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# *Hepatology at home*: a novel pathway for the integrated management of patients with liver disease in the home

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## ABSTRACT

**Objective** Hospital admissions and deaths due to liver disease are increasing worldwide, representing a significant burden on acute services. We describe the first 12 months of *Hepatology at home*, a novel service that delivers hospital-level care to patients with liver disease in their own home as an alternative to ambulatory or inpatient management.

The primary aim was to evaluate the number of at-home days where a patient received assessment and management at home rather than attending hospital.

**Method** Processes of care and outcomes of patients referred to *Hepatology at Home* at Oxford University Hospitals NHS Foundation Trust, United Kingdom were collected prospectively for 12 months from 27 April 2024 to 26 April 2025.

**Results** 40 patients (n=16 female, median age 67) with 67 discrete episodes of care were referred. Most patients (90%) had cirrhosis associated with metabolic and/or alcohol risk factors. The most common reason for referral was the management of ascites/oedema (62.7%). Interventions performed in the home included ascitic tap (n=5), large volume paracentesis (n=5), venesection (n=6) and administration of intravenous iron, diuretics or antibiotics (n=13). Patients had an additional 269 days at home (per-patient median 5, range 1–72), of which 156 replaced inpatient hospital days and 113 replaced hospital-based ambulatory hepatology reviews. Within 30 days of discharge, 58.7% required a further *Hepatology at home* encounter or inpatient admission. The 30-day mortality rate was 32.5%. There were no unexpected deaths.

**Conclusion** *Hepatology at Home* is an alternative to hospital-based ambulatory or inpatient care for patients with liver disease.

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Hospital at home services provides hospital-level care to patients in their own home, with patients reporting higher satisfaction, maintenance of physical activity and reduced likelihood of requiring subsequent residential care. One hospital at home service for patients with complications of liver disease has been described in an Australian healthcare setting (LivR Well) and has reported feasibility and positive patient experiences.

### WHAT THIS STUDY ADDS

⇒ This is a service evaluation of the first 12 months of *Hepatology at home*, the first service to provide hospital-level care to patients with liver disease in their own home in England. We show the model is feasible in a National Health Service healthcare setting and enables patients to have an increased number of at-home days replacing either hospital-based inpatient or ambulatory management.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ *Hepatology at home* is an exemplar of community-based patient-centred care for patients with liver disease, which can act as a blueprint for the development of similar services in other centres. Future research should prioritise understanding efficacy, cost-effectiveness and how patients and carers experience home-based hepatology care as well as how such services can be integrated across the health system.

## INTRODUCTION

Morbidity and mortality resulting from liver cirrhosis and its complications have considerably increased over the past two decades, particularly from an increased incidence of alcohol and metabolic-related liver diseases.[1 2] In England, the National Health Service (NHS) has seen an increase in unplanned hospital admissions due to liver disease by over 50% in the last decade.[1 3] Such patients have high early mortality of up to 35% within 60 days of discharge with wide regional variation and readmission rates between 28% and 44%.[4–6] The Lancet Commission into liver disease and National Confidential Enquiry into Patient Outcomes and Death due to alcohol-related liver disease both concluded that the current provision of care in the UK for this patient cohort is unacceptable, due to increasing hospital admissions and mortality, and novel care models are urgently needed.[3 7 8]

Patients with cirrhosis are at risk of rapidly and unpredictably developing complications that carry a high risk of organ dysfunction and death, including gastrointestinal bleeding, hepatic encephalopathy and infections such as spontaneous bacterial peritonitis (SBP).[9] Progressive ascites, peripheral oedema, encephalopathy and frailty can become chronic and their presence is associated with rehospitalisation within 30 days.[10 11] In many patients unsuitable for definitive treatment with liver transplantation, these symptoms contribute to poor quality of life, high palliative care needs and often precipitate frequent hospital admissions, when the patients' priority is to remain at home as much as possible.[5 12] Services caring for such patients therefore need to integrate specialist expertise from hepatology, acute medicine and palliative care, while being flexible and readily accessible to patients and their carers. Community-based models of integrated care are supported as one potential way of improving access to quality care for patients with liver disease and reducing early readmission rates to acute hospitals.[8 13]

In response to a sustained increase in emergency hospital presentations, high bed occupancy rates and emergency department overcrowding[14–16] in patients with acute medical problems including complications of liver disease, same day emergency care and ambulatory units for unscheduled general medical presentations have become commonplace. Hospital at home (HaH) services, that provide hospital-level diagnostics, specialist clinical assessment and treatment to patients in their own home,[17 18] are supported as one way of achieving increased care delivery outside the acute hospital,[15] especially for frail patients can find travel to ambulatory units burdensome.[19]

Widening access to HaH services as a way of moving care into the community is a key component of the recent Darzi Review, NHS Long Term Plan and NHS 10-year plan.[20–22] Several HaH service models have been described worldwide, with the majority serving older populations.[23–29] Randomised trials in older populations have shown HaH to be cost-effective compared with inpatient admission and patients randomised to HaH had a reduced likelihood of living in residential care with equivalent short-term and medium-term mortality.[30–32] HaH services also reduce the risks of known hospital-associated harms such as hospital-acquired infection, poor sleep, confusion and functional decline,[33 34] and patients experience higher satisfaction levels due to improved continuity of care, sleep and maintenance of physical activity.[32 35]

