Received: 29 April 2022 | First decision: 19 May 2022 | Accepted: 3 November 2022

DOI: 10.1111/apt.17307

AP&T Alimentary Pharmacology & Therapeutics WILEY

The Liverpool alcohol-related liver disease algorithm identifies twice as many emergency admissions compared to standard methods when applied to Hospital Episode Statistics for England

Ashwin Dhanda[1,2] | Keith Bodger[3,4] | Steve Hood[4] | Clive Henn[5] | Michael Allison[6] | Chioma Amasiatu[5] | Robyn Burton[5] | Matthew Cramp[1,2] | Ewan Forrest[7] | Meetal Khetani[5] | Alastair MacGilchrist[8] | Steven Masson[9] | Richard Parker[10] | Nick Sheron[5] | Ken Simpson[8] | Nikhil Vergis[11,12] | Martin White[5] | BASL ARLD SIG National Service Evaluation Group

[1]University of Plymouth, Plymouth, UK

[2]South West Liver Unit, University Hospitals Plymouth NHS Trust, Plymouth, UK

[3]University of Liverpool, Liverpool, UK

[4]Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK

[5]Addiction and Inclusion Directorate, Office for Health Improvement and Disparities, Department for Health and Social Care, London, UK

[6]Cambridge Liver Unit, Cambridge NIHR Biomedical Research Centre, Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK

[7]Glasgow Royal Infirmary, Glasgow, UK

[8]Liver Unit, Royal Infirmary of Edinburgh, NHS Lothian, Edinburgh, UK

[9]Liver Unit, Newcastle Hospitals NHS Trust, Newcastle, UK

[10]Leeds Liver Unit, Leeds Teaching Hospitals NHS Trust, Leeds, UK

[11]Imperial College London, London, UK

[12]Research and Development, GlaxoSmithKline (GSK), Hertfordshire, UK

Summary

Background: Emergency admissions in England for alcohol-related liver disease (ArLD) have increased steadily for decades. Statistics based on administrative data typically focus on the ArLD-specific code as the primary diagnosis and are therefore at risk of excluding ArLD admissions defined by other coding combinations.

Aim: To deploy the Liverpool ArLD Algorithm (LAA), which accounts for alternative coding patterns (*e.g.*, ArLD secondary diagnosis with alcohol/liver-related primary diagnosis), to national and local datasets in the context of studying trends in ArLD admissions before and during the COVID-19 pandemic.

Methods: We applied the standard approach and LAA to Hospital Episode Statistics for England (2013–21). The algorithm was also deployed at 28 hospitals to discharge coding for emergency admissions during a common 7-day period in 2019 and 2020, in which eligible patient records were reviewed manually to verify the diagnosis and extract data.

Results: Nationally, LAA identified approximately 100% more monthly emergency admissions from 2013 to 2021 than the standard method. The annual number of ArLD-specific admissions increased by 30.4%. Of 39,667 admissions in 2020/21, only 19,949 were identified with standard approach, an estimated admission cost of £70 million in under-recorded cases. Within 28 local hospital datasets, 233 admissions were identified using the standard approach and a further 250 locally verified cases

Ashwin Dhanda and Keith Bodger are joint first author.

Complete author list of "BASL ARLD SIG National Service Evaluation Group" is presented in Appendix section.

The Handling Editor for this article was Dr Rohit Loomba, and it was accepted for publication after full peer-review.

Correspondence
Ashwin Dhanda, John Bull Building, 16 Research Way, Plymouth PL6 8BU, UK.
Email: ashwin.dhanda@plymouth.ac.uk

using the LAA (107% uplift). There was an 18% absolute increase in ArLD admissions in the seven-day evaluation period in 2020 versus 2019. There were no differences in disease severity or mortality, or in the proportion of admissions with decompensation of cirrhosis or alcoholic hepatitis.

Conclusions: The LAA can be applied successfully to local and national datasets. It consistently identifies approximately 100% more cases than the standard coding approach. The algorithm has revealed the true extent of ArLD admissions. The pandemic has compounded a long-term rise in ArLD admissions and mortality.

1 | BACKGROUND

The number of unplanned hospital admissions wholly or partly attributable to alcohol in England has risen by 19% over a decade, reaching 358,000 by 2018/19.[1] In parallel, the number of admissions for alcohol-related liver disease (ArLD) and alcohol-specific mortality has increased. Worryingly, the coronavirus pandemic year of 2020/21 saw the greatest single-year increase in alcohol-specific deaths with a 20% jump compared to 2019/20, and a 21% increase for ArLD deaths.[2] This may be related to changes in drinking behaviour—alcohol sales data show that the heaviest buying quintile in the 2 years prior to the pandemic increased their alcohol purchases by 14% accounting for 42% of the total increase.[2] These sales data support reports that the highest-risk alcohol drinkers have increased their consumption by between 5% and 13% during the pandemic compared to previous years.[3,4]

Admissions for ArLD increased by 3.2% during 2020/21 compared to the preceding year,[2] which was in the context of much lower overall unplanned hospital admissions. However, these data are derived from counting admissions where the primary diagnosis recorded in Hospital Episode Statistics was one of six specific International Classification of Diseases (ICD-10) codes for ArLD (Table 1). Although this method is the standard approach for identifying ArLD admissions and is highly specific, recent evidence suggests sensitivity may be as low as 62%.[5] The use of algorithms that seek relevant codes in either primary or non-primary positions has been suggested to improve sensitivity for finding true cases of cirrhosis[5] and alcoholic hepatitis[6] in administrative data.

In clinical practice, the coding patterns for ArLD admissions are complex. Patients can be coded with a symptom, sign or complication of liver disease as their primary diagnosis with one of the six ArLD-specific codes as a secondary diagnosis. Furthermore, alcohol may not be specified as the cause of liver disease but can be inferred from the presence of other alcohol-specific codes. The Liverpool ArLD Algorithm[7] (LAA) accounts for this diversity of coding patterns using combinations of primary and secondary diagnoses compatible with ArLD. The application of this method to a regional administrative dataset in the North West of England uplifted the apparent case volume by 94.2%.

In this study, we aimed to apply the algorithm to the national HES dataset to evaluate its implications for the reporting of national statistics on volume of emergency admissions for ArLD compared with the current 'primary' method. Given the reported changes in drinking behaviour and dependence in high-risk drinkers during the pandemic,[2] we wanted to determine whether the use of the algorithm provided different insights into temporal trends in the burden of acute care for ArLD. We also deployed the algorithm locally to support case finding as part of a multi-centre service evaluation examining changes in case load, patient characteristics and outcomes for ArLD before and during the pandemic.

