Evaluating the clinical experience of a regional in-center nocturnal hemodialysis program: The patient and staff perspective

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Abstract

Introduction: End-stage kidney disease causes significant morbidity, mortality, and reduced quality of life. Despite improvements in conventional hemodialysis, these problems persist. In-center nocturnal hemodialysis (INHD) has been shown to be beneficial in observational studies. This report outlines a 4-year renal network experience of INHD from the patient and frontline staff perspective.

Methods: Staff and patients’ experiences of INHD were evaluated through two work streams. Work stream one: 12 patients who chose to stop INHD and 24 patients who chose to continue with INHD completed an anonymous survey. Work stream two: one-to-one interviews with 20 patients receiving INHD and seven staff working INHD shifts were conducted. Clinical incident reporting for conventional hemodialysis and INHD from April 2014 to December 2018 was reviewed.

Findings: Work stream one: Five themes were identified; facilities, time, health and well-being, sleep, and transport. A patient “starter pack” was developed and improvements to the dialysis unit were completed. Work stream two: Patient interviews demonstrated starter packs to aid sleep were well received; sleep itself was not a single reason to discontinue INHD. Staff indicated that their greatest concern was staffing levels; although staff-to-patient ratio remains unchanged, total numbers on INHD shifts were fewer, causing concern around less colleague availability for support during an emergency. Safety: 363 clinical incidents were reported across all dialysis
INTRODUCTION

Over 66,000 adults in the United Kingdom receive renal replacement therapy (RRT) with the prevalence of end-stage kidney disease (ESKD) increasing each year. In-center hemodialysis is the treatment modality for a third of patients and typically consists of 4-hourly thrice weekly hemodialysis sessions for individuals with minimal residual renal function. Although hemodialysis is often the only suitable treatment available for those for whom a kidney transplant is not an option, it is associated with significant morbidity and mortality. Individual health-related quality of life (HRQoL) reflects the impact of long-term medical conditions (both physical and mental), treatment, health risks, socioeconomic status, functional ability, and support on overall well-being. The Dialysis Outcomes and Practice Patterns Study demonstrated that HRQoL is an independent predictor of adverse events, including hospitalization and mortality, in the dialysis population, and hemodialysis is associated with poor self-reported HRQoL when compared to the general population norms across three different continents.

In-center nocturnal hemodialysis (INHD) facilitates longer treatment times overnight, but is not routinely available. Data from observational studies suggest that extending hemodialysis treatment time is associated with improvements in mortality, cardiovascular disease, biochemical parameters, and self-reported HRQoL. A recent systematic review of randomized and nonrandomized trial data found no effect of extended-hours hemodialysis regimens (such as INHD) on HRQoL and mortality; however, the studies were found to be of high risk of bias and low quality. This demonstrates the requirement for well-designed randomized controlled trials to assess the impact of INHD on outcomes compared to conventional hemodialysis to inform patient choice and clinical practice.

The Standardized Outcomes in Nephrology initiative has identified the lack of progress in improving the health and quality of life for prevalent dialysis patients, and the importance of generating findings relevant to patients, caregivers and health care professionals. Due to the potential benefits of INHD, a randomized controlled trial is an essential next step in our understanding of this alternative dialysis regimen. This will be addressed in the upcoming National Institute for Health Research (NIHR) funded NightLife study: a randomized controlled trial assessing the effectiveness and cost effectiveness of thrice weekly, extended, INHD versus standard care using a mixed methods approach (trial registration: ISRCTN87042063, funder reference: NIHR127440). To optimize trial design, our group has completed quality improvement cycles of the INHD program across the Leicester Renal Network, which was initiated in 2014. In this article, we report the findings of our patient-centered evaluation of the INHD program to demonstrate factors which affect uptake and adherence to INHD, the role of a patient-centered intervention to support transition to INHD, and to establish dialysis unit staff concerns as they provide a novel dialysis treatment.

