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Original Investigation

In-Center Nocturnal Hemodialysis Versus Conventional Hemodialysis: A Systematic Review of the Evidence

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Background: Owing to its longer treatment duration—up to 8 hours per dialysis treatment—in-center thrice-weekly nocturnal hemodialysis (HD) is receiving greater attention. To better understand the evidence for in-center nocturnal HD, we sought to systematically review the literature to determine the effects of in-center nocturnal HD versus conventional HD on clinically relevant outcomes.

Study Design: We searched MEDLINE, Embase, Evidence-Based Medicine Reviews (EBMR), Web of Science, and Scopus from the earliest date in the database to November 2016.

Setting & Population: Adults receiving in-center nocturnal HD compared with those receiving conventional HD.

Selection Criteria for Studies: All quasi-experimental and observational studies were considered; randomized trials were sought but not found.

Predictor: Nocturnal vs conventional in-center HD.

Outcomes: Indexes of blood pressure and left ventricular hypertrophy, markers of anemia, measures of bone mineral metabolism, nutrition, quality of life, sleep quality, episodes of intradialytic hypotension, hospitalization, and mortality.

Results: Of 2,086 identified citations, 21 met the inclusion criteria, comprising a total of 1,165 in-center nocturnal HD patients and 15,865 conventional HD patients. Although there was substantial heterogeneity in reporting of outcomes, we pooled data for measures of blood pressure, anemia, and mineral metabolism. Though heterogeneity was generally high, in-center nocturnal HD was associated with improved systolic blood pressure (−3.18 [95% CI, −5.58 to −0.78) mm Hg, increased hemoglobin levels (0.53 [95% CI, 0.11-0.94] g/dL), and lower serum phosphate levels (−0.97 [95% CI, −1.48 to −0.46] mg/dL).

Limitations: No randomized trials have been conducted to address the clinical effects of in-center nocturnal HD. The quality of the observational literature contributing to the results of this review was generally poor to moderate. Confounded outcomes are a significant concern. Publication bias and outcome reporting bias remain possibilities.

Conclusions: Relative to conventional HD, in-center nocturnal HD was associated with improvements in several clinically relevant outcomes. Other benefits may not have been detected due to small sample sizes of included studies; no prespecified outcome was worse with in-center nocturnal HD.

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INDEX WORDS: Hemodialysis (HD); in-center nocturnal HD; nocturnal HD; conventional HD; left ventricular hypertrophy; cardiac geometry; blood pressure; mineral metabolism; hyperphosphatemia; intradialytic hypotension; hospitalization; mortality; intensive HD; dialysis dose; dialysis modality; systematic review.

Home nocturnal hemodialysis (HD) conducted 5 or 6 nights per week has received increased attention owing to the significant body of evidence describing its benefits compared to conventional thrice-weekly in-center HD. A systematic review by Walsh et al[1] summarized these benefits as they pertain to decreased blood pressure, improved indexes of mineral metabolism, decreased medication use, and improved quality of life. Subsequent studies, including 2 randomized controlled trials, have supported many of these outcomes and suggest that these benefits may translate into improved survival.[2-5]

However, not all patients are suitable candidates for home nocturnal HD 5 or more times per week, although intensive therapy may otherwise be indicated. The reasons are varied and may include unsuitable environment in the home, inadequate social support, lack of personal resources, and/or comorbid conditions prohibiting self-administration of HD. This has led some renal programs to offer a variation of

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home nocturnal HD, but in an in-center setting. Drawing on the success of home nocturnal HD[6-8] and the decades-long experience of thrice-weekly 8-hour in-center dialysis (as practiced in Tassin, France[9,10]), in-center nocturnal HD is usually conducted 3 nights per week, with each session lasting up to 8 hours. Thus, in-center nocturnal HD avoids some of the patient-perceived barriers to home dialysis, including the fear of self-cannulation, medicalization of the home, and the potential for catastrophic events during unsupervised dialysis.[11,12] Interest in this treatment paradigm is also increasing for a number of reasons. First, because it is administered at night with each session lasting up to 8 hours, there is hope that thrice-weekly in-center nocturnal HD will result in many or some of the benefits typically associated with intensive home nocturnal HD provided 5 or more nights per week. Second, because in-center nocturnal HD uses existing dialysis facilities during hours when the dialysis unit is otherwise not operational, it may be a means to increase the capacity of a renal program by opening an additional shift (an overnight fourth shift) without the capital expenditure to build an entirely new unit or expand an existing one.[13] Thus, how in-center nocturnal HD compares to conventional dialysis is of considerable interest not only to clinicians, but also dialysis providers and administrators.