TABLE 1 A summary of diagnostic coding used in the LAA to identify ArLD admissions

The list of ICD-10 codes must conform to one of four patterns:

1. ArLD-specific code recorded as primary diagnosis (ArLD-primary)
2. ArLD-specific code recorded as secondary diagnosis
   All higher order diagnoses must be either:
   A) Symptom, sign or complication (jaundice, varices, acute kidney injury, encephalopathy and other relevant diagnoses suggesting admission for ARLD complications), or
   B) Other alcohol-specific diagnosis (codes for other alcohol-specific disorders such as alcohol intoxication, withdrawal, and organ-specific disorders, e.g. alcoholic gastritis)
3. Nonspecific liver disease recorded as a primary diagnosis (codes for liver disease without specific aetiology, e.g. cirrhosis unspecified)
   All lower order diagnoses must be either:
   A) Symptom, sign or complication, or
   B) Other alcohol-specific diagnosis (at least one must be recorded)
4. Nonspecific liver disease recorded as a secondary diagnosis
   All higher order diagnoses must be either:
   A) Symptom, sign or complication, or
   B) Other alcohol-specific diagnosis (at least one must be recorded)

2 | METHODS

2.1 | Approvals

Ethical approval was not required for analysis of the HES dataset. A national service evaluation was centrally registered with and approved by the Clinical Audit Department at University Hospitals Plymouth NHS Trust. Each participating centre registered the evaluation with their Trust as a service evaluation according to local requirements. Local or NHS ethical approval was not required for this service evaluation.

2.2 | The Liverpool ArLD Algorithm (LAA)

Full methods of the algorithm have been published elsewhere.[7] In brief, ICD-10 codes must conform to one of four patterns (Table 1 and Table S4): (1) ArLD-specific codes as a primary diagnosis (standard approach); (2) ArLD-specific code as a secondary diagnosis with all higher order diagnoses either a symptom, sign or complication of liver disease or another alcohol-specific diagnosis; (3) nonspecific liver disease recorded as a primary diagnosis with all lower order diagnoses either a symptom, sign or complication of liver disease or an alcohol-specific diagnosis; (4) nonspecific liver disease recorded as a secondary diagnosis with all higher order diagnoses either a symptom, sign or complication of liver disease or alcohol-specific diagnosis. Each care episode contains up to 23 diagnostic codes assigned by clinical coders after discharge using the International Classification of Disease 10th Revision.

2.3 | Application of LAA to HES

In collaboration with the Office for Health Improvement and Disparities (formerly Public Health England [PHE]), the LAA was applied to England's HES dataset.

In our analysis, admissions with any of the six specific codes for ArLD recorded as primary diagnosis were identified as ARLD-primary admissions. This reflects the standard approach to recording ArLD admissions. Next, admissions were extracted where codes were not in the primary position and derived from the rules given in 2, 3 and 4 of Table 1, which are referred to as ArLD-uplift admissions. ArLD-primary and ArLD-uplift admissions were then added together to understand the magnitude of undetected ArLD admissions in the standard approach. The algorithm was applied to monthly HES data to extract the number of completed unplanned ArLD-primary and ArLD-uplift admissions and compared these.

2.4 | Application of LAA to local datasets

A national service evaluation of ArLD hospital admissions in the UK was conducted, led by the ArLD Special Interest Group of the British Association for the Study of the Liver (BASL). All sites applied a standardised protocol to identify patients with ArLD as described below.

Patients with a completed unplanned hospital episode in the two periods from 17 to 23 Aug 2019 and from 17 to 23 Aug 2020 inclusive were identified by application of the Liverpool ArLD Algorithm to hospital datasets. Two 7-day periods were chosen to reduce administrative burden on clinicians extracting data. The week in August 2020 was selected as this was shortly after the end of most lockdown restrictions in England and coincided with anecdotes of higher number of ArLD admissions from clinicians.

Diagnosis codes of all completed unplanned hospital admissions during the evaluation periods were obtained from hospital coding departments and were populated in a coded Microsoft Excel spreadsheet, which identified eligible cases. These cases were manually reviewed by a member of the clinical team at each site and were eligible for the service evaluation if they met the following criteria: (1) age greater than 18; (2) diagnosis of liver disease including steatosis by clinical, radiological, histological or non-invasive parameters; (3) history of active or previous harmful alcohol use and (4) completed unplanned hospital episode during service evaluation period.

Data were collected into a pre-populated Excel spreadsheet on the following: (1) severity of disease on admission (Model for End-stage Liver Disease [MELD] and Child Pugh scores); (2) primary and secondary diagnoses; (3) complications of cirrhosis (variceal bleed, hepatic encephalopathy, ascites, spontaneous bacterial peritonitis, hepatorenal syndrome, alcoholic hepatitis as defined in a consensus paper[8]); (4) age and sex; (5) active alcohol use within 4 weeks prior to the admission; (6) quantity of alcohol consumed (units/week); (7) type of alcohol consumed; (8) referral and admission to critical care units and (9) in-hospital mortality.

Data from hospitals in England were also analysed separately to permit comparison to HES data, which are specific to England only.

Anonymised data were analysed using IBM SPSS version 25. Continuous data were compared using the unpaired t-test and categorical data with Fisher's exact test.

2.5 | Role of the funding source

This study did not receive any funding. BASL and the Department of Health and Social Care did not have any role in the study design, data collection, analysis and interpretation, in the writing of the report and in the decision to submit the paper for publication.

3 | RESULTS

3.1 | Quality assurance of the application of the LAA to HES

To ensure the correct application of the algorithm, we compared the percentage uplift in the number of hospital admissions and their age and gender distribution using the national data for the seven acute hospital admissions listed in the original population to that published regional dataset.[7] The uplift consisted of 49.2% of all cases identified compared to 48.5% in the regional dataset. The mean age was similar between the national and regional datasets (54.1 vs. 53.4 years), and there was a similar proportion of males (66.0% vs. 63.0%). These data provide confidence that the regional algorithm was applied correctly to the national HES dataset.