MATERIALS AND METHODS

Two consecutive work streams were developed to assess the INHD program provided by the Leicester Renal Network. The Leicester Renal Network is one of the largest renal programs in the United Kingdom, providing in-center hemodialysis for almost 900 adults with ESKD across 10 dialysis units. In-center nocturnal hemodialysis has been offered since 2014 and is ongoing, with the availability to two cohorts over six nights of the week at one hospital dialysis unit and two satellite dialysis units in the Leicester Renal Network. At the time of data collection, ≈8% of the outpatient dialysis appointments at these three units were delivered through INHD.
Definition of the intervention

The INHD program provides individuals requiring maintenance hemodialysis with 6 to 8 hours of in-center hemodialysis thrice weekly overnight (largely dependent upon patient choice). Typically, patients arrive at the dialysis unit between 10 p.m. and 11 p.m., and have commenced their hemodialysis treatment by 11:30 p.m.; midnight until 6 am is designated as sleep time with minimized disturbance to enhance rest. Patients leave their INHD session between 5 a.m. and 6 a.m., often with prearranged hospital transport, or occasionally their own transport. In most cases, connection to the hemodialysis machine is completed by a dialysis nursing staff; however, there are some patients who assist with setup as part of an individual shared-care plan. Hemodialysis access can be either an arteriovenous fistula or graft, or venous catheter. All hemodialysis treatments are completed by 6 a.m., providing enough time for the dialysis unit team to prepare the unit for the next hemodialysis session. The hemodialysis prescription is individualized and takes into account the effect of extended hours treatment on: anticoagulation, dialysate potassium concentration, phosphate supplementation, and urea clearance.

Definition of usual care

Conventional hemodialysis was defined as three and a half to five hours of in-center hemodialysis thrice weekly during the day. Hemodialysis access can either be through an arteriovenous fistula or graft, or central venous catheter, and setup on hemodialysis can be led by the dialysis nursing staff or as part of an individual shared-care plan.

Project registration

This project was registered with the University Hospitals of Leicester Clinical Audit Department (registration number 6610) and received funding from the Kidney Care Appeal, registered charity number 1056804.

Work stream one

Work stream one was designed to identify the factors influencing uptake and adherence to INHD. A patient survey was developed following discussion with the dialysis unit nursing team, and patients receiving both conventional hemodialysis and INHD to ensure considerations valuable to patients were being addressed.

Work stream two

Work stream two reassessed patient experiences 12-months after implementation of the patient-centered intervention. It also explored dialysis staff concerns across two of the dialysis units offering INHD. Initially patients and staff were invited to an open forum; uptake was poor due to the requirement for an additional visit to the hospital. Instead, patients and staff were approached on the dialysis unit at the start of INHD shifts for a brief informal one-to-one interview with verbal consent; notes were taken, all the opinions were anonymized and underwent thematic analysis. To further assess any safety concerns of the dialysis nursing staff, clinical incidents (reported through the DatixWeb system [v14.0.30, Datix Ltd., London UK]—an electronic system used by individual healthcare organizations) for the dialysis units were collected from April 2014 (the initiation of the INHD service) to December 2018.

Data analysis

The free text sections of the survey and notes gathered from the informal one-to-one interviews underwent thematic analysis. Percentages were calculated for multiple choice questions. Continuous data (POS-S renal and time to recovery) were compared between the groups (INHD vs conventional hemodialysis) using independent t-tests or Mann–Whitney test as appropriate. The clinical incident reports were categorized for both INHD and conventional hemodialysis. To review the proportion of different
types of clinical incidents reported for INHD and conventional hemodialysis, percentages were calculated. All percentages are reported to one decimal place followed by the number used to calculate the percentage in brackets.

RESULTS

Work stream one

At the time of data collection, 34 patients were identified from the Leicester Renal Network as having stopped receiving INHD as a maintenance treatment. Twenty-one of these patients stopped INHD due to a specific change of clinical circumstance, as reported in Table 1, and were not approached to complete the survey. Thirteen of these patients chose to return to conventional hemodialysis after experiencing INHD, and 12 agreed to complete the survey. Patients who chose to continue with INHD were approached to complete the survey until data saturation was achieved (n = 24); all those approached agreed to participate. Therefore, in total, 36 anonymous surveys were completed from patients who both chose to stop or continue with INHD, as outlined in Figure 1. Table 2 reports the demographic features of these 36 patients that completed the anonymous survey.

From all the completed surveys (n = 36), the multiple-choice questions indicated: 69% (n = 25) patients reported they preferred INHD, 72% (n = 26) patients reported INHD was convenient or caused less disruption compared to conventional hemodialysis, and 75% (n = 27) reported they were unable or had difficulty falling asleep on INHD with 67% (n = 24) of patients stating their sleep quality was worse than usual. 67% (n = 24) patients reported that they either felt “slightly better” or “significantly better” in their general health when receiving INHD. Table 3 reports a full breakdown of the closed question results. The POS-S renal questionnaire to assess symptom experience was lower for patients receiving INHD (total = 11) than those on conventional hemodialysis (total = 14), but this difference was not statistically significant (p = 0.3). Similarly, the length of time required to recover from a session of hemodialysis was shorter for patients on INHD (42 min) than those on conventional hemodialysis (262 min), but this difference was not statistically significant (p = 0.2).

