# Hospitalised adults with pneumonia are frequently misclassified as another diagnosis

Nathan J Brendish1,2\*, Ahalya K Malachira3, Kate R Beard1, Lawrence Armstrong3, Patrick J Lillie3,4, Tristan W Clark1,3,5,6

1 Academic Unit of Clinical and Experimental Sciences, University of Southampton, Southampton, UK.

2 NIHR Southampton Clinical Research Facility, University Hospital Southampton NHS Foundation Trust, Southampton, UK.

3 Department of Infection, University Hospital Southampton NHS Foundation Trust, Southampton, UK

4 Infectious Diseases Department, Hull and East Yorkshire Hospitals NHS Trust, Hull, UK

5 NIHR Southampton Biomedical Research Centre, University Hospital Southampton NHS Foundation Trust, Southampton, UK.

6 NIHR Post-Doctoral Fellowship Programme.

\*Corresponding author:

Dr Nathan James Brendish, Clinical Research Fellow in Infectious Diseases

Address: NIHR Southampton Clinical Research Facility, University Hospital Southampton NHS Foundation Trust, Tremona Road, Southampton UK

Tel: (00 44) (0)2381204989 E-mail address: Nathan.Brendish@uhs.nhs.uk

## Abstract

Using data from a large randomised controlled trial of adults hospitalised with acute respiratory illness, we examined the reliability of pneumonia diagnosis on discharge documentation. 50 (28.2%) of 177 patients with a pneumonia diagnosis had no radiological evidence of pneumonia. 67 (34.9%) of 192 patients with clinico-radiological evidence of pneumonia did not have a diagnosis of pneumonia listed; ‘COPD exacerbation’ or ‘lower respiratory tract infection’ was often listed instead. These patients more frequently had a respiratory comorbidity and lower oxygen saturations, CRP and temperature at presentation. Pneumonia diagnoses misclassification on discharge documentation may have clinical, financial, and research data implications.

### Keywords

Pneumonia, Diagnosis

## Introduction

A recent study British Thoracic Society (BTS) study identified a cohort of hospitalised adult patients diagnosed and coded as having community-acquired pneumonia (CAP) who did not have radiological evidence of pneumonia, and these patients had differing clinical characteristics [[[1]](#endnote-1)]. However, the magnitude of this misattribution of diagnosis was not calculable and in addition, the counter entity (i.e. patients with clinico-radiological evidence of CAP who are not correctly recorded as having CAP), was not studied. We aimed to address both these evidence gaps using data from a large, pragmatic, randomised controlled trial of routine molecular point-of-care testing for respiratory viruses in adults presenting to hospital with acute respiratory illness (ResPOC) [[[2]](#endnote-2)].

## Methods

The ResPOC trial enrolled adults with acute respiratory illness presenting to the emergency department or acute medical unit of a large teaching hospital in the UK during winter months. Patients were ≥18 years old, had acute respiratory illness and/or fever of ≤7 days duration, and were enrolled within 24 hours of presentation to hospital. The trial was prospectively registered on a trials database (ISRCTN90211642); the protocol is publically available [[[3]](#endnote-3)].

We used the BTS definition of CAP in hospitalised adults: “symptoms and signs consistent with an acute lower respiratory tract infection associated with new radiographic shadowing for which there is no other explanation.”[[[4]](#endnote-4)]. The Infectious Diseases Society of America / American Thoracic Society consensus guidelines definition is, in essence, the same [[[5]](#endnote-5)]. Trial participants were classified as having CAP by their admission chest radiograph and/or first computed tomography (CT) scan where performed. In patients who had a CT scan, CT scan reports superseded chest radiograph reports. Subsequent chest radiographs or CT scans were not reviewed. All imaging was reported by radiologists not associated with the study. Discharge summary data was analysed from hospital electronic records. A discharge summary may have multiple diagnoses listed and a diagnoses list that included the word ‘pneumonia’ was considered as pneumonia for this study, excluding hospital-acquired pneumonia.

Statistical analyses were done with Prism version 7.03 (GraphPad Software, La Jolla, CA, USA). Groups were compared using differences in proportions for binary data (using Chi-square test or Fisher’s exact test as appropriate), and Mann-Whitney U tests for continuous data.