The algorithm was quality assured by two independent analysts by comparison to previously published admission data from seven acute NHS hospitals in the North West of England.[7] The LAA was applied to HES data between the financial years 2014/15 to 2017/18 for adults aged 18 and above who were residents in England or who

were recorded as having their residence as 'unknown' or no fixed abode. Additionally, the algorithm was applied only to emergency admissions, finished episode and the last episode of a spell (final consultant episode of hospital admission).

3.2 | Demographic and socioeconomic profile of primary and uplift admissions

The age profile of the primary and uplift populations was highly comparable and remained consistent over time, with a mean age of between 51 and 53 years for both groups in every year of the national time series. The same can be said for the distribution of admissions by deprivation quintile. The yearly proportion of total admissions from the most deprived areas (quintile 5) ranged from 33% to 37% overall, with a corresponding range of 33%–38% for the primary group and 33%–38% for the uplift group (Figure S1). These data support the assertion that the primary and uplift admissions are drawn from the same demographic of people presenting with ARLD.

3.3 | Clinical profile of ArLD-uplift admissions

There were 138,783 ArLD-uplift admissions, whereby the primary code was either (1) a symptom, sign or complication of liver disease (76,508, 55.1%), (2) another alcohol-specific condition (48,908, 35.2%) or (3) a non-specific liver disease (13,367, 9.7%). The frequency of the top 20 diagnostic codes is provided in Table S1. The first and largest subgroup included codes for gastrointestinal bleeding, varices or portal hypertension (26,399, 19% of uplift admissions); ascites, oedema or abdominal swelling (13,597, 9.8%); abdominal pain (6,137, 4.4%); sepsis (5,946, 4.3%); electrolyte disturbances (5,663, 4.1%); acute kidney injury (5,348, 3.9%); encephalopathy, confusional states or altered consciousness (2,983, 2.1%); liver cell cancer (2,186, 1.6%); hypotension or volume depletion (1,817, 1.3%); jaundice, hepatomegaly or abnormal liver tests (847, 1%); and haematological or coagulation abnormalities (692, 0.5%). These are all well-recognised acute presentations of ArLD.

The second subgroup included mainly admissions with a primary code for alcohol intoxication or a withdrawal state (38,468 admissions; 28.4%), with lesser contributions from other alcohol-specific conditions (e.g., alcoholic gastritis, 3036, 2.2%). As with the first subgroup, specific codes for ArLD were recorded as secondary diagnoses. The third and smallest group comprised admissions with an unspecified code for liver disease, mostly liver failure (8862, 6.4%) or cirrhosis (1823, 1.3%) recorded as the primary diagnosis but where the coding sequence also contained at least one alcohol-specific condition—highly suggestive of an alcoholic aetiology.

Within this national dataset, we cannot validate whether ArLD was the true reason for admission but the profile of primary diagnostic codes reflects the well-recognised diversity of acute presentations of patients with ArLD (Table S1). These data provide strong face-validity for the algorithm's ability to capture relevant emergency admissions that would otherwise be missed.

3.4 | The LAA identifies twice the number of emergency admissions per annum

Applying the LAA increased the estimate of the number of completed unplanned hospital admissions by between 99.4% and 107.1% per annum between 2013/14 and 2020/21 (Figure 1). The annual total number of emergency admissions in England increased by 30.8% from 30,320 to 39,667 between 2013/14 and 2020/21. The pandemic year of 2020/21 saw the greatest annual increase in ArLD admissions of 8.4%. From 2013/14 to 2020/21, the number of ARLD-primary admissions increased by 37.4% from 14,523 to 19,949, while

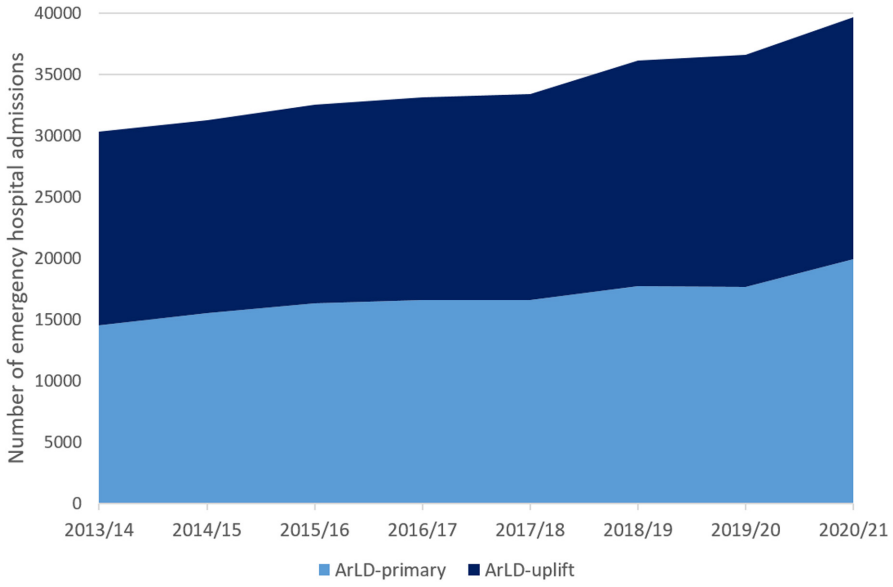

FIGURE 1 The annual number of ArLD-primary and ArLD-uplift completed unplanned hospital admissions in England, 2013/14 to 2020/21.

ARLD-uplift admissions increased by 24.8% from 15,797 to 19,718. The total number of admissions per 100,000 population increased from 73.9 (95% Confidence Interval 73.1–74.7) in 2013–14 to 92.1 (91.3–93.1) in 2020–21 (Figure S2).

The NHS publishes reference costs of providing services to NHS patients in England, which are used to set prices for NHS-funded services in England.[9] Assuming costs for 2019–20 and that all ArLD admissions required a minimum single intervention (and using the cost of these single intervention admissions), in 2020, the under-recording of ARLD admissions equates to an estimated hospital admission cost of £70,456,752, although this could be as much as £127,412,984 if all admissions required multiple interventions.[9]

3.5 | Completed unplanned hospital admissions during the pandemic

The PHE report on alcohol harm during the pandemic found an increase in ArLD admissions of 3.2% in 2020/21 compared to the previous year.[2] However, the algorithm finds an increase of 8.4% in ArLD admissions, which is in contrast to a reduction of 25.6% in all completed hospital admissions over the same period.[10] The LAA increased the number of identified admissions by 99% in 2020/21.