Assessment of the free text sections identified five key themes: facilities, time, health and well-being, sleep, and transport. Problems with the local facilities in the unit was a common issue with patients reporting disruption from noise (e.g. dialysis machine alarms), disruption from lights, unit temperature (especially being too cold with the air conditioning), and bedding quality (e.g. uncomfortable mattresses). Waking hours-time not impacted by treatment was a key motivating factor to commence and remain on INHD as patients reported they had more time between hemodialysis sessions which was beneficial for resting, time with their family, and employment. Furthermore, many patients reported significant improvements in their health and general well-being including reduced medication burden, better symptom management (particularly breathlessness from fluid overload), and stable blood results. Patients reported being able to do more with their day. Conversely, poor sleep quality and subsequent fatigue was a recurring issue and a key reason for some stopping INHD. Delays in hospital transport causing late commencement of dialysis or delayed journeys home were a common issue for both INHD and conventional hemodialysis. Table 4 demonstrates some of the comments made for each identified theme.

These results led to the development of a “patient starter pack” for INHD which included a sleep pack (ear plugs and eye masks) and a patient information leaflet with practical advice on how to prepare for INHD. Alterations to the dialysis unit facilities were made with soft close bins and doors, increased number of torches for nursing staff to avoid using main lights during the night, and an agreed “lights out time” whereby disruption is minimized to enhance sleep quality.

WORK STREAM TWO

Patient interviews

Twenty patients receiving INHD were interviewed and the following key themes identified: facilities, health and well-being, sleep, and starter packs. With regard to facilities, there were mixed reports with patients expressing both satisfaction (e.g. no concerns, comfortable bedding, and quiet during the night) and criticism (e.g. temperature of the dialysis unit and noise disruption from machines alarming). There were no concerns raised.
regarding the lighting or any other noise disruption. In concordance with work stream one, improvements in health and well-being were frequently reported; generally feeling better with enhanced energy levels which enabled patients to achieve more during the day (e.g. travel to see friends and relatives, complete active tasks at home), reduced side effects from dialysis, stable blood results, and better control of fluid balance. Sleep remained an issue for some; however, patients often overcame this by having a short period of rest at home following their INHD. Additionally, due to the perceived health benefits, sleep would not be a reason to stop INHD and the patients would recommend it as a RRT option.

The starter packs were well received by the patients with reports of improved sleep quality with ear plugs and face masks.

### Staff interviews

Seven unit nursing staff were interviewed. The most frequently reported concern was staffing levels; although the staff-to-patient ratio was unchanged, the total number of staff on INHD shifts was less, generating concerns around the availability of support in an emergency. This led to a belief that more complex patients should not have access to INHD. Hemodialysis access was also a
common theme, with the nursing staff expressing a preference for patients to have well-established access prior to commencing INHD to avoid poor dialysis flows and persistent machine alarming, which disturbs patients. The potential impact of less sleep during INHD and transport delays after INHD was identified. Nonetheless, nursing staff also frequently reported patients informing them that their quality of life has improved with INHD, with staff also independently observing improvement in patient fatigue.

### Report of clinical incidents

From April 2014 to December 2018, 363 clinical incidents were reported; 327 for conventional hemodialysis and 36 for INHD. These have been categorized in Table 5. For all the clinical incidents, after internal investigation, 82.1% (n = 298) were approved as causing “no harm” and 17.6% (n = 64) as causing “minor harm” (i.e., nonpermanent harm or first aid required such as after a fall in the dialysis unit). There was one incident reported as “moderate harm” occurring during conventional hemodialysis as a result of suspected pulmonary edema due to blood transfusion volume not being accounted for in an ultrafiltration target.