A randomised trial of Hospital at Home care in the USA has reported its experience of treating 22 patients at home with cirrhosis of which six had decompensated disease.[36] Only one model for home-based care specifically for patients with liver disease (LivR Well) has been previously reported, delivered in an Australian healthcare setting. The programme provides scheduled generalist HaH home visits with weekly hospital attendance for hepatologist medical review to patients meeting Asia Pacific Association for the Study of the Liver (APASL) criteria for acute on chronic liver failure (ACLF)[37] and has reported promising efficacy and patient experience outcomes.[38] In England, no HaH services for patients with liver disease have been described.[39]

Here we describe *Hepatology at home*, a care model integrating acute general medical and specialist hepatology services providing hospital-level care to patients with liver disease in the home. We describe the clinical characteristics, processes of care and outcomes of patients referred in the first 12 months. The primary aim was to evaluate the number of at-home days where a patient received assessment and management at home rather than being required to travel to hospital or be admitted overnight.

## METHODS

### Study design and setting

This is a single-centre descriptive service evaluation of the *Hepatology at home* care model, conducted at the Oxford Liver Unit, Oxford University Hospitals NHS Foundation Trust, a non-transplant tertiary referral centre for hepatology in Oxford, England, United Kingdom. As well as adult inpatient beds, the Oxford Liver Unit has a Hepatology Ambulatory Unit (HAU) run by Hepatology Advance Nurse Practitioners (ANP), who perform bedside large volume paracentesis (LVP), intravenous infusions, venesections, prescriptions and advanced assessment of patients with liver disease-related complications without an overnight stay in hospital. All patients triaged to the *Hepatology at home* service during its first 12 months from 27 April 2024 to 26 April 2025 were included.

The primary aim was to evaluate the number of at-home days where a patient received assessment and management at home rather than being required to travel to hospital or be admitted overnight. Secondary

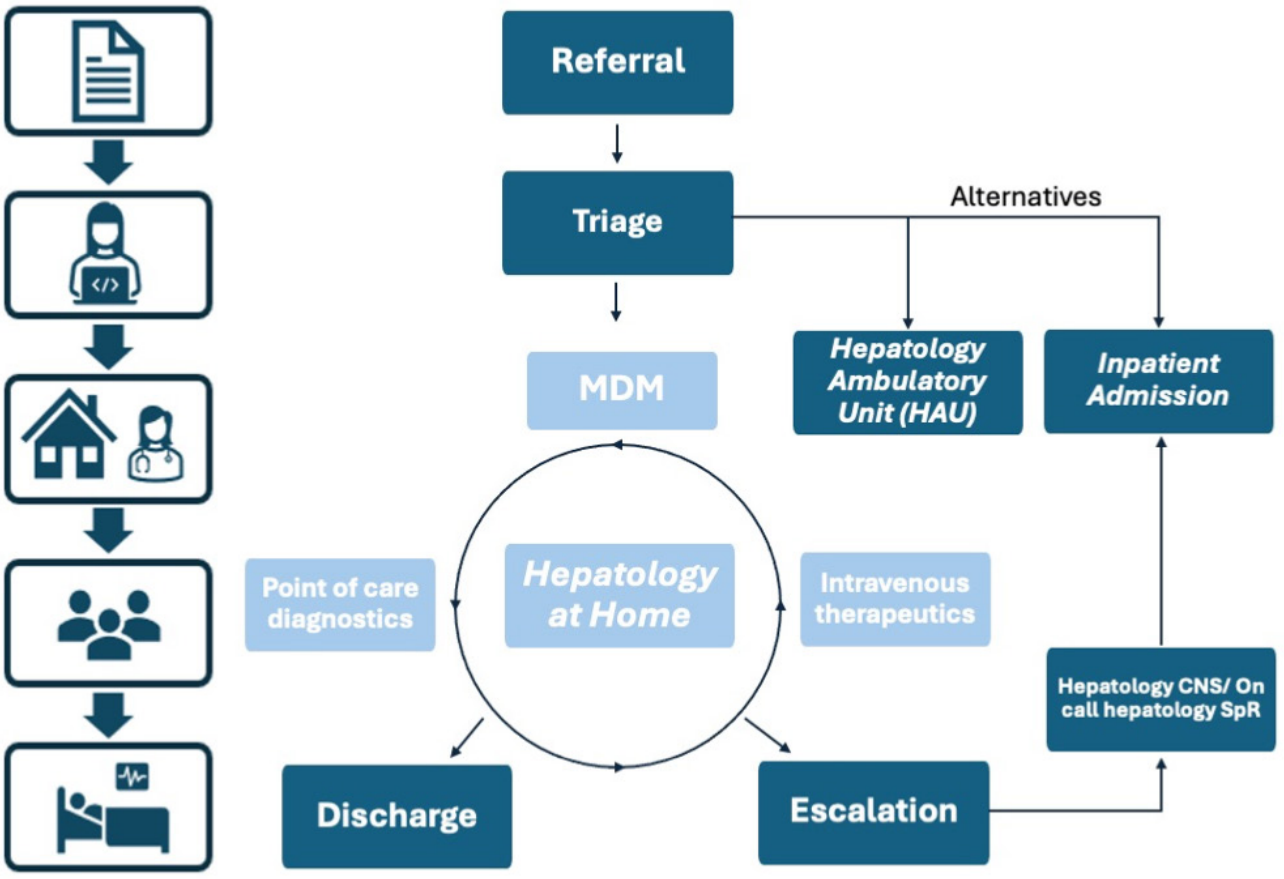


**Figure 1** *Hepatology at home* service model. Flowchart showing overview of patient journey from referral, home-based care and discharge from a *Hepatology at home* encounter. MDM, multidisciplinary meeting.

aims included evaluating outcomes of *Hepatology at home* episodes, including escalation to inpatient admission, and 30-day mortality.