Monthly ArLD admissions fell dramatically during the initial lockdown on 23 March 2020 by 30% from 3206 in January to 2235 in April 2020 and then rose to a peak in July 2020 of 3767, the highest monthly number ever recorded in HES data (Figure 2). Subsequent monthly admissions gradually fell to levels similar to before the pandemic but have again risen from the start of 2021. In contrast to the rapid increase in monthly ArLD admissions after UK's first lockdown, it should be noted that total completed unplanned hospital admissions decreased during the first UK lockdown and had not recovered to baseline levels by March 2021 (Figure 2).[10]

Number of in-hospital deaths of patients with ArLD identified by the algorithm were obtained from HES dataset analysis. The trend of monthly deaths closely followed the monthly trend in ArLD unplanned admissions with a sharp reduction during early lockdown with a quick recovery to higher than baseline levels (Figure 3). Before the first UK lockdown from August 2019 to February 2020, there was a mean of 304 deaths per month compared with a mean of 356 after the lockdown from July 2020 to March 2021, a significant increase of 17% ($p < 0.01$; Figure 3). The proportion of in-hospital deaths remained similar pre-, during and post-lockdown at 9.9%, 10.2% and 10.5% ($p = 0.56$) respectively.

3.6 | Application of the LAA to local datasets

3.6.1 | Numbers of completed unplanned ArLD admissions

Data were obtained from 26 acute hospitals in England and two in Scotland. Of these, 12 were tertiary centres, nine district general

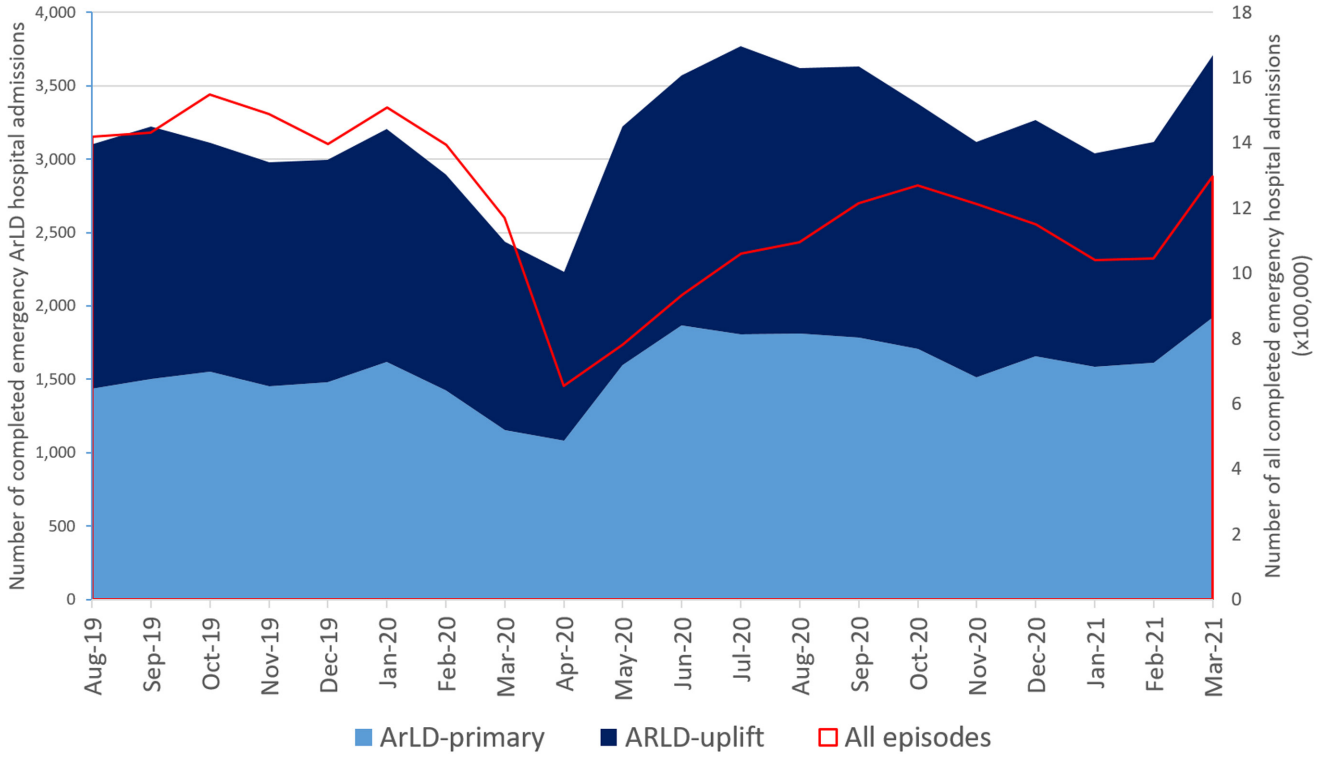

FIGURE 2 Number of total completed hospital admissions in England (red line; data from NHS Digital[11]) and ArLD-primary and -uplift admissions (light and dark blue lines) per month determined by applying the Liverpool ArLD Algorithm to the HES dataset from August 2019 to March 2021.

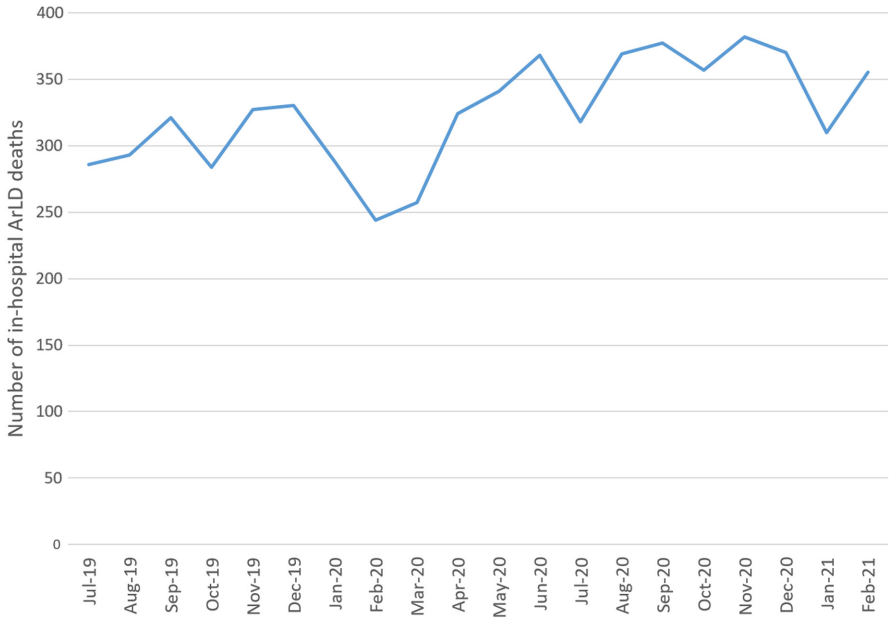

FIGURE 3 Monthly trend of in-hospital deaths of patients with ArLD from August 2019 to March 2021 using the Liverpool ArLD Algorithm applied to HES dataset.

hospitals and seven transplant centres. During the evaluation period in 2019 in all participating sites, there were 223 unplanned admissions for patients with ArLD compared to 263 in 2020, an absolute increase of 18%.

