Risk of hospitalisation or death in households with a case of COVID-19 in England: an analysis using the HOSTED dataset

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Risk of hospitalisation or death in households with a case of COVID-19 in England: an analysis using the HOSTED dataset

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Conflict of interest statement

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Abstract

Objective

To determine whether household contacts of confirmed cases of COVID-19 have an increased risk of hospitalisation or death.

Methods

We used the HOSTED dataset of index cases of COVID-19 in England between June and November 2020, linked to Secondary Uses Service data on hospital episodes and Office for National Statistics' mortality data. Multivariable logistic regression models of the odds of household contacts being hospitalised or dying within six weeks of an index case, adjusted for case type, age, sex and calendar month were calculated. Excess risk was determined by comparing the first six weeks after the index case with 6-12 weeks after the index case in a survival analysis framework.

Results

Index cases were more likely to be hospitalised or die than either secondary cases or non-cases, having adjusted for age and sex. There was an increased risk of hospitalisation for non-cases (adjusted hazard ratio (aHR) 1.10 (95% CI 1.04, 1.16)) and of death (aHR 1.57 (95% CI 1.14, 2.16)) in the first six weeks after an index case, compared to 6-12 weeks after.

Conclusion

Risks of hospitalisation and mortality are predictably higher in cases compared to non-cases. The short-term increase in risks for non-case contacts following diagnosis of the index case may suggest incomplete case ascertainment among contacts, although this was relatively small.**Abstract word count**: 215

Introduction

The Household Transmission Evaluation Dataset (HOSTED) [1] provides a unique opportunity to explore the risk of hospitalisation and death in household contacts of confirmed cases of COVID-19 to determine if there is any excess risk to them, regardless of whether they are diagnosed with COVID-19 themselves. This is particularly important in the scenario of limited testing where cases may be missed, as was the case in England early in the pandemic.

Methods

The HOSTED methodology has been described elsewhere[1]; in brief, it is an ongoing surveillance system that has identified the residential household contacts of laboratory confirmed cases in England since 20th April 2020, including both Pillar 1 (testing of persons for a clinical need in healthcare or as part of a public health investigation) and Pillar 2 (community-based testing accessible to members of the public). Linkages with hospital episodes from Secondary Uses Service (SUS) data (a national administrative dataset based on healthcare providers' clinical activities) and ONS (Office for National Statistics) mortality data for all anonymised cases and contacts within HOSTED enable us to investigate whether there is any increase risk in hospitalisation or death for household contacts of confirmed cases of COVID-19.

There is very limited evidence on hospitalisation and deaths of household contacts of confirmed COVID-19 cases. Data from a cohort study in Scotland has shown that between 1st March and 6th June 2020 household contacts of cases of COVID-19 in the general public had a risk of admission with COVID-19 of 0.05%; it was higher for healthcare workers and their household contacts[2].

We considered individuals in households where the index case occurred between 1st June 2020 and 8th November 2020, extracted on the 31st January 2021, to allow for complete follow up of hospitalisations within six weeks of the index case, and a further six weeks buffer in case of reporting delays in the SUS data. Hospitalised individuals were grouped using ICD-10 codes in to "COVID" (U07 and derivatives), "pneumonia (B97 and J12) and possible interest", and "other" (all other ICD-10

codes). ICD-10 codes of 'possible interest' were co-morbidities thought to be risk factors for adverse outcomes of COVID-19 on discussion with clinicians. This predominantly included diseases of the cardiovascular, cerebrovascular, respiratory and renal systems, cancer, diseases that cause immunosuppression or require treatment with immuosuppressives, diabetes, and obesity. The pneumonia codes were selected in case of misdiagnosis of a COVID-19 case as another viral pneumonia. This grouping together captured people in whom a diagnosis of COVID-19 could have been missed. We had data on whether the person had died, but not their cause of death.

Statistical analysis

The proportion hospitalised or dying within 6 weeks of the index case testing positive (starting from the specimen date of the positive test) was modelled using logistic regression; covariates included case category (index case, secondary case, contact without positive test), age group (0-34, 35-54, 55-69 and 70+) and sex. Time trends were considered by including calendar month, and age-specific trends. In order to ascertain whether there was any excess risk of hospitalisation in non-cases, we examined hospitalisation rates in the first six weeks after the index case compared to 6-12 weeks in a survival analysis framework. Hazards were assumed constant within each time interval and estimated hazard ratios (HR) adjusted for age, sex and calendar time. Analysis was restricted to patients with 18 weeks observable follow-up.

Ethics approval

The HOSTED surveillance system was reviewed and approved by the PHE Research Ethics Governance Group. The data was collected and linked by NHS Digital. The data was processed lawfully under GDPR Article 6(1)e and 9(2)i and shared under Regulation 3(4) of the Health Service (Control of Patient Information) Regulations 2002.

Results

In England there were 1.68 million individuals living in a household in which a confirmed case occurred between 1st June and 8th November 2020. The median household size was 4 (interquartile range, IQR: 3-5); the median age of individuals in the dataset was 32 (IQR 19-50), with 326,606 children under age 16 (19.4%) and 63,994 age 70+ (3.8%). In 74.5% of the data for this time period, the index case occurred in October/November, when cases were increasing rapidly in England, but before the emergence of the Alpha variant.