### *Hepatology at home* service model development and intervention

The *Hepatology at Home* service was developed as a clinical collaboration between the Oxford Liver Unit and Oxford Acute Medicine HaH service. The aim of the service was to enable patients with liver-related complications, to have a choice of care at home as an alternative to ambulatory management or inpatient admission. No additional funding was required for the service, as it utilised two service models already in existence (the Oxford Liver Unit Ambulatory Hepatology service and the Oxford Acute Medicine HaH service). There is an established referral and discharge pathway from the community (General Practice) to Oxford Acute Medicine HaH, and all patients received letters to general practice on discharge as standard.

The service model is outlined in figure 1. Patients could be referred with any symptomatic complication of liver disease including acute and non-acute decompensation. Criteria for clinical suitability for *Hepatology at Home* are outlined in online supplemental table 2. Priority was given to patients who preferred at-home management due to frailty or palliative trajectory. Unsuitable referrals included a patient preference for hospital-based care, ambulant patients with ascites requiring frequent LVP, suspicion of acute upper gastrointestinal bleeding for consideration of urgent endoscopic assessment and patients meeting European Association for the Study of the Liver (EASL) ACLF criteria,[9 40] if there was potential reversibility with organ support.

The *Hepatology at Home* clinical team and their roles are outlined in online supplemental table 3. Referrals were triaged by the Hepatology ANP to either *Hepatology at Home*, HAU ambulatory management or inpatient admission. Referrals were classified as 'step-up' from an initial assessment in the emergency department or ambulatory unit or 'step-down' from an inpatient admission or a period of ambulatory management. After triage patients were visited by acute HaH nurses or doctors providing clinical assessment, point of care diagnostics (point-of-care haematology and biochemistry blood tests, point-of-care ultrasound (POCUS) and formal hospital laboratory blood tests) and intravenous medications in the home including crystalloid fluid, albumin, iron, antibiotics and diuretics. Patients were jointly discussed

in bi-weekly multidisciplinary meetings (MDM) by HaH and hepatology specialists to determine the overarching management plan. The frequency of clinical reviews and interventions performed in the home was reactive to clinical need rather than being prescriptive and was classified as either replacing ambulatory unit attendance or inpatient level care depending on the intensity and complexity.

A *Hepatology at Home* episode was defined as a distinct episode of care in the home for a distinct complication of liver disease with a referral and discharge date. During a *Hepatology at home* episode, patients could attend an ambulatory unit for assessment if required and could be seen at home several times during a single episode of care, either on sequential days or after a time interval.

Patients were discharged from a *Hepatology at Home* episode based on the judgement of the attending clinical team. When a patient reached a period of clinical stability and their acute reason for more intensive hepatology management had resolved, their care was de-escalated to interim follow-up arranged in hepatology outpatient clinic or an HAU attendance. In the case of patient deterioration, they could immediately be discussed with the hepatology team (hepatology ANP or on-call registrar), such that escalation to inpatient admission could be organised if that was judged to be necessary.

### Data collection

All patients triaged to *Hepatology at home* care during the initial 12 months of the service from 27 April 2024 to 26 April 2025 were included. There was no comparator group. We did not collect data on patients triaged to alternative services (HAU or inpatient admission).

Data collected prospectively from electronic patient records included patient demographics, performance status and liver disease clinical information, reason for referral, reason for home management, frequency and nature of at home visits, diagnostics and therapeutics performed in the home and outcome data including 30-day readmission rates and mortality (online supplemental table 1).

### Definitions of collected variables

Where possible, internationally agreed definitions of clinical variables were adhered to. Cirrhosis was defined as either histological confirmation or a clinical diagnosis based on examination, radiological and biochemical evidence.[41] Child-Pugh,[42 43] Model for End-Stage Liver Disease Sodium (MELD-Na)[44] and the United Kingdom Model for End-Stage Liver Disease (UKELD)[45] scores were collected. Acute decompensation was defined as the development of ascites, overt hepatic encephalopathy or variceal bleeding requiring unscheduled hospitalisation.[46 47] Non-acute decompensation was defined as ascites, jaundice or hepatic encephalopathy with gradual onset, without an episode of acute decompensation within the preceding 3 months.[48] The EASL criteria were used to define ACLF.[40] Functional status was measured by calculating the Rockwood Clinical Frailty Score (CFS)[49] and Eastern Cooperative Oncology Group/WHO performance status.[50] The Bristol Prognostic Score[51] was applied to identify patients at high risk of dying within 12 months.

We defined 'Hospital at home' as a care episode where hospital-level diagnostics, monitoring, clinical decision-making or therapeutics were delivered in the patients home, as defined by the World Hospital at Home consensus definition and NHS-England operational framework for virtual wards.[52 53] In accordance with these definitions, hospital-level diagnostics include point of care and laboratory blood tests, physical examination, POCUS and assessment by a hospital specialist. Hospital-level therapeutics include intravenous medications, oxygen and invasive therapeutic procedures but excluded long-course outpatient parenteral antibiotic therapy (OPAT).

