm (220 x 220 DPI)
Figure 3: Forest plots showing the effect of introducing the NHS 111 online service on the number of triaged calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 71.5\%$ (95% CI: 54.1% to 82.3%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.

228x228mm (150 x 150 DPI)
Figure 4: Forest plots showing the effect of introducing the NHS 111 online service on the total number of calls to the NHS 111 telephone service. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: \( I^2 = 68.0\% \) (95% CI: 47.7% to 80.4%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Figure 5: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations for ambulance call outs. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 89.8\%$ (95% CI: 85.4% to 92.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.

228x228mm (150 x 150 DPI)
Figure 6: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to attend ED. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 94.4\%$ (95% CI: 92.4% to 95.8%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Figure 7: Forest plots showing the effect of introducing the NHS 111 online service on the number of recommendations to contact primary care. (A) Estimated effects for individual areas and the overall average effect from the primary analysis (Negative Binomial GLM). Heterogeneity: $I^2 = 84.3\%$ (95% CI: 76.4% to 89.5%). (B) Average effects from the primary analysis and sensitivity analyses. Estimates are incident rate ratios per 1,000 online contacts.
Appendix Figure 1: Model fit: Difference plot of four test sites

182x136mm (220 x 220 DPI)
Appendix Figure 2: ACF plots of the four test sites

179x134mm (220 x 220 DPI)
Appendix Figure 3: PACF plots of the four test sites

185x139mm (220 x 220 DPI)
## Appendix

### Table 1: NHS 111 Area code and CCG list

| Code             | CCG                                                                 |
|------------------|----------------------------------------------------------------------|
| **North East-111AA1** | NHS Darlington CCG                                                  |
|                  | NHS Durham Dales, Easington and Sedgefield CCG                     |
|                  | NHS Hartlepool and Stockton-on-Tees CCG                            |
|                  | NHS Newcastle Gateshead CCG                                         |
|                  | NHS North Durham CCG                                               |
|                  | NHS North Tyneside CCG                                             |
|                  | NHS Northumberland CCG                                             |
|                  | NHS South Tees CCG                                                 |
|                  | NHS South Tyneside CCG                                             |
|                  | NHS Sunderland CCG                                                 |
| **Lincolnshire-111AA2** | NHS Lincolnshire East CCG                                        |
|                  | NHS Lincolnshire West CCG                                          |
|                  | NHS South Lincolnshire CCG                                         |
|                  | NHS South West Lincolnshire CCG                                     |
| **Nottinghamshire-111AA4** | NHS Mansfield and Ashfield CCG                                    |
|                  | NHS Newark and Sherwood CCG                                        |
|                  | NHS Nottingham City CCG                                            |
|                  | NHS Nottingham North and East CCG                                   |
|                  | NHS Nottingham West CCG                                            |
|                  | NHS Rushcliffe CCG                                                  |
| **Derbyshire-111AA5** | NHS Derby and Derbyshire CCG                                       |
|                  | NHS Erewash CCG                                                    |
|                  | NHS Hardwick CCG                                                   |
|                  | NHS North Derbyshire CCG                                           |
|                  | NHS Southern Derbyshire CCG                                         |
| **Isle of Wight-111AA6** | NHS Isle of Wight CCG                                            |
| Area                                         | CCGs                                                                 |
|----------------------------------------------|----------------------------------------------------------------------|
| Inner North West London-111AA7               | NHS Central London (Westminster) CCG                                  |
|                                              | NHS Hammersmith and Fulham CCG                                       |
|                                              | NHS West London CCG                                                  |
| Hillingdon-111AA9                            | NHS Hillingdon CCG                                                   |
| Hertfordshire-111AB2                         | NHS East and North Hertfordshire CCG                                  |
|                                              | NHS Herts Valleys CCG                                               |
| Cambridgeshire and Peterborough-111AC5       | NHS Cambridgeshire and Peterborough CCG                              |
| Northamptonshire111AC6                       | NHS Corby CCG                                                        |
|                                              | NHS Nene CCG                                                         |
| Milton Keynes-111AC7                         | NHS Milton Keynes CCG                                                |
| Leicestershire and Rutland-111AC8            | NHS East Leicestershire and Rutland CCG                              |
|                                              | NHS Leicester City CCG                                              |
|                                              | NHS West Leicestershire CCG                                          |
| Outer North West London-111AD4               | NHS Brent CCG                                                        |
|                                              | NHS Ealing CCG                                                       |
|                                              | NHS Harrow CCG                                                       |
|                                              | NHS Hounslow CCG                                                     |
| North Central London-111AD5                  | NHS Barnet CCG                                                       |
|                                              | NHS Camden CCG                                                       |
|                                              | NHS Enfield CCG                                                      |
|                                              | NHS Haringey CCG                                                     |
|                                              | NHS Islington CCG                                                    |
| South East London-111AD7                     | NHS Bexley CCG                                                       |
|                                              | NHS Bromley CCG                                                      |
|                                              | NHS Greenwich CCG                                                    |
|                                              | NHS Lambeth CCG                                                      |
|                                              | NHS Lewisham CCG                                                     |
|                                              | NHS Southwark CCG                                                    |
|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| **Bristol, North Somerset & South Gloucestershire-111AE7** | NHS Bristol, North Somerset and South Gloucestershire CCG                              |
| **Cornwall-111AF1** | NHS Kernow CCG                                                                         |
| **Staffordshire-111AF4** | NHS Cannock Chase CCG                     |
|               | NHS East Staffordshire CCG                                                            |
|               | NHS North Staffordshire CCG                                                           |
|               | NHS South East Staffordshire and Seisdon Peninsula CCG                               |
|               | NHS Stafford and Surrounds CCG                                                        |
|               | NHS Stoke on Trent CCG                                                                |