Hospitalisation

49,516 individuals (2.95%) were hospitalised within 42 days of the index case date. 28,843/477,034 (6.05%) index cases were hospitalised and 4,685/92,243 (5.08%) secondary cases. In comparison, among household contacts without laboratory diagnosed COVID-19, 13,876 were hospitalised out of 1.05 million (1.32%).

In logistic regression of all persons in the dataset, index cases were most likely to be hospitalised (aOR 4.49 95%CI 4.40, 4.59) compared to non-cases, after adjusting for age and sex, as were secondary cases (aOR 3.54 95%CI 3.40, 3.65). Rates of hospitalisation increased with age, as did the risk associated with being a case compared to a contact, regardless of reason for admission. Of those aged over 70, 27.9% were admitted with COVID-19 within six weeks of laboratory confirmation and 4.14% were admitted with pneumonia or other potentially relevant ICD-10 code, compared to 1.26% and 0.35% respectively in index cases aged 0-34. Among household contacts who were not laboratory confirmed COVID-19 cases, 0.35% of over 70s were admitted with COVID-19, 3.18% with pneumonia or other relevant condition and 0.58% for other reasons, according to the SUS data. For every age group the percentages of non-COVID-19 admissions are higher in COVID-19 cases than those not diagnosed with COVID-19.

Hospitalisations due to any cause in index cases of COVID-19 fell in all age groups from June to October 2020, though the risks decreased most for those under 35. Hospitalisation in non-cases also fell slightly in every age group between June-October 2020, and younger age groups were consistently more likely to be hospitalised for reasons other than COVID-19/pneumonia.

Examining only the non-COVID-19 admissions, both index and secondary cases were more likely to be admitted to hospital in the six weeks following a positive test for SARS-CoV-2, particularly if they were over 70 years old, both for pneumonia/other relevant conditions or for another reason.

Mortality

6,414 individuals (0.38%) died within 42 days of the index case date. 5,230 of 477,034 index cases died (1.10%), 596 of 92,243 secondary cases died (0.65%), and 419 of 1.05 million non-cases died (0.04%).

Death was considerably more likely in index cases (aOR 22.9 95%CI 20.7, 25.3) and secondary cases (aOR 13.1 95%CI 11.5, 14.8) than in individuals not diagnosed with COVID-19, having adjusted for age and sex. In terms of trends, risk of death in index cases reduced over time with a similar pattern to hospitalisation, with the greatest reduction over time in the younger groups. Trends are more stable for secondary cases, although data are sparse and confidence intervals wide. For those not diagnosed, there are declining trends in the youngest and oldest age groups, similar to hospitalisations, but confidence intervals are wide and the results are not significant.

Excess risk

The adjusted hazard ratio (HR) for hospitalisation within six weeks vs. 6-12 weeks was 1.10 (95% CI 1.04, 1.16), indicating a modest increase in hospitalisation rates in non-cases around the time of the index case. For mortality, the adjusted HR was 1.57 (95% CI 1.14, 2.16) for the first six weeks after

the index case compared to 7-12 weeks after. As shown in Figure 1, this was driven by increased hospitalisation and deaths in the over 55s.

<<< FIGURE 1 HERE >>>>

Discussion

Index cases had the highest risk of hospitalisation and death followed by secondary cases compared to household contacts who did not become laboratory-confirmed cases (non-cases). The higher risk in index cases could be due to testing being biased towards more severe index cases, whereas case ascertainment may be less dependent on severity for secondary cases.

We found some evidence of a modest increase risk of hospitalisation in household contacts of laboratory confirmed cases of COVID-19 who did not become laboratory confirmed cases themselves. This suggests that, over the timeframe considered, case ascertainment has been good, if not complete. We found a higher risk of admission than the Scottish study which is likely because we included all hospitalisations, not only those for COVID-19(2).

Mortality may be increased by around 50% in non-cases immediately following the index case, although absolute mortality rates remain low and confidence intervals for any excess risk were relatively wide. This may indicate incomplete case ascertainment if a person died before being tested. Routine post-mortem testing for SARS-CoV-2 could reveal the true burden of the disease[3].

Strengths and Limitations

The HOSTED dataset is large, covering all laboratory confirmed cases and their household contacts in the England. However, as a passive surveillance system, the data are subject to a number of limitations, including incomplete case ascertainment and a lack of information on testing uptake which could introduce bias. Without genomics data we cannot confirm household transmission versus secondary cases having acquired their infection elsewhere. However, self-isolation of households following COVID-19 symptoms even prior to confirmation reduces the likelihood of

acquiring an infection outside of the household. Previous sensitivity analysis showed that secondary attack rates within the household were robust to changing the definition of a secondary case from 2-14days after the index case to 4-14 days after the index case.

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Conflict of interest statement

None declared

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Data Availability Statement

The data underlying this article cannot be shared publicly due to the legal and policy controls placed on data used as part of the government's response to the Covid19 pandemic.

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181 **Figure legend**

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183 **Figure 1**. Proportion of non-diagnosed contacts hospitalised (any cause) or dying per week since date

184 of index case positive, by age. Y-axis scales vary between panels.

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