There are no accepted definitions of criteria for acute admission, inpatient hospital-level care or ambulatory care for patients with complications of liver disease. We defined 'criteria for acute admission under hepatology' as a patient with an acute complication of liver disease (either ACLF or acute decompensation, as defined above), where 'hospital-level care' as defined above was deemed appropriate for management by the assessing clinician, when access to hospital-level diagnostics, monitoring, clinical decision-making or therapeutics was necessary at a frequency of less than three times in a 7-day period. Avoidance of an 'inpatient day' during a *Hepatology at Home* episode was defined as a 24-hour period where a patient met criteria for acute admission, as defined above, but was offered and accepted *Hepatology at Home* instead, avoiding an overnight stay in hospital. A 'hepatology ambulatory review' was defined as a single assessment on HAU by the hepatology ANP or on the medical ambulatory unit for a hepatology-related problem, where an overnight stay in hospital was not required, but access to hospital-level diagnostics, monitoring, clinical decision-making or therapeutics was necessary at a frequency of less than three times in a 7-day period, as judged by the assessing clinician. The avoidance of a hepatology ambulatory review during a *Hepatology at Home* episode was defined as a single clinical assessment episode where a single ambulatory review was avoided due to the clinical assessment and management being undertaken in the home.

### Data analysis

Data analysis was conducted using GraphPad PRISM V.10 (Boston, USA). Descriptive statistics reported, using median and IQR for non-normally distributed data. Survival curve comparisons were performed using Logrank test for trend.

## RESULTS

### Characteristics of patients referred to the *Hepatology at home service*

Forty patients (n=16 female, median age 67, range 30–91 years) were triaged to the *Hepatology at home* service during the study period (baseline characteristics in table 1). Most lived in Oxfordshire were of white British ethnicity (n=33, 82.5%) and had a median English index of multiple deprivation decile (IMD) of 9 (range 2–10). The median distance of the patients residence to hospital was 10.5 miles (range 1–33.5).

The primary diagnosis was cirrhosis with decompensation in the majority (n=36, 90%) with remainder having liver transplant with chronic graft failure, non-cirrhotic portal hypertension or haemochromatosis requiring venesection. Relevant secondary diagnoses included heart failure (n=4) and hepatocellular carcinoma (n=4). One patient had a transjugular intrahepatic portosystemic shunt and two had long-term abdominal drains for drainage of refractory ascites. The most common aetiologies of cirrhosis were alcohol (n=13, 36.1%), metabolic dysfunction-associated steatotic liver disease (n=13, 36.1%) and metabolic dysfunction and alcohol-related liver disease (n=5, 13.8%). At the time of initial referral, most were Child-Pugh Class B (n=25, 62.5%) or C (n=11, 27.5) with median score 9 (range 6–11), with median MELD-Na score 17 (range 7–29) and median UKELD score 53 (range 43–67).

All patients triaged to *Hepatology at home* stated that they preferred home-based care, due either to frailty or to being in their last months of life. Most patients were frail (n=30, 75% CFS >5 mild, moderate or severe frailty) with a median CFS of 6 (range 3–9) and median ECOG score of 3 (range 1–4). At time of initial referral episode, 20 patients (64.5%) had a valid do not attempt cardiopulmonary resuscitation order in place and 10 patients (32.3%) were already known to Community Palliative Care services. Patients had a median Bristol Prognostic Score of 2 (range 0–4). Most patients (n=30, 96.8%) still wished to attend hospital for assessment/admission should they develop a reversible complication of liver disease requiring interventions only available on the hospital site, such as upper gastrointestinal tract endoscopy.

**Table 1** Baseline characteristics of patients triaged to *Hepatology at home* care at time of initial referral

| Patient characteristic | |
|---|---|
| Gender female | |
| Number, (%) | 16 (40) |
| Age years | |
| Median (range) | 67 (30–91) |
| Ethnicity | |
| Number, (%) | |
| White British | 33 (82.5%) |
| White—any other white background | 2 (5%) |
| Not stated | 5 (12.5%) |
| English index of multiple deprivation decile | |
| Median (range) | 9 (2-10) |
| Distance of patient residence to hospital miles | |
| Median (range) | 10.5 (1–33.5) |
| Primary diagnosis | |
| Number, (%) | |
| Cirrhosis with decompensation | 36 (90) |
| Liver transplantation with chronic rejection | 2 (5) |
| Non-cirrhotic portal hypertension | 1 (2.5) |
| Haemochromatosis without cirrhosis | 1 (2.5) |
| Aetiology of cirrhosis | |
| Number, (%) | |
| Alcohol | 13 (36.1) |
| MASLD | 13 (36.1) |
| MetALD | 5 (13.8) |
| AIH | 1 (2.7) |
| PSC | 1 (2.7) |
| Congestive | 2 (5.6) |
| Cryptogenic | 1 (2.7) |
| Liver prognostic scores | |
| Median (range) | |
| Child-Pugh | 9 (6–11) |
| MeLD-Na | 17 (7–29) |
| UKELD | 53 (43–67) |
| Bristol prognostic score | 2 (0–4) |
| Frailty scores | |
| Median (range) | |
| Rockwood clinical frailty score | 6 (3-9) |
| ECOG performance status | 3 (1-4) |
| Ceilings of care | |
| DNACPR | 29 (72.5) |
| Not for TIPS | 27 (67.5) |
| Not for liver transplantation | 32 (80) |
| Not for transfer to hospital | 4 (10) |

AIH, autoimmune hepatitis; DNACPR, do not attempt cardiopulmonary resussitation; ECOG, Eastern Cooperative Oncology Group; MASLD, metabolic associated steatotic liver disease; MELD-Na, model for end-stage liver disease with sodium; MetALD, metabolic and alcohol associated steatotic liver disease; PSC, primary sclerosing cholangitis; TIPS, transjugular intrahepatic portosystemic shunt; UKELD, United Kingdom Model for End-Stage Liver Disease.