On application of the LAA, 104 (46.6%) and 129 (49.0%) admissions were identified using ArLD-primary codes in 2019 and 2020 respectively. The remainder were identified using ArLD-uplift coding giving an uplift of 114% and 104% in 2019 and 2020, respectively, and 107% in total.

Median number of admissions per site was similar in 2019 and 2020 (6 [range 1–29] and 6 [2–35] respectively; $p = 0.25$). When the two sites in Scotland were excluded, there were 191 admissions in 2019 compared to 230 in 2020, a 20% increase, while in Scotland there were 32 in 2019 and 33 in 2020, a 3% increase.

3.6.2 | Diagnoses

The commonest presentation was decompensation of ArLD. Primary diagnoses were similar between 2019 and 2020 (Table S1). When English and Scottish sites were considered separately, there was no statistical difference between any primary diagnosis.

3.6.3 | Clinical outcomes

Comparing 2019 and 2020, there were no differences in age (56 vs. 54; $p = 0.12$), gender (both 37% female) or death during admission (9.0% vs. 7.2%; $p = 0.51$). There were also no differences between patients with variceal bleeding, hepatic encephalopathy, ascites, spontaneous bacterial peritonitis, hepatorenal syndrome, alcoholic hepatitis, any decompensation or referral and admissions to critical care units (Table S2). When only cases with a primary alcohol-related diagnosis were considered, there were no statistical differences in any severity score or clinical outcome comparing 2019 and 2020. Neither were there statistical differences in rates of complications or in-hospital mortality when sites in England and Scotland were considered separately.

3.6.4 | Disease severity

Patients in this evaluation had advanced liver disease with a mean Child Pugh Score of 8 (standard deviation [SD] 2.4) and MELD of 14 (SD 7.1). Comparing 2019 and 2020, there was no difference in severity of liver disease measured by Child Pugh Score (8.3 vs. 8.3 $p = 0.93$) or MELD (14.1 vs. 13.9; $p = 0.16$).

In patients with a diagnosis of alcoholic hepatitis, the mean Child Pugh score was 10 (SD 2.3), MELD 20 (SD 7.5) and the discriminant function was 90.4 (SD 69.6). These patients consumed a mean of 148 units of alcohol per week immediately prior to hospital admission.

3.6.5 | Alcohol consumption

There was an increase in the number of patients who were actively drinking within four weeks of presentation from 151 to 196 ($p = 0.09$). Among the active drinkers, there were no statistical differences in any clinical outcomes. However, the mean amount of alcohol consumed per active drinker was significantly lower in 2019 than 2020 (127 (SD 96) vs. 154 (SD 119) units per week; $p = 0.02$; Figure S3).

In active alcohol consumers, the most common type of alcohol consumed was spirits (38%) followed by beer, cider and wine. There were no significant differences in types of alcohol between 2019 and 2020, but there was a trend to more spirit consumption (Figure S4).

4 | DISCUSSION

This study has demonstrated the successful application of an ArLD coding algorithm to national and local datasets to improve the accuracy of identification of unplanned hospital admissions of patients with ArLD. After careful quality assurance, we show that the Liverpool ArLD Algorithm consistently identified approximately twice the number of admissions compared to the standard approach when applied to HES data from 2013 to 2021 as well as to local hospital datasets. Due to under-recording of ArLD cases, the additional annual cost to the NHS of hospital admissions is estimated at £70 million.

The LAA demonstrated a sustained increase in numbers of ArLD admissions and in-hospital deaths during the pandemic after the initial lockdown period from July 2020 onwards. This is consistent with other reports[2] and clinician experience and reveals the true extent of ArLD admissions. In 2020/21, there were 19,718 ArLD-primary admissions compared to 39,667 identified by the algorithm, an uplift of 101%.

By pairing the national findings of increased ArLD admissions with detailed information at a local level, we have documented the effect of the pandemic on ArLD patient characteristics. Although there were no differences in clinical presentations, diagnoses or complications of patients with ARLD in the two evaluation periods, there was an overall 18% increase in admissions from 2019 to 2020. This group of patients is of working age (mean age 54) and has advanced liver disease with a mean Child Pugh score 8 and MELD 14. More than half of these patients present with alcoholic hepatitis or complications of cirrhosis such as ascites. Admissions in the two centres in Scotland remained flat compared to a 20% increase in English hospitals.

Worryingly, the pandemic year of 2020/21 has seen the greatest single-year increase in alcohol-specific deaths with a 20% jump compared to 2019/20, and a 21% increase in ArLD deaths.[2] One-third of these were from the most deprived communities in England and 80% were due to ArLD.[2] Both ArLD hospital admissions and mortality has been steadily increasing over the last two decades[12]; the effect of the pandemic has compounded a growing problem and widened inequalities. Our study's analysis of HES data confirmed an absolute increase in the number of in-hospital deaths from ArLD, which closely paralleled ArLD unplanned episode numbers with a 17% increase during compared with before the pandemic. Reassuringly, the rate of referral or admission to critical care units (a marker of access to care for critically ill patients) and in-hospital mortality remained constant, the latter at 10% throughout the pandemic, suggesting that patient care did not deteriorate during this period. However, such a high mortality rate in ArLD patients is concerning. When put in perspective it is similar to 30-day mortality reported for acute myocardial infarction at 11.6% and acute ischaemic stroke at 8.6%, which both affect an older population than ArLD.[13]

