

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

Running title: Alcohol-related liver disease algorithm

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Contributors

AD, KB, SH, CH – conceptualisation; AD, KB, SH, CH, MA, RB, MC, EF, AM, SM, RP, NS, KS, NV – methodology; AD, CA, RB, MK, MW - formal analysis and data curation; CA, MK - validation (both have verified the underlying data reported in the manuscript); All collaborative authors - investigation (data acquisition); AD, KB - original draft; All authors - writing - review and editing

Summary

Background and aims 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 thus at risk of excluding ArLD admissions defined by other coding combinations. We aimed 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 The standard approach and LAA were applied 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 seven-day period in 2019 and 2020, in which eligible patient records were reviewed manually to verify diagnosis and extract data.

Results Nationally, LAA identified approximately 100% more monthly emergency admissions from 2013-21 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 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, nor in the proportion of admissions with decompensation of cirrhosis or alcoholic hepatitis.

Conclusions The LAA can be applied successfully to local and national datasets and 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.

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 have 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 two 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 (panel 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 cirrhosis⁵ and alcoholic hepatitis⁶ 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 Algorithm⁷ (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.

Methods

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.

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 (panel 1 and supplementary table 4): (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.

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 panel 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.

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 17 to 23 Aug 2020 inclusive were identified by application of the Liverpool ArLD Algorithm to hospital datasets. Two seven-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; 4) completed unplanned hospital episode during service evaluation period.

Data were collected into a pre-populated Excel spreadsheet on: 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 paper⁸); 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; 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 exact test.

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.

Results

Quality assurance of the application of the LAA to HES

To ensure 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 dataset⁷. The uplift consisted of 49.2% of all cases identified compared to 48.5% in the regional dataset. 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 admissions 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 a hospital admission).

Demographic and socioeconomic profile of primary and uplift admissions

The age profile of the primary and uplift populations were highly comparable and remained consistent over time, with a mean age of between 51-53 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 33-37% overall, with a corresponding range of 33-38% for the

primary group and 33-38% for the uplift group (supplementary figure 1). These data support the assertion that the primary and uplift admissions are drawn from the same demographic of people presenting with ArLD.

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 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, 3,036, 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 (8,862, 6.4%) or cirrhosis (1,823, 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 (supplementary table 1). These data provide strong face-validity for the algorithm’s ability to capture relevant emergency admissions that would otherwise be missed.

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 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 (supplementary figure 2).

Assuming costs for 2019-20 and that all ArLD admissions required a minimum single intervention, 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

Completed unplanned hospital admissions during the pandemic

The PHE report on alcohol harm during the pandemic found an increase of 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 3,206 in January to 2,235 in April 2020 and then rose to a peak in July 2020 of 3,767, 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.

Application of the LAA to local datasets

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 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.

Diagnoses

The commonest presentation was decompensation of ArLD. Primary diagnoses were similar between 2019 and 2020 (supplementary table 1). When English and Scottish sites were considered separately, there was no statistical difference between any primary diagnosis.

Clinical outcomes

Comparing 2019 and 2020, there were no differences in age (56 v 54; $p=0.12$), gender (both 37% female) or death during admission (9.0% v 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 (supplementary table 2). 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.

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

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; $p=0.02$; supplementary figure 3).

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 (supplementary figure 4).

Discussion

This study has demonstrated the successful application of an ArLD coding algorithm to national and local datasets to improve 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 reports² 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 for 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.[Bengtsson, Scand J Gastro 2020] 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.[Hagstrom, UEGJ 2022; Gut 2021; CGH 2022] 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 2018.¹⁴ 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).¹⁵⁻¹⁷ 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.^{18,19} 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 2040.²⁰

The majority of these studies apply standard ArLD ICD codes as the primary diagnosis to identify ArLD admissions[Kragland, Clin Epid 2021; Singal, Am J Gastro 2021]. 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.[Bergman, Clin Epid 2020] 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.[Beste, Gastroenterol 2015] In this database, the alcoholic cirrhosis code alone only had a 71% positive predictive value when compared to physician review of the medical record [Kaplan, APT 2008] and the subsequent algorithm has not been validated. It has since been applied to the US National Inpatient Sample to document ArLD inpatient mortality[Ladhani, Alcohol Alcohol 2020] and incidence of acute-on-chronic liver failure in ArLD.[Singal, Am J Gastroenterol 2020] 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 PHE² 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.²¹ 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.²² Furthermore, a retrospective analysis of admissions with decompensated ArLD at seven Scottish hospitals found no impact of the pandemic on numbers and disease severity.²³ 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 highlight 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 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.²⁴ 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 seven-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.

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Tables

Panel 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)

Figure legends

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

Figure 2: Number of total completed hospital admissions in England (red line; data from NHS Digital¹⁰) 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.