### Referral characteristics, processes of care and resource allocation of *Hepatology at home* episodes

There were with 67 discrete episodes of *Hepatology at home* care for the 40 patients referred (referral characteristics in table 2). Most referrals were from the hepatology department (n=56, 83.6%), other referral sources included the emergency department, acute general medicine or community palliative care. Nearly half of referrals were 'step-up' to *Hepatology at home* after an initial assessment in the Emergency Department or ambulatory unit (n=27, 40.3%). The remainder were 'step-down' for further care with *Hepatology at home* after an inpatient admission or a period of ambulatory management (n=40, 59.7%).

Most referrals were due to complications of cirrhosis either due to acute decompensation (n=27, 40.3%) or

**Table 2** Referral characteristics, processes of care and resource allocation *Hepatology at home* episodes

| Referral characteristic | |
|---|---|
| Source of referral | |
| Number, (%) | |
| Hepatology | 56 (83.6) |
| Acute general medicine | 5 (7.5) |
| Emergency department | 2 (3.0) |
| Community palliative care | 3 (4.5) |
| Outpatient parenteral antimicrobial therapy | 1 (1.5) |
| Type of referral | |
| Number, (%) | |
| Step-up | 27 (40.3) |
| Step-down | 40 (59.7) |
| Primary reason for referral | |
| Number, (%) | |
| Fluid assessment | 42 (62.7) |
| Acute kidney injury | 5 (7.5) |
| Acute infection | 6 (8.9) |
| Venesection | 6 (8.9) |
| Large volume paracentesis | 6 (8.9) |
| Symptomatic anaemia | 1 (1.5) |
| Hyperkalaemia | 1 (1.5) |
| Process of care | |
| Length of *Hepatology at home* episode (days from first assessment to discharge) | |
| Median (range) | 7 (0–47) |
| Frequency of clinical activity | |
| median (range) | |
| Any home visit | 2 (0–43) |
| Hepatology at home MDM | 1 (0–14) |
| Type of healthcare professional performing clinical review at home at any time during an episode | |
| Number, (%) | |
| HaH doctor | 31 (46.3) |
| HaH nurse or allied healthcare professional | 54 (80.1) |
| Hepatology doctor | 4 (6.0) |
| Frequency of home visit by healthcare professional per episode | |
| Median (range) | |
| HaH doctor | 0 (0–6) |
| HaH nurse | 13 (0–40) |
| HaH pharmacist | 0 (0–3) |
| Hepatology doctor | 0 (0–4) |
| Episode where diagnostic test performed | |
| Number, (%) | |
| Bloods | 57 (85.1) |
| Weight | 34 (50.7) |
| Ascitic tap | 5 (7.4) |
| POCUS | 33 (49.3) |
| Frequency of diagnostic test per episode | |
| Median (range) | |
| Blood test | 2 (0–23) |
| Weight | 0 (0–38) |
| Point of care ultrasound | 0 (0–6) |
| Ascitic tap | 0 (0–1) |
| Episode where interventions performed at home | |
| Number, (%) | |
| Intravenous iron | 3 (4.5) |
| Intravenous diuretics | 4 (6.0) |
| Intravenous antibiotics | 6 (9.0) |
| Intravenous HAS | 2 (3.0) |
| Diuretic dose changed | 32 (47.8) |
| Large volume paracentesis | 5 (7.5) |
| Venesection | 6 (9.0) |
| Frequency of intervention per episode | |
| Median (range) | |
| Intravenous iron | 0 (0–1) |
| Intravenous diuretics | 0 (0–39) |
| Intravenous antibiotics | 0 (0–21) |
| Intravenous HAS | 0 (0–3) |
| Diuretic dose changed | 0 (0–7) |
| Large volume paracentesis | 0 (0–2) |
| Venesection | 0 (0–1) |
| Episode where advanced care planning was undertaken | |
| Number, (%) | |
| Advanced care planning discussion | 14 (20.1) |
| New referral to community palliative care | 6 (9.0) |

HaH, hospital at home; HAS, human albumin solution; MDM, multidisciplinary meeting; POCUS, point of care ultrasound; SpR, specialist registrar.

non-acute decompensation (n=29, 43.3%, table 2). No patient met the EASL criteria for ACLF,[40] either at time of acute decompensation or at time of being first seen by *Hepatology at home*. The most common reason for referral was for fluid assessment and management of ascites and/or peripheral oedema (n=42 episodes, 62.7%). Other reasons included the assessment and management of acute kidney injury (AKI, n=5 episodes, 7.5%), acute infection (n=6 episodes, 8.9%), venesection (n=6 episodes, 8.9%), LVP (n=6 episodes, 8.9%), hyperkalaemia (n=1 episodes, 1.5%) and symptomatic anaemia (n=1 episodes, 1.5%, table 2).