## Results

The ResPOC trial included 714 patients in the modified intention-to-treat analysis. 177 patients had a diagnosis of CAP listed on their discharge summary, of which 50 (28.2%) had no radiological evidence of pneumonia.

192 of 714 patients had clinico-radiological evidence of CAP. 67 (34.9%) of the 192 patients with pneumonia did not have diagnosis of pneumonia recorded on their discharge summary. Of these patients, 24 (35.8%) of 67 patients had ‘COPD exacerbation’ listed as a diagnosis and 20 (29.9%) of 67 had ‘lower respiratory tract infection’ or ‘LRTI’ listed. 14 (20.9%) of 67 patients with pneumonia had no acute respiratory diagnosis recorded (Table 1).

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| **Table 1:** Pneumonia diagnosis in the ResPOC trial (adults presenting to hospital with acute respiratory illness) |
|   | **n** | **total** | **percentage** |
| Patients with pneumonia listed on discharge summary | 177 | 714 | 24.8% |
| Patients with clinico-radiological evidence of pneumonia | 192 | 714 | 26.9% |
| Patients with pneumonia on discharge summary and clinico-radiological evidence | 125 | 714 | 17.5% |
|  |  |  |  |
| Patients with clinico-radiological evidence of pneumonia without pneumonia recorded on discharge summary | 67 | 192 | 34.9% |
|  |  |  |  |
| Pneumonia recorded on discharge summary but no radiological evidence of pneumonia | 50 | 177 | 28.2% |
|  |  |  |  |
| Patients with clinico-radiological evidence of pneumonia with pneumonia not recorded on discharge summary: |  |  |  |
|  with asthma exacerbation listed as a discharge diagnosis\* | 9 | 67 | 13.4% |
|  with COPD exacerbation listed as a discharge diagnosis\* | 24 | 67 | 35.8% |
|  with bronchiectasis exacerbation listed as a discharge diagnosis\* | 5 | 67 | 7.5% |
|  with lower respiratory tract infection or 'LRTI' listed as a discharge diagnosis\* | 20 | 67 | 29.9% |
|  with ILD listed as a discharge diagnosis\* | 1 | 67 | 1.5% |
|  with no respiratory diagnosis recorded | 14 | 67 | 20.9% |
| \*patients may have more than one respiratory diagnosis listed on their discharge summary. |
|  ILD, interstitial lung disease. |

Patients with pneumonia where pneumonia was not listed as a discharge diagnosis more frequently had an underlying respiratory comorbidity (64.2% vs 38.4%; p<0.001), and a lower median temperature (37.0 vs 37.5, p=0.032), a lower median CRP level (66 vs 109.5, p=0.017), and lower O2 saturations (94% vs 95%; p=0.032) at presentation, compared with patients correctly recorded as having pneumonia. (Patient characteristics are shown in Table 2).