The literature reporting the effects of in-center nocturnal HD is limited to single-center observational studies with small sample sizes. Thus, we sought to conduct a systematic review to summarize the available studies of clinically relevant outcomes of in-center nocturnal HD compared to conventional HD. These outcomes include indexes of blood pressure control and left ventricular hypertrophy, markers of anemia management, measures of bone mineral metabolism, nutrition, quality of life, sleep quality, incidence of intradialytic hypotension, hospitalizations, and mortality.

METHODS

Overview

This systematic review was conducted and is reported in accordance with published guidelines.[14] The review protocol was registered with the National Institute for Health Research's International Prospective Register of Systematic Reviews database (PROSPERO; registration number CRD42012003330).

Data Sources and Searches

B.W., M.M., and R.P.P. conducted a comprehensive search of the literature in collaboration with 2 health information specialists at the University of Alberta (D.S. and S.C.). The Evidence-Based Medicine Reviews database available on the Ovid platform (EBMR; all records up to November 2016) was searched, in addition to MEDLINE (1946 to November 2016), Embase (1974 to November 2016), Web of Science, and Scopus. Searches were not restricted by language. Detailed search strategies can be found in Item S1 (provided as online supplementary material). Two reviewers (B.W. and M.M.) independently screened the abstracts; any study considered potentially relevant by at least one reviewer was recovered for further review.

Study Selection

Peer-reviewed studies were eligible for inclusion if they reported important clinical outcomes in an in-center nocturnal HD population and included a conventional HD comparator group. These consisted of randomized controlled trials and all forms of nonrandomized controlled studies, including quasi-experimental trials and observational studies. Clinically relevant outcomes are described in detail in a later section. The following were excluded: abstracts, case reports, cross-sectional studies, editorials, reviews, pediatric studies, unpublished studies, grey literature, and studies containing previously published subsets of data. Two reviewers (B.W. and M.M.) independently assessed the full text of each potentially relevant study for inclusion using predetermined eligibility criteria. Disagreements were arbitrated by a third reviewer (R.P.P.).

Data Extraction

B.W. and D.C. independently extracted the following parameters from each study: study characteristics (country, year, study design, prespecified outcome, sample size, and duration of follow-up), patient characteristics (age, sex distribution, and dialysis vintage), in-center nocturnal HD regimen, and control regimen. Assessed outcomes included indexes of blood pressure control (systolic blood pressure [SBP], diastolic blood pressure [DBP], mean arterial blood pressure, and antihypertensive use) and left ventricular hypertrophy, markers of anemia management (hemoglobin and erythropoiesis-stimulating agent [ESA] use), measures of bone mineral metabolism (calcium, phosphate, and parathyroid hormone [PTH] concentrations and phosphate-binder use), nutrition (body mass index, postdialysis weight, albumin level, and protein catabolic rate), quality of life and sleep quality, incidence of intradialytic hypotension, hospitalization rate, and mortality.

Risk-of-Bias Assessment

Risk of bias within studies was evaluated using an assessment tool based on the Ottawa-Newcastle criteria.[15] These criteria include items of study design (selection of participants, matching for covariates, and outcome definitions), statistical analysis (calculation of sample size and adjustment for potential confounding), and results (losses to follow-up). Authors were also contacted and asked to provide a study protocol to determine risk for outcome reporting bias.

Data Synthesis and Analysis

Data from each of the included studies were tabulated. When overlapping populations existed, only the outcome of the larger cohort was reported in the text or used for statistical pooling in this review (however, Tables 1-4 list all studies, including those with overlapping populations, which are identified by footnotes). Due to heterogeneity in reporting of outcomes among the included studies and the confounding of outcomes by covariates, results were pooled only for outcomes selected based on their clinical relevance and data availability. These outcomes included predialysis SBP and DBP, left ventricular mass (LVM) index (LVMi), and hemoglobin, phosphate, calcium, and PTH levels. For each of the 7 outcomes selected for pooling, the corresponding authors were contacted in an attempt to obtain missing data.

Data were analyzed using Stata, version 13.1 (StataCorp LP). Median values were substituted for mean values and missing standard deviations were imputed according to Wiebe et al.[16] The mean difference and corresponding standard error for each study were calculated prior to pooling. For studies with a pre-post design or matched groups, the correlation present in these designs was