The median time from date of first assessment to discharge of the 67 *Hepatology at home* care episodes was 7 days (range 0–47, detailed in table 2). There was a median of 1 MDM per episode at which there was always at least a HaH doctor, a HaH nurse, a hepatology doctor and a hepatology specialist nurse. Thirty minutes were allocated twice a week for MDMs.

There was a median of 2 (range 0–43) clinical visits in the home per episode (table 2). HaH nurses or allied healthcare professionals (AHP, paramedics or pharmacists) performed one or more clinical visits in the home in 54 episodes (80.1%). Other healthcare professionals that performed visits included HaH senior medical doctors in 31 episodes (46.3%) and hepatology specialist doctors in four episodes (6.0%, table 2). HaH nurses most frequently performed visits

(median 13, range 0–40 per episode, table 2). Other specialties involved in management during completed episodes included cardiology, respiratory, infectious diseases, nephrology, community palliative care and the alcohol care team.

Diagnostics undertaken in the home (table 2) included blood tests in n=57 episodes (85.1%), weight in 34 episodes (50.7%), POCUS in 33 episodes (49.3%) and ascitic tap in 5 episodes (7.4%). Blood tests were the most frequently performed diagnostic test (median 2, range 0–23 per episode). POCUS was used for assessment of ascites depth and location and to assess the presence and grade of hydronephrosis in cases of AKI.

The frequency of interventions performed in the home is detailed in table 2. Interventions included alteration in diuretic dosing in 32 episodes (47.8%), intravenous iron in three episodes (4.5%), intravenous diuretics in four episodes (6.0%) and intravenous antibiotics in six episodes (9.0%) and intravenous human albumin solution (HAS) in two episodes (3.0%). Procedures undertaken in the home included LVP in five episodes (7.5%) and venesection in six episodes (9.0%) (table 2). In addition, one patient was treated for SBP at home with antibiotics and HAS as he did not want admission to hospital. Another developed hernia breakdown with ascites leakage and did not want hospital admission, so this was managed at home with LVP and glueing of the defect.

During *Hepatology at Home* episodes of care, advanced care planning discussions occurred in 20.8% (n=14) and new referrals were made to the community palliative care team in 8.9% (n=6), on the judgement of the attending clinician. In addition, the community palliative care team had active input in parallel to the *Hepatology at Home* team in 25.3% (n=17) episodes of care (table 2).

### Outcomes of *Hepatology at home* episodes

The 40 patients referred to the *Hepatology at home* service were followed up for a cumulative total of 3219 days since initial patient referral to the end of the follow-up period or death (median 174, range 1–351 days per patient). No patient was lost to follow-up. All patients were followed up to death or 30-days or more following discharge from a *Hepatology at home* episode.

Patients referred to *Hepatology at home* spent a cumulative 269 days at home (median 5, range 1–72 per patient), where a hospital visit would otherwise have been required. *Hepatology at home* replaced ambulatory assessment on HAU on at least one occasion during 57 episodes (85.1%) of *Hepatology at home* care for 37 patients (92.5%). A cumulative total of 107 HAU assessments were avoided (median 2, range 1–6 per *Hepatology at home* episode, figure 2A). The ratio of HAU assessments avoided to HAU assessments undertaken over the same period was 1:12.8.