Clinical incidents reported during conventional hemodialysis included a larger proportion relating to medical intervention (treatment side effects, issues with blood transfusions, medication errors), infection control and transport. With INHD, there were a larger

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**Table 3** Responses to closed questions for the patient survey in work stream one

| Survey item                        | Total % (n = 36) | Current INHD % (n = 24) | Previous INHD % (n = 12) |
|------------------------------------|-----------------|-------------------------|--------------------------|
| Dialysis regimen preferencea      |                 |                         |                          |
| INHD                               | 69.4% (25)      | 91.6% (22)              | 25.0% (3)                |
| CHD                                | 25.0% (9)       | 0                       | 75.0% (9)                |
| Convenience of INHD                |                 |                         |                          |
| Inconvenient                       | 16.7% (6)       | 0                       | 50.0% (6)                |
| More disruption                    | 8.3% (3)        | 4.2% (1)                | 16.7% (2)                |
| No difference                      | 2.8% (1)        | 0                       | 8.3% (1)                 |
| Less disruption                    | 22.2% (8)       | 25.0% (6)               | 16.7% (2)                |
| Convenient                         | 50.0% (18)      | 70.8% (17)              | 8.3% (1)                 |
| Ability to fall asleep on INHD     |                 |                         |                          |
| Unable to fall asleep              | 30.6% (11)      | 20.8% (5)               | 50.0% (6)                |
| Harder than usual                  | 44.4% (16)      | 50.0% (12)              | 33.3% (4)                |
| No change                          | 16.7% (6)       | 16.7% (4)               | 16.7% (2)                |
| Easier than usual                  | 5.6% (2)        | 8.3% (2)                | 0                        |
| Ability to remain asleep on INHD   |                 |                         |                          |
| Unable to remain asleep            | 33.3% (12)      | 20.8% (5)               | 58.3% (7)                |
| More restless than usual           | 33.3% (12)      | 33.3% (8)               | 33.3% (4)                |
| No change                          | 30.6% (11)      | 41.7% (10)              | 8.3% (1)                 |
| Less restless than usual           | 0               | 0                       | 0                        |
| Overall sleep quality              |                 |                         |                          |
| Significantly worse                | 41.7% (15)      | 20.8% (5)               | 83.3% (10)               |
| Slightly worse                     | 25.0% (9)       | 33.3% (8)               | 8.3% (1)                 |
| No change                          | 27.8% (10)      | 37.5% (9)               | 8.3% (1)                 |
| Better than usual                  | 2.8% (1)        | 4.2% (1)                | 0                        |
| General health whilst on INHD      |                 |                         |                          |
| Significantly worse                | 11.1% (4)       | 0                       | 33.2% (4)                |
| Slightly worse                     | 5.6% (2)        | 0                       | 16.7% (2)                |
| No difference                      | 13.9% (5)       | 8.3% (2)                | 25.0% (3)                |
| Slightly better                    | 25.0% (9)       | 37.5% (9)               | 0                        |
| Significantly better               | 41.7% (15)      | 50.0% (12)              | 25.0% (3)                |

*aOne patient stated “no preference,” one patient did not respond to this question (both current in-center nocturnal hemodialysis [INHD] patients).
proportion of clinical incidents relating to communication with patients or their relatives, delays in patient transfers, medical device or equipment error (most frequently issues with dialysis machines), and issues with the facilities (some nocturnal dialysis sessions were interrupted by water treatment). A larger proportion of patients on conventional hemodialysis missed dialysis compared to INHD and the proportion of patients that became clinically unwell during INHD and conventional hemodialysis was similar.

With regard to staffing levels, the majority of clinical incidents occurring during INHD were due to dialysis unit nursing staff being moved to support inpatient care; however, minimum ratios were always maintained and there was no subsequent harm to patients. Clinical incidents relating to conventional hemodialysis staffing levels were due to sickness absence and there was no subsequent harm to patients.

These results are demonstrated in Table 5 with the proportion of clinical incidents reported at a percentage followed by the actual number in brackets.

**DISCUSSION**

This report has identified that the key motivators for starting and adhering to INHD are: more free time during the day despite increased total dialysis hours and perceived health benefits and reduction in ESKD associated symptoms, including fatigue. Poor sleep quality is a frequent barrier to continuing with INHD, but only when the subsequent fatigue causes the loss of time initially gained by dialyzing at night. Simple adjustments in dialysis unit facilities (e.g. soft-close bins and doors, portable lights and telephones, and sleep packs consisting of ear plugs and an eye mask) can help improve patient sleep and overall experience. Dialysis unit nursing staff require support when transitioning from daytime to INHD shifts...
to alleviate concerns regarding reduced overall staffing numbers (although ratios maintained).

