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Original Research

The Royal Free Hospital 'hub-and-spoke network model' delivers effective care and increased access to liver transplantation

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ABSTRACT

Objectives: 'Hub-and-spoke' networks may be one solution to reduce the geographical inequality in access to liver transplantation (LT) and the growing demands on, and saturation of, LT centres. It is not clear if such networks improve equity of access, deliver comparable patient outcomes or effect patient satisfaction.

Study design: Retrospective evaluation of outcomes and patient satisfaction within the Royal Free liver transplant 'hub-and-spoke' network.

Methods: Patient outcomes in those assessed for LT between September 2011 and 2014 at spoke centres ($n = 4$) were compared retrospectively with those assessed at the LT hub centre. Patient satisfaction questionnaires were completed and changes in LT referral patterns were explored with data obtained directly from NHS Blood and Transplant (NHSBT).

Results: A total of 655 patients (180 spoke; 475 hub) were assessed for LT. Patients referred from spoke centres were more likely to have viral hepatitis as an underlying aetiology (72/180 vs 110/475; $P < 0.001$), or hepatocellular carcinoma (48/180 vs 60/475; $P < 0.001$) as an indication for LT and were more likely to be listed for LT when compared with hub patients (139/180 vs 312/475, $P = 0.005$). Mortality on the waiting list (9/123 vs 25/269, $P = 0.57$), waiting time to LT (64-days vs 78-days, $P = 0.91$) and Model for End-Stage liver disease (MELD)/United Kingdom End-Stage Liver Disease (UKELD) score ($P = 0.24/0.26$) in listed patients were equivalent as were 1- and 3-year patient and graft survival rates. Patient satisfaction rates were high at both types of centre, with significantly more patients preferring 'locally delivered care' at spoke vs hub (11/50 vs 70/73, $P \leq 0.0001$). Since the development of formal hub-and-spoke networks data from NHSBT based on postcode confirmed a significant increase in patients undergoing LT (153%) from spoke centres, whereas numbers assessed and transplanted from the hub centre have remained static.

Conclusion: Hub-and-spoke LT networks are effective in offering equivalent clinical outcomes, high patient satisfaction and alleviate clinical pressure on the hub centre. They

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have to potential to help eliminate the geographical disparity in mortality rates from chronic liver disease.

Introduction

Liver disease in the United Kingdom (UK) is the third commonest cause of premature death with a 400% increase in standardised mortality since the 1970s and remains the glaring exception to the vast improvements made within UK health care over the last 30 years.[1–3] In England and Wales, approximately 60,000 patients have cirrhosis, with 1- and 5-year survival rates of just 0.55 and 0.31 respectively for those with a previous liver-related hospital admission.[4,5] There is a significant and worrisome geographical disparity in mortality rates for cirrhosis, such that premature death rates from chronic liver disease in England vary 3.9 fold between primary care trusts.[1,4] The recent Atlas of Variation in Liver disease published by NHS England this year, shows an almost eight times variation in the rates of premature death form liver disease across the UK, highlighting the stark variation in liver services.[6] Moreover, it is clear that 'non-specialist' liver hospitals are denying a significant proportion of their population access to LT via lack of referral.[7] In 2014 and 2015, *The Lancet* commission highlighted these issues and proposed strategies to improve outcomes for patients with liver disease, including hub-and-spoke referral pathways to improve access to liver transplantation (LT).[1,8]

LT is a life-saving, life-enhancing procedure for patients with decompensated chronic liver disease (CLD) with survival rates of 90% and 80% at 1 and 5 years respectively.[9] The number of transplants performed annually in the UK is increasing but lags behind the number needing LT which has more than doubled between 2008 and 2015.[10] A failure to invest in, or to develop, LT services over the last 20 years means LT centres are in a poor position to adapt to increased demand,[11] while the number of LT centres within England (six) remaining static over that time. The current NHS Blood and Transplant (NHSBT) 2020 strategy to increase the number of LT performed by 50% by 2020 (by donor optimisation, improved organ offering procedures, policies to encourage organ donation and use of deceased after cardiac death organs) raises concerns regarding the capacity of LT centres to cope with the anticipated increase.[11,12] An additional challenge regarding LT within the UK is that access to LT services is not geographically equitable; LT rates in the UK are highest with geographical proximity LT centres, as opposed to reflecting regions with the greatest disease burden.[4,7]

Historically, patients being considered for LT are referred to a particular LT centre where pretransplant optimisation, the LT assessment process, waiting list management, surgery and post-operative care are delivered. It is accepted that the current configuration of LT services in England reflect historical enterprise and centres were not established with the epidemiology of CLD, geographical variation in disease burden or patient need in mind.[12] Bilateral arrangements between LT and regional centres have been adopted *ad hoc* as a potential solution to improve access and to cope with increased demand using a 'hub-and-spoke' model,[12] which has proved effective in other conditions including stroke and cancer care.[13–15]

Our view is that established networks with spoke centres defined by need based on patient population and geographical remoteness in conjunction with local and central enthusiasm is the best model to deliver LT with mutual benefits for the hub, spoke and the patient (Table 1). Although recommended as a model for LT care, the hub-and-spoke model has not been assessed with regards to outcomes, patient satisfaction or impact on improving geographical access to LT.[8,12]

The aim of the present study was to determine if LT 'hub-and-spoke' network arrangements delivered equitable clinical outcomes and patient satisfaction when compared with patients managed solely at the hub. Moreover, we assessed if access to LT (via number of LTs performed per region over time) increased with the introduction of a hub-and-spoke network.

Methods

In September 2011, formal network arrangements were established between the Royal Free Hospital (RFH) and four specialist tertiary liver units (The Royal London Hospital, London [RLH], St Mary's Hospital, London [SMH], The Royal Devon & Exeter, Exeter [RDE] and United Hospitals Bristol, Bristol [UHB]). Patients were defined as managed at the hub alone (RFH) or at one of the four spoke centres.

Service level agreements (SLAs) for assessment, management on the waiting list and post-operative care were predefined; all aspects of pre- and post-operative care, short of LT surgery and immediate post-operative recovery were managed at the spoke centres with regular outreach sessions provided by RFH physicians (Fig. 1). Data were collected retrospectively on all patients referred and assessed for LT at the RFH between September 2011 and September 2015, and these patients were followed up until the censor point in May 2016. Patients referred or transplanted for acute liver failure were excluded. Baseline characteristics were collated (Table 2). Patients were classified as having decompensated CLD if they had a qualifying United Kingdom End-Stage Liver Disease (UKELD) score *and* an episode of hepatic decompensation, irrespective of hepatocellular carcinoma (HCC) status, and patients were classified as having HCC when this was their only indication for LT. Significant clinical outcomes were recorded including listing for LT, waiting time to LT, death on the waiting list, access to donation after brain death (DBD) organs and 1- and 3-year patient and graft survival rates were recorded.