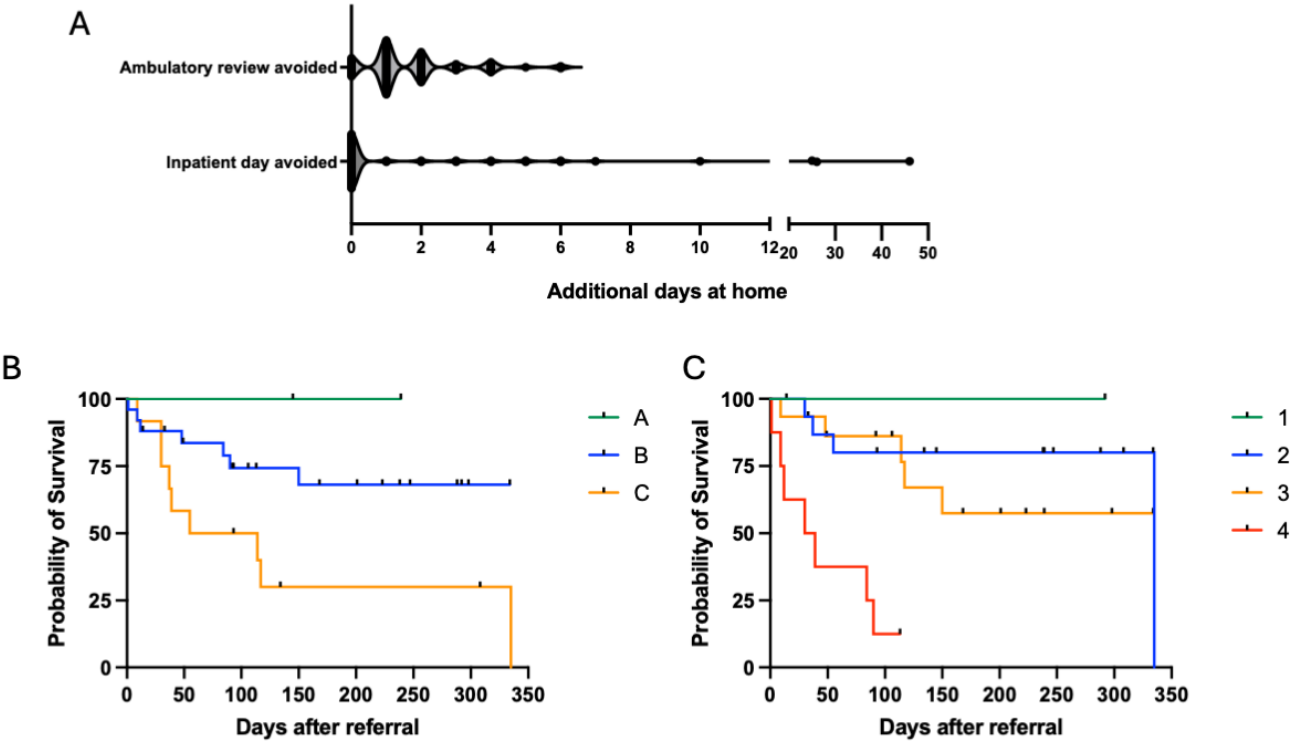


**Figure 2** Outcomes of patients referred to the *Hepatology at home* service. For 40 patients over 67 *Hepatology at home* episodes, (A) violin plots show additional days at home due to ambulatory review avoided (upper plot) or inpatient day avoided (lower plot). Survival curves show probability of survival in days from initial referral to death or end of follow-up by Child-Pugh Class A, B or C (B) and ECOG (Eastern Cooperative Oncology Group) performance status 1, 2, 3 or 4 (C) at time of initial referral.

*Hepatology at home* replaced inpatient admission in 12 patients (30%) across 13 episodes (19.4%). A total of 156 cumulative hospital inpatient days were avoided (median 6 days, range 1–46 per episode, figure 2A). The ratio of inpatient days avoided to hepatology inpatient admission days over the same period was 1:12.5.

Most *Hepatology at home* episodes of care resulted in discharge back to usual hepatology follow-up, either in outpatients or on HAU (n=51, 76.1%). The remainder (n=16, 23.8%) led to direct inpatient admission, due to overt hepatic encephalopathy (n=7), suspicion of upper gastrointestinal tract bleeding (n=4), worsening fluid status (n=2), worsening infection parameters (n=2) or hyperkalaemia (n=1). Within 30 days of discharge from a *Hepatology at home* episode, 38.8% (n=26) went onto require inpatient admission.

Of 40 patients referred, 17 (42.5%) died during the follow-up period. The median time to death from day of initial referral was 66 days (range 1–335). Most deaths (n=13, 76.5%), occurred within 30 days of discharge. There were no unexpected deaths. Child Pugh class and ECOG performance status were significantly associated with survival (p=0.0114, figure 2B and p=0.0003, figure 2C, respectively). Decompensated cirrhosis was the primary cause of death in the majority (n=12, 70.6%). All patients had palliative care input before death and over half died either at home or in a hospice (n=10, 58.8%).

## DISCUSSION

*Hepatology at home* is to our knowledge the first service in the UK providing specialist services to patients with complications of liver disease in the home, replacing either inpatient admission or hospital attendance for ambulatory assessment. We describe a cohort of patients with liver disease that can be managed in the home setting by a predominantly generalist medical team, with specialist hepatology input. We demonstrate that procedures including LVP are feasible and safe to perform at home.

Most patients referred to the *Hepatology at home* service had cirrhosis with acute or non-acute decompensation in an accelerated phase of risk. All patients had a preference to receive care at home, and the majority were frail and/or in their last months of life. The service empowered these patients to have greater choice about where their care was received and enabled them to spend more days at home rather than attending the hospital site for ambulatory reviews or inpatient overnight stays. With the use of point of care blood tests and ultrasound, education of general medical healthcare practitioners in assessing hepatic encephalopathy, and 24-hour access to specialist hepatologist input, the *Hepatology at home* model enabled close specialist management of these patients in the home. When complications such as worsening fluid status, hepatic encephalopathy or upper gastrointestinal bleeding developed in some patients, they were identified early, so transfer to hospital for further management could occur in a timely manner.

*Hepatology at home* was one modality within the continuum of care for our cohort of patients with liver disease, who moved between home-based, ambulatory and inpatient care depending on the changing clinical requirements. Most patients were referred to *Hepatology at home* for assessment and management of fluid overload with ascites. Diuresis in these patients requires close monitoring to balance effective symptom control with risk of electrolyte disturbance, AKI and precipitation of hepatic encephalopathy. Previous data suggest the presence of ascites and peripheral oedema is associated with early readmission to hospital[6 10] and in our institution, general disorders of fluid and electrolyte imbalance are one of the most frequent reasons for attendance at the acute medicine same day emergency care unit.[54] Previously published data that specifically designed interventions in ambulatory 'day hospital' settings have reported reduced mortality and readmission rates in this cohort,[55 56] but the recent ALFIE trial of a complex chronic disease management intervention for such patients did not significantly reduce readmission rates.[57] We did not collect data to evaluate whether the *Hepatology at home* intervention reduces 30-day readmission rates for fluid overload and further studies will be required to investigate this.