Similar themes regarding the reasons to commence and adhere to INHD were identified in work stream one (anonymous surveys from individuals who continued and stopped INHD) and work stream two (patient and staff informal one-to-one interviews, review of clinical incidents). Patients value the convenience and experience of having more time in the day as a result of INHD, and this frequently outweighed the reduced sleep quality during the INHD session. The value of free-time has been reported in a number of patient cohorts; chronic kidney disease patients have expressed a desire for more research to ensure their treatment fits in with daily life. Home daily and nocturnal hemodialysis patients report more control in their life from the availability of free-time, home hemodialysis patients report treatment and lifestyle flexibility, and daily hemodialysis patients report improvements coordinating their day-to-day routine including work. Improvements in health, reflected by reduced medications, enhanced symptom control, and better energy levels, were reported as a key motivating factor to continue with INHD in this service evaluation. In their assessment on the impact of pill burden on maintenance hemodialysis patient, Chiu et al. found that in 233 participants (79% in-center hemodialysis), higher pill burden was associated with lower physical component summary scale scores. Symptom burden is associated with reduced quality of life in patients with ESKD receiving dialysis or palliative management, and this impact is comparable to that experienced by patients with advanced malignancy.

Two-thirds of patients on INHD reported impact on sleep quality, which influenced adherence to the service; any detriment to sleep quality is a concern as it is associated with reduced quality of life and mortality. Conversely, there are reports of improved sleep quality with INHD; Koch et al. found that 6-months of INHD resulted in improved objective and subjective assessments of sleep quality and some resolution of the nocturnal melatonin rhythm, which is typically disrupted in patients with ESKD. Hanly et al. demonstrated significant reductions in the number of apneic and hypopneic episodes when patients with sleep apnea converted from conventional hemodialysis to nocturnal hemodialysis. In this report, simple measures to reduce disturbance during the night—for instance a dedicated “lights out” time, sleep packs containing an eye mask and ear plugs—improved patient experience, with enhanced symptom control and more time available during the day contending the impact on sleep.

Although this report is unable to fully establish the safety of INHD compared to conventional hemodialysis due to the limitations of data collection and assessment, there are some observed differences and similarities in clinical incidents between the two types of hemodialysis. A larger proportion of incidents were related to delayed admission to inpatient care during INHD; however, as the availability of porters and hospital beds is dictated by out of hours hospital activity, this is unlikely to be a specific INHD practice issue. There were also a greater proportion of communication incidents with patients and relatives (as a result of reduced availability of face-to-face consults on the unit). Therefore, alternative doctor and nurse led consults may be needed for patients receiving INHD, such as telephone appointments, to provide updates regarding care. Dialysis unit nursing staff did report concern regarding staffing levels as the total number of staff is fewer during the night, although staff to patient ratios are maintained. Throughout both work streams, safety concerns were not expressed by any of the patients. When interviewing 12 patients receiving maintenance hemodialysis, Lovink et al. found that although patients do identify risks associated with hemodialysis, they often felt safe during hemodialysis due to the presence and influence of their nursing care.

There are a number of limitations when evaluating our findings. This work focuses on patient and staff experience, and a review of clinical incident reports. Our findings could guide practical approaches when developing or improving a dialysis service and engender theories as to the impact of INHD on patient experience and outcomes for further research, but firm conclusions cannot be drawn. The data are at risk of substantial bias due to their reliance on self-report from patients and dialysis unit nursing staff, and the variance in clinical incident reporting practices between staff. In addition, the number of patients and cohort characteristics, as well as the volume and nature of work, will vary between conventional hemodialysis and INHD, and adjustments for this was not feasible when comparing clinical incident reporting. Data were gathered from a single renal network and so may not be representative of the national dialysis population. However, data were collected from three dialysis units (one hospital based and two satellite units) and so does reflect practice of one of the largest dialysis programs in the United Kingdom.

**CONCLUSION**

In-center nocturnal hemodialysis offers an alternative RRT modality for patients with ESKD. Increased social time and perceived health benefits are key factors for the uptake and adherence to INHD. Reductions in sleep quality may impact continuation with the service. Simple
adjustments to the dialysis environment can enhance patient experience and sleep during INHD. There is a lack of randomized controlled trial data assessing the impact of INHD on patient outcomes, and quality of life is an under-assessed outcome despite being of value to patients, caregivers, and the clinical team.

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CONFLICT OF INTEREST
The authors declared no potential conflicts of interest.

STATEMENT OF ETHICS
Ethical approval was not required. This report was registered at the University Hospitals of Leicester NHS Trust audit department.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section at the end of this article.

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