The mortality and hospitalization rates associated with the long interdialytic gap in thrice-weekly hemodialysis patients

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Excess mortality and hospitalization have been identified after the 2-day gap in thrice-weekly hemodialysis patients compared with 1-day intervals, although findings vary internationally. Here we aimed to identify factors associated with mortality and hospitalization events in England using an incident cohort of 5864 hemodialysis patients from years