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| **Table 2: Comparison of demographics and clinical characteristics of patients with clinico-radiological evidence of pneumonia, where pneumonia was not documented on the discharge summary, and where pneumonia was listed on the discharge summary** |
|   | **Pneumonia not on discharge summary (n=67)** | **Pneumonia on discharge summary (n=125)** | **Difference (95% CI)** | **p value** |
| Age, years | 68 (53-76.5) | 65 (44-77) | 3 (-4 to 8) | 0.553 |
| Female | 42 (62.7%) | 62 (49.6%) | 13.1% (-1.7 to 26.8) | 0.096 |
| Current Smoker | 18 (26.9%) | 26 (20.8%) | 6.1% (-6.0 to 19.3) | 0.370 |
| Received influenza vaccine\* | 42 (62.7%) | 74 (59.2%) | 3.5% (-11.0 to 17.2) | 0.757 |
| *Ethnicity* |  |  |  |  |
| White British | 64 (95.5%) | 119 (95.2%) | 0.3% (-8.0 to 6.4) | 1.0 |
| *Comorbidities* |  |  |  |  |
| Pregnant | 1 (1.5%) | 2 (1.6%) | -0.1% (-4.3 to 6.5) | 1.0 |
| Cardiovascular disease | 32 (47.8%) | 51 (40.8%) | 7.0% (-7.5 to 21.3) | 0.364 |
| Respiratory disease | 43 (64.2%) | 48 (38.4%) | 25.8% (11.0 to 39.0) | **<0.001** |
| Renal disease | 5 (7.5%) | 9 (7.2%) | 0.3% (-7.0 to 9.7) | 1.0 |
| Liver disease | 0 | 1 (0.8%) | -0.8% (-4.4 to 4.7) | 1.0 |
| Diabetes Mellitus | 11 (16.4%) | 18 (14.4%) | 2.0% (-8.8 to 13.8) | 0.833 |
| Cancer | 6 (9.0%) | 10 (8.0%) | 1.0% (-6.8 to 10.9) | 0.791 |
| Immunocompromised | 3 (4.5%) | 4 (3.2%) | 1.3% (-5.0 to 9.4) | 0.697 |
| *Clinical features on admission* |  |  |  |
| Duration of symptoms, days | 4 (3-5) | 3 (3-5.25) | 1 (0 to 1) | 0.658 |
| Pulse rate, beats/min | 100 (90-120) | 100 (85-110) | 0 (-5 to 8) | 0.600 |
| Respiratory rate, breaths/min | 24 (20-28) | 22 (18.5-28.5) | 2 (-2 to 2) | 0.532 |
| Oxygen saturations, % | 94 (91.5-96) | 95 (93-97) | -1 (-2 to 0) | **0.032** |
| Use of supplementary oxygen | 19 (28.4%) | 44 (35.2%) | -6.8% (-19.6 to 7.3) | 0.420 |
| Temperature, °C | 37.0 (36.4-37.8) | 37.5 (36.6-38.3) | -0.5 (-0.7 to 0) | **0.032** |
| C-Reactive Protein, mg/L | 66 (25.8-156.5) | 109.5 (56.5-205.5) | -43.5 (-59 to 5) | **0.017** |
| *CURB65 score*† |  |  |  |  |
| 0 | 28 (41.8%) | 64 (51.2%) | -9.4% (-23.4 to 5.3) | 0.229 |
| 1 | 32 (47.8%) | 39 (31.2%) | 16.6% (2.2 to 30.5) | **0.028** |
| 2 | 7 (10.4%) | 18 (14.4%) | -4.0% (-12.9 to 6.9) | 0.506 |
| 3 | 0 | 4 (3.2%) | -3.2% (-7.9 to 2.6) | 0.300 |
| 4 | 0 | 0 | 0.0% | 1.0 |
| Median CURB65 | 1 | 0 | 1 (0 to 0) | 0.628 |
| *Adverse events* |  |  |  |  |
| ICU admission | 4 (6.0%) | 9 (7.2%) | -1.2% (-8.2 to 7.8) | 1.0 |
| RHDU admission | 2 (3.0%) | 4 (3.2%) | -0.2% (-5.4 to 7.3) | 1.0 |
| 30-day mortality | 4 (6.0%) | 8 (6.4%) | -0.4% (-7.2 to 8.5) | 1.0 |
| Readmitted‡ | 4 (6.0%) | 9 (7.2%) | -1.2% (-8.2 to 7.8) | 1.0 |
| Represented (but not admitted)‡ | 13 (19.4%) | 14 (11.2%) | 8.2% (-2.0 to 20.1) | 0.132 |
| *Grade of doctor signing discharge summary*‖ |  |  |  |
| Consultant | 2 (3.0%) | 3 (2.4%) | 0.6% (-4.3 to 8.0) | 1.0 |
| Registrar | 1 (1.5%) | 5 (4.0%) | -2.5% (-7.7 to 4.4) | 0.667 |
| FY2 or SHO | 28 (41.8%) | 59 (47.2%) | -5.4% (-19.5 to 9.3) | 0.544 |
| FY1 | 29 (43.3%) | 54 (43.2%) | 0.1% (-14.1 to 14.6) | 1.0 |
|  |   |   |

Data are n (%), or median (IQR), or stated otherwise.

\*Received vaccine for current influenza season.

†For CURB65 scores 0 to 3 combined p=0.082.

‡Within 30 days.

‖For overall Grade of doctor signing discharge summary p=0.388.

RHDU, respiratory high dependency unit; ICU, intensive care unit.

FY1, Foundation Year 1 doctor; FY2 Foundation Year 2 doctor;

SHO, Senior House Officer (includes Core/Specialty Trainee Year 1 and Year 2 doctors).

Figures in **bold** are those with p<0.05.