Internationally, there are few reports of ArLD hospital admissions using national databases. Sweden's National Patient Register has a 91% positive predictive value for the ICD-10 code 'K703: alcoholic cirrhosis of the liver' when coded as an inpatient.[14] Several studies have combined this with the Swedish histopathology cohort to demonstrate higher rates of infections, mortality and cancer compared to matched controls after a biopsy-proven diagnosis of ArLD.[15–17] However, these data do not document hospital admissions and only report the subset of patients with biopsy-proven disease. Furthermore, the use of the K70 ICD-10 codes as the primary diagnosis only may miss those with alternative coding patterns. A nationwide healthcare registry in Denmark found a reduction in ArLD admissions from 357 per 1,000,000 in 2009 to 240 per 1,000,000 in 2018.[18] In contrast, increases of between 33 and 38% in ArLD admissions have been documented over the decade to 2016 in Brazil, Ireland and the United States (US).[19–21] During the pandemic, increases in ArLD admissions have been reported in the US with a 50% increase in alcoholic hepatitis admissions reported in one city.[22,23] Modelling based on increased alcohol use during the pandemic in the US predicts an additional 8000 deaths and 18,700 cases of decompensated ArLD between 2020 and 2040.[24]

The majority of these studies apply standard ArLD ICD codes as the primary diagnosis to identify ArLD admissions.[25,26] However, methodology has been developed to more accurately identify alcohol-related conditions. Twenty-nine alcohol-related ICD codes were agreed by expert consensus and applied to the Swedish National Patient Register to estimate incidence and prevalence of all alcohol-related disorders and diseases.[27] However, the population was not restricted to liver disease and did not investigate number of hospital admissions. Although the number of relevant ICD codes was expanded, combinations such as those employed in the current study, were not used. In the US, an algorithm combining cirrhosis codes with one of 11 alcohol-specific codes was applied to the Veterans Affairs Health Care Database.[28] In this database, the alcoholic cirrhosis code alone only had a 71% positive predictive value when compared to physician review of the medical record[29] and the subsequent algorithm has not been validated. It has since been applied to the US National Inpatient Sample to document ArLD inpatient mortality[30] and incidence of acute-on-chronic liver failure in ArLD.[26] Further work is required to validate this algorithm and compare it to the LAA.

The overall rising number of deaths of ArLD patients noted in the first Lancet Commission on Liver Disease report,[12] recently documented again by PHE[2] and now reported here, must be addressed. Ten key recommendations were made in the original Lancet Commission report, including the need to introduce public health measures such as minimum unit alcohol pricing, to improve early detection of liver disease and to develop community and hospital resources for patients with liver disease.[12] However, progress with many developments has stalled and requires improved implementation by official bodies.[31] Scotland introduced minimum unit pricing in 2018 but our study did not include Scottish national data to determine the effects of the pandemic on alcohol use and harm. However, analysis of Scottish hospital episode statistics demonstrated a 9.3% reduction in ArLD hospital admissions in 2020 compared to the 2017–19 average.[32] Furthermore, a retrospective analysis of admissions with decompensated ArLD at seven Scottish hospitals

found no impact of the pandemic on numbers and disease severity.[33] Taken together, this shows a difference in clinical outcomes between England and Scotland that may be attributable to the contrasting public health policies of the two nations including minimum unit pricing in Scotland.

Our study together with the recent PHE report highlights the need for implementation of public health measures to reduce harmful alcohol use and further improvements in the early identification and treatment of patients with ArLD. Further resources are required to improve the management of these patients both in primary and secondary care. This must include adequate numbers of alcohol liaison workers who can work outside the bounds of gastroenterology and hepatology, who are supported by Alcohol Clinical Leads at each trust. Alcohol Care Teams, which exist or are being developed in some regions, are integral for the management of ArLD patients and bridge the gap between hospital and community settings.[34] Methods to reduce alcohol consumption in ArLD patients, who are at high risk of decompensation and death from ongoing alcohol consumption, in a community setting are urgently needed.

The purpose of the study was to pair trends in national HES data with patient level information through a coordinated national service evaluation. This was limited by the short duration of data collection of two 7-day periods in August 2019 and 2020 in a small number of acute hospital trusts in England and Scotland. The short data collection period was chosen to reduce the burden of data extraction on already overstretched clinicians during the second wave of the pandemic in the UK. The sample of 28 hospitals included a representative selection of district generals and tertiary centres from all regions of England but liver transplant centres were over-represented. Scotland was represented by just two sites and there were no participating centres in Wales or Northern Ireland. We are unable to comment on the study's generalisability to Scotland, Wales and Northern Ireland as we did not have access to those nations' HES data. Furthermore, it was not possible to analyse service evaluation data to compare ArLD-primary with ArLD-uplift cases to determine whether there were differences in disease severity or presentation.

In conclusion, this study has demonstrated the strength and flexibility of deploying the Liverpool ArLD algorithm to identify unplanned ArLD hospital admissions from local and regional datasets. It has revealed that the true burden of ArLD admissions to the NHS is double that reported in official statistics at an estimated £70 million in additional costs.

AUTHOR CONTRIBUTIONS

Ashwin D Dhanda: Conceptualization (lead); formal analysis (equal); methodology (equal); project administration (lead); supervision (lead); writing – original draft (lead); writing – review and editing (equal). **Keith Bodger:** Conceptualization (equal); methodology (equal); writing – original draft (equal); writing – review and editing (equal). **Steve Hood:** Conceptualization (equal); methodology (equal); writing – review and editing (equal). **Clive Henn:** Conceptualization (equal); methodology (equal); writing – review and editing (equal). **Michael Allison:** Methodology (equal); writing – review and editing (equal). **Chioma Amasiatu:** Formal analysis (equal); validation (equal); writing – review and editing (equal). **Robyn Burton:** Data curation (equal); formal analysis (equal); methodology (equal); writing – review and editing (equal). **Matthew Cramp:** Methodology (equal); writing – review and editing (equal). **Ewan Forrest:** Methodology (equal); writing – review and editing (equal). **Meetal Khetani:** Formal analysis (equal); validation (equal); writing – review and editing (equal). **Alastair MacGilchrist:** Methodology (equal); writing – review and editing (equal). **Steven Masson:** Methodology (equal); writing – review and editing (equal). **Richard Parker:** Methodology (equal); writing – review and editing (equal). **Nick Sheron:** Methodology (equal); writing – review and editing (equal). **K J Simpson:** Methodology (equal); writing – review and editing (equal). **Nikhil Vergis:** Methodology (equal); writing – review and editing (equal). **Martin White:** Formal analysis (equal); methodology (equal); writing – review and editing (equal).

ACKNOWLEDGEMENT

We are grateful to Professor Guruprasad Aithal as past president of the British Association for the Study of the Liver and the BASL admin team for supporting this work.

FUNDING INFORMATION

This study received no funding. The British Association for the Study of the Liver and the Department of Health and Social Care did not have any role in the study design, data collection, analysis and interpretation, in the writing of the report and in the decision to submit the paper for publication.

CONFLICT OF INTEREST

Richard Parker: Speaking fees from Norgine, Siemens and Shionogi, consulting fees from DURECT. Robyn Burton: Paid consultancy for the World Health Organization (2019 and 2020). Nikhil Vergis: Changed affiliation during the study from Imperial College London to GlaxoSmithKline (GSK). GSK did not have any involvement in any aspect of this study. None of the other authors have any competing interest to declare

ORCID

Ashwin Dhanda https://orcid.org/0000-0002-0523-0193
Keith Bodger https://orcid.org/0000-0002-1825-3239
Ewan Forrest https://orcid.org/0000-0002-7293-2574
Steven Masson https://orcid.org/0000-0003-1041-9844
Richard Parker https://orcid.org/0000-0003-4888-8670

REFERENCES

1. NHS Digital. Statistics on Alcohol, England 2020. NHS Digital. 2020. Accessed 10/09/2021. https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-alcohol/2020
2. Public Health England. Monitoring alcohol consumption and harm during the COVID-19 pandemic. London: Public Health England; 2021.
3. Daly M, Robinson E. High-risk drinking in midlife before versus during the COVID-19 crisis: longitudinal evidence from the United Kingdom. Am J Prev Med. 2021;60(2):294–7.

4. Jackson SE, Garnett C, Shahab L, Oldham M, Brown J. Association of the COVID-19 lockdown with smoking, drinking and attempts to quit in England: an analysis of 2019-20 data. Addiction. 2021;116(5):1233–44.
5. Ramrakhiani NS, Le MH, Yeo YH, Le AK, Maeda M, Nguyen MH. Validity of international classification of diseases, tenth revision, codes for cirrhosis. Dig Dis. 2021;39(3):243–6.
6. Pang JX, Ross E, Borman MA, Zimmer S, Kaplan GG, Heitman SJ, et al. Validation of coding algorithms for the identification of patients hospitalized for alcoholic hepatitis using administrative data. BMC Gastroenterol. 2015;15:116.
7. Kallis C, Dixon P, Silberberg B, Affarah L, Shawihdi M, Grainger R, et al. Reducing variation in hospital mortality for alcohol-related liver disease in North West England. Aliment Pharmacol Ther. 2020;52(1):182–95.
8. Crabb DW, Bataller R, Chalasani NP, Kamath PS, Lucey M, Mathurin P, et al. Standard definitions and common data elements for clinical trials in patients with alcoholic hepatitis: recommendation from the NIAAA alcoholic hepatitis consortia. Gastroenterology. 2016;150(4):785–90.
9. NHS Digital. Reference costs 2018/19. Accessed date: 06.10.2022. Available at: https://digital.nhs.uk/about-nhs-digital/corporate-information-and-documents/directions-and-data-provision-notices/data-provision-notices-dpns/reference-costs
10. NHS Digital. Provisional Monthly Hospital Episode Statistics for Admitted Patient Care, Outpatient and Accident and Emergency data April 2020—March 2021 (M13). 2021. Accessed 10/09/2021. https://digital.nhs.uk/data-and-information/publications/statistical/hospital-episode-statistics-for-admitted-patient-care-outpatient-and-accident-and-emergency-data/april-2020---march-2021-m13
11. Kim JU, Majid A, Judge R, Crook P, Nathwani R, Selvapatt N, et al. Effect of COVID-19 lockdown on alcohol consumption in patients with pre-existing alcohol use disorder. Lancet Gastroenterol Hepatol. 2020;5(10):886–7.
12. Williams R, Aspinall R, Bellis M, Camps-Walsh G, Cramp M, Dhawan A, et al. Addressing liver disease in the UK: a blueprint for attaining excellence in health care and reducing premature mortality from lifestyle issues of excess consumption of alcohol, obesity, and viral hepatitis. Lancet. 2014;384(9958):1953–97.
13. Nuffield Trust. Stroke and heart attack mortality. Nuffield Trust. 2020.
14. Bengtsson B, Askling J, Ludvigsson JF, Hagstrom H. Validity of administrative codes associated with cirrhosis in Sweden. Scand J Gastroenterol. 2020;55(10):1205–10.
15. Hagström H, Thiele M, Simon TG, Sharma R, Röckert Tjernberg A, Roelstraete B, et al. Risk of infections and their role on subsequent mortality in biopsy-proven alcohol-related liver disease. United European Gastroenterol J. 2022;10(2):198–211.
16. Hagstrom H, Thiele M, Roelstraete B, Soderling J, Ludvigsson JF. Mortality in biopsy-proven alcohol-related liver disease: a population-based nationwide cohort study of 3453 patients. Gut. 2021;70(1):170–9.
17. Hagström H, Thiele M, Sharma R, Simon TG, Roelstraete B, Söderling J, et al. Risk of cancer in biopsy-proven alcohol-related liver disease: a population-based cohort study of 3410 persons. Clin Gastroenterol Hepatol. 2022;20(4):918–929.e918.
18. Kraglund F, Deleuran T, Askgaard G, Fleming KM, Jepsen P. Decreasing incidence of alcohol-related liver disease in Denmark: a 25-year nationwide study. Clin Epidemiol. 2021;13:1–11.
19. Lyra AC, de Almeida LMC, Mise YF, Cavalcante LN. Epidemiological profile of alcoholic liver disease hospital admissions in a Latin American country over a 10-year period. World J Hepatol. 2020;12(5):230–8.
20. Armstrong PR, Ring E, MacNicholas R. A decade of rising alcoholic liver disease hospital admissions and deaths in Irish hospitals, 2007-2016: a retrospective cross-sectional analysis. Eur J Gastroenterol Hepatol. 2022;34:671–7.
21. Dang K, Hirode G, Singal AK, Sundaram V, Wong RJ. Alcoholic liver disease epidemiology in the United States: a retrospective analysis of 3 US databases. Am J Gastroenterol. 2020;115(1):96–104.
22. Rutledge SM, Schiano TD, Florman S, Im GY. COVID-19 aftershocks on alcohol-associated liver disease: an early cross-sectional report from the U.S. Epicenter. Hepatol Commun. 2021;5(7):1151–5.
23. Gonzalez HC, Zhou Y, Nimri FM, Rupp LB, Trudeau S, Gordon SC. Alcohol-related hepatitis admissions increased 50% in the first months of the COVID-19 pandemic in the USA. Liver Int. 2022;42(4):762–4.
24. Julien J, Ayer T, Tapper EB, Barbosa C, Dowd WN, Chhatwal J. Effect of increased alcohol consumption during COVID-19 pandemic on alcohol-associated liver disease: a modeling study. Hepatology. 2021;75(6):1480–90.
25. Kraglund F, Deleuran T, Askgaard G, Fleming KM, Jepsen P. Decreasing incidence of alcohol-related liver disease in Denmark: a 25-year nationwide study. Clin Epidemiol. 2021;13:1–11.
26. Singal AK, Arsalan A, Dunn W, Arab JP, Wong RJ, Kuo YF, et al. Alcohol-associated liver disease in the United States is associated with severe forms of disease among young, females and Hispanics. Aliment Pharmacol Ther. 2021;54(4):451–61.
27. Bergman D, Hagström H, Capusan AJ, Mårild K, Nyberg F, Sundquist K, et al. Incidence of ICD-based diagnoses of alcohol-related disorders and diseases from Swedish Nationwide Registers and suggestions for coding. Clin Epidemiol. 2020;12:1433–42.
28. Beste LA, Leipertz SL, Green PK, Dominitz JA, Ross D, Ioannou GN. Trends in burden of cirrhosis and hepatocellular carcinoma by underlying liver disease in US veterans, 2001–2013. Gastroenterology. 2015;149(6):1471–82.
29. Kramer JR, Davila JA, Miller ED, Richardson P, Giordano TP, El-Serag HB. The validity of viral hepatitis and chronic liver disease diagnoses in veterans affairs administrative databases. Aliment Pharmacol Ther. 2008;27(3):274–82.
30. Ladhani S, Hirode G, Singal AK, Wong RJ. Impact of safety-net burden on in-hospital mortality and hospitalization costs among patients with alcoholic hepatitis and alcoholic cirrhosis. Alcohol Alcohol. 2021;56(3):368–75.
31. Williams R, Aithal G, Alexander GJ, Allison M, Armstrong I, Aspinall R, et al. Unacceptable failures: the final report of the lancet commission into liver disease in the UK. Lancet. 2020;395(10219):226–39.
32. Public Health Scotland. Alcohol sales and harm in Scotland during the COVID-19 pandemic. Edinburgh: Public Health Scotland; 2022.
33. Manship T, Brennan PN, Campbell I, Campbell S, Clouston T, Dillon JF, et al. Effect of COVID-19 on presentations of decompensated liver disease in Scotland. BMJ Open Gastroenterol. 2022;9(1):e000795.
34. Moriarty KJ. Alcohol care teams: where are we now? Frontline Gastroenterology. 2020;11(4):293–302.