The 30-day rate of inpatient admission and 30-day mortality reflects the high risk of unpredictable worsening clinical status in this population and is comparable to published data in patients with liver disease.[4–6] A non-randomised pilot study of a home-based liver service for patients in Australia diagnosed with ACLF according to APASL criteria (LivR Well) had a much lower 30-day mortality of 3% and readmission rate of 15%.[38] This difference is surprising, given that the median baseline Child Pugh (8 vs 9) and MELD-Na (16 vs 17) scores at baseline were similar in the LivR Well and *Hepatology at Home* cohorts, respectively. Furthermore, none of the patients referred to *Hepatology at home* met EASL criteria for ACLF, which carries a higher mortality than acute or non-acute decompensation in patients with cirrhosis.[9 48] In the *Hepatology at Home* cohort, both Child Pugh class and ECOG performance status predicted survival. Patients triaged to *Hepatology at home* were older than patients referred to LivR Well (median age 51 vs 67) and may have been frailer with a worse performance status, which may explain the difference in mortality.

Patients with cirrhosis and their families often do not receive palliative care at the end of life and the majority die in hospital.[12 58 59] During *Hepatology at home* episodes, a fifth of patients had advanced care planning discussions, or such consultations were planned on discharge to be conducted in outpatient clinic. A quarter of episodes had active input from community palliative care alongside *Hepatology at home* or were referred to community palliative care

on discharge. Over half of patients who died during follow-up after a *Hepatology at home* referral died at home or in a hospice. *Hepatology at home* is an example of parallel care, bringing hepatologists, acute general medics and palliative care specialists together and is an intervention that could be replicated in other centres to improve holistic care to patients with liver disease nearing the end of life.

Mortality from liver disease in England has risen by over 40% over the past two decades and varies widely by region, which may be related to inequalities in access to healthcare underpinned by socioeconomic differences.[1 5] The patients triaged to *Hepatology at Home* had a median IMD of 9 (with IMD 1 being most deprived and 10 least deprived). Future work will need to understand whether this matches the underlying IMD distribution of all patients with liver disease locally, or whether patients from more deprived backgrounds are experience barriers to access *Hepatology at Home* care.

Increased distance to tertiary referral centres or liver transplant centres and lack of specialist hepatologists in many District General Hospitals have also been suggested as factors that might account for regional inequalities in liver disease mortality in England,[60] but this has not been assessed outside the UK. *Hepatology at Home* is the first service in the UK to our knowledge of a service where the mainstay of clinical assessment is undertaken by non-specialists and point-of-care diagnostics enable expert hepatologists to remotely inform clinical management decisions in real time. This model has enabled more efficient use of hepatology specialist time, freeing up access to hepatology inpatient beds and hospital-based ambulatory assessment for other patients, for example, those requiring regular LVP. It has empowered general medical physicians, nurses and allied healthcare professionals with experience in clinically assessing and managing patients with complications of liver disease. *Hepatology at Home* is an effective example of a specialist hepatology 'hub-and-spoke' model, suggested as one solution to address the inequalities in care for patients with liver disease, whereby within regions generalists refer into a centre to access hepatology advice in MDMs.[13]

This study has limitations. It is a single centre prospective description of the first 12 months of the *Hepatology at home* service. The absence of criteria for discharge from a *Hepatology at home* episode means the primary outcome of number of at-home days may have been biased by the judgement of the attending clinical team, who are likely to have had different thresholds for discharging via de-escalation to usual outpatient or ambulatory clinical care or escalation to inpatient admission. The population studied were triaged to, and accepting of at-home care. As such, they were subjected to selection bias from both triaging clinician and self-selection, which may affect generalisability to other institutions with different geographical and cultural settings.

Equivalence in terms of efficacy and cost-effectiveness to alternative care models including inpatient or ambulatory hepatology care cannot be inferred. The study does not explore the experiences of patients and their carers who were referred to the *Hepatology at home* service and patient-reported outcome measures were not collected. The service model as described here may not be generalisable in this form to other centres, where human and capital resource and service set up may differ, particularly in centres without an established HaH service.

Going forward, it will be necessary to understand whether the clinical efficacy and cost-effectiveness of *Hepatology at home* and other home-based care models for patients with liver disease are comparable to hospital-based standard-of-care through randomised controlled trials, natural experiments or realist methods.[61–63] The ongoing randomised trial of LivR Well will answer some of these questions.[52] However, it will be necessary to understand how home-based services for liver disease can be delivered effectively in a variety of contexts, where health service infrastructure and patient population differ. The acceptability and efficacy of hepatology-specific remote monitoring technologies such as CirrhoCare[64] and POCUS in patients with liver disease also need to be explored, to understand whether these technologies can strengthen the quality of care delivered in the home environment. Finally, a better understanding of the patient and carer experiences of home-based services is crucial, to identify outcomes beyond mortality that may be of greater importance to patients. Although quality of life data collection in patients with liver disease nearing the end of life can be challenging, such data have been successfully collected in patients undergoing ascitic drainage via long-term indwelling abdominal drains in the home.[65]

In summary, we describe *Hepatology at home* a service that provides hospital-level care to patients with liver disease in the home. We describe the clinical characteristics, processes of care and outcomes of patients referred in the first 12 months of the service and find this model is feasible and enabled patients to have an increased number of at-home days. *Hepatology at home* is an exemplar of community-based patient-centred care for patients with liver disease, which can act as a blueprint for the development of similar services in other centres.

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**Competing interests** DL has undertaken education and training events (unpaid) for Butterfly Network Inc (manufacturer of a point of care ultrasound system).

**Patient consent for publication** Not applicable.

**Ethics approval** The study was conducted in accordance with the Declarations of Helsinki and Istanbul. It was registered and approved as a quality improvement clinical service evaluation by OUH NHS Foundation Trust, number 9705. As such no written informed consent was required from participants.

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