## Discussion

We identified that around a third of patients diagnosed as having community-acquired pneumonia did not in fact have radiological evidence of pneumonia. This adds to previous research by providing an estimate of the prevalence of this misdiagnosis [1].

We also found that around a third of patients with clinico-radiological evidence of CAP did not have pneumonia recorded as a diagnosis on their discharge summary. These patients were frequently recorded as having a ‘COPD exacerbation’ or ‘lower respiratory tract infection’ and around a fifth of patients had no respiratory diagnosis on their discharge summary. These patients more frequently had underlying respiratory disease which may have complicated the clinical picture and led to an error in diagnosis. Similarly, having a lower CRP or temperature may have falsely suggested to clinicians that these patients did not have pneumonia.

Patients who had pneumonia that was not recorded as a diagnosis at discharge had different clinical characteristics. Therefore it is possible that they may have different clinical outcomes. It is common practice to follow up patients with pneumonia as unresolved symptoms or persistent radiological changes may indicate malignancy [[[6]](#endnote-6)], and a previous study has suggested a higher prevalence of malignancies in similar incorrectly coded patients [[[7]](#endnote-7)]. As the majority of hospitalised patients treated for COPD exacerbations and other acute respiratory illnesses receive antibiotics, most patients with undiagnosed pneumonia are still likely to have received appropriate antimicrobial treatment [2,[[8]](#endnote-8)].

This study highlights the limitations of electronic medical records due to incorrect data input by clinicians. Poor quality pneumonia data may contribute to invalid conclusions in disease prevalence research and vaccine effectiveness studies, an area already burdened by imprecise data [[[9]](#endnote-9)]. Where hospital diagnosis coding data is misleading, hospitals may receive incorrect reimbursements for patient hospitalisations in both nationalised healthcare and insurance-based systems.

Limitations of this study include that it is a single-centre study and that patients lacking capacity to consent through cognitive impairment or severe illness were excluded. However, as the study had broad inclusion criteria and set in a typical large teaching hospital in the UK, the findings are likely to be applicable to patients in similar hospitals nationally and internationally. Recent studies have demonstrated that chest radiographs are imperfect in the diagnosis or exclusion of pneumonia in adults hospitalised with acute respiratory illness and methods of improving pneumonia diagnoses including routine CT scans and biomarkers have been considered [[[10]](#endnote-10), [[11]](#endnote-11)]. However, chest radiography is the imaging modality currently recommended by guidelines internationally to define pneumonia in hospitalised patients [4,5].

A larger study is required to corroborate these findings and assess if misdiagnosis has an impact on clinical outcomes. Interventions to highlight senior physicians’ opinions or radiologists’ reports on chest imaging to junior physicians who typically write discharge summaries may improve the reliability of the recorded diagnoses.

In conclusion, we found that around a third of patients with clinico-radiological evidence of community-acquired pneumonia did not have pneumonia recorded on their discharge summary. We also found that around a third of patients classified as having pneumonia on their discharge summary had no radiological evidence of pneumonia. Patients with a diagnosis of pneumonia missed from their discharge summary had different clinical characteristics compared with patients with a correct pneumonia diagnosis. The misclassification of pneumonia diagnosis on discharge documentation may have clinical, financial and research implications. Interventions are needed to improve the reliability of hospital discharge data.

## Footnotes

### Acknowledgements

We thank all the patients and staff at University Hospital Southampton NHS Foundation Trust involved. The ResPOC trial was supported by NIHR Southampton Biomedical Research Centre, the NIHR Southampton Clinical Research Facility, the NIHR Clinical Research Network, Wessex, and the NIHR Post Doctoral Fellowship Programme (to which TWC is affiliated). This report is independent research supported by the National Institute for Health Research. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the National Institute for Health Research, or the Department of Health.

### Contributors

Study design and concept: NJB and TWC. Data collection: NJB, AKM, LA, PJL, TWC. Analysis: NJB, AKM, KB and TWC. Data interpretation and drafting of the manuscript: NJB, AKM, KB and TWC. All authors critically read, contributed to, and approved the final version of the manuscript.

### Funding

University of Southampton.

### Declarations of interest

None.

### Ethics approval

The ResPOC trial was approved by the North West - Preston Regional Ethics Committee (NW/14/1467).

### Data presented

NJB presented some of this data at the 28th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID) in Madrid in April 2018 (mini-oral session O1039).

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