SUPPORTING INFORMATION

Additional supporting information will be found online in the Supporting Information section.

How to cite this article: Dhanda A, Bodger K, Hood S, Henn C, Allison M, Amasiatu C, et al. The Liverpool alcohol-related liver disease algorithm identifies twice as many emergency admissions compared to standard methods when applied to Hospital Episode Statistics for England. Aliment Pharmacol Ther. 2023;57:368–377. https://doi.org/10.1111/apt.17307

APPENDIX A

British Association for the Study of the Liver Alcohol-related Liver Disease Special Interest Group

National service evaluation group.

Ahmed Saleh, Hull University Teaching Hospitals NHS Trust. Alex Boyd, University Hospitals Birmingham NHS Foundation Trust. Alison Brind, University Hospitals of North Midlands NHS Trust. Alka Joshi, University Hospital Bristol and Weston NHS Foundation Trust. Angie Rund, Aintree University Hospital NHS Foundation Trust. Ankur Srivastava, North Bristol NHS Trust. Anne McCune, University Hospital Bristol and Weston NHS Foundation Trust. Anthony Gartland, Royal Surrey NHS Foundation Trust. Ben Hudson, Royal Devon and Exeter NHS Foundation Trust. Bill Stableforth, Royal Cornwall Hospital NHS Foundation Trust. Christopher John, University Hospital Southampton NHS Foundation Trust. Ema Maxan, Croydon University Hospital NHS Foundation Trust. Esther Unitt, University Hospitals Coventry and Warwickshire NHS Trust. Frederica Beetteridge, North Bristol NHS Trust. Heather Lewis, Imperial College Healthcare NHS Trust. Helen Fellows, Wye Valley NHS Trust. Ihteshamul Haq, Sheffield Teaching Hospitals NHS Foundation Trust. Janisha Patel, University Hospital Southampton NHS Foundation Trust. Jennifer Ryan, Royal Free London NHS Foundation Trust. Jeremy Cobbold, Oxford University Hospitals NHS Foundation Trust. Keith Pohl, Royal Devon and Exeter NHS Foundation Trust. Kevin Raeburn, Royal Free London NHS Foundation Trust. Lynsey Corless, Hull University Teaching Hospitals NHS Trust. Michael Johnston, NHS Greater Glasgow and Clyde. Mohsen Subhani, Nottingham University Hospital NHS Foundation Trust. Naina Shah, King's College Hospital NHS Foundation Trust. Nasima Ali, Oxford University Hospitals NHS Foundation Trust. Neil Rajoriya, University Hospitals Birmingham NHS Foundation Trust. Olly Bendall, Royal Cornwall Hospital NHS Foundation Trust. Omar Saeed, University Hospitals Coventry and Warwickshire NHS Trust. Philip Berry, Guy's and St Thomas' NHS Foundation Trust. Prebashan Moodley, University Hospitals Plymouth NHS Trust. Sherif Abdelbadiee, Aintree University Hospital NHS Foundation Trust. Sian Davies, Royal Surrey NHS Foundation Trust. Sreelakshmi Kotha, Guy's and St Thomas' NHS Foundation Trust. Steve Ryder, Nottingham University Hospital NHS Foundation Trust. Sumita Verma, Brighton and Sussex University Hospitals NHS Trust. Tom Manship, NHS Lothian. Vinay Kumar, King's College Hospital NHS Foundation Trust. Yazan Haddadin, Brighton and Sussex University Hospitals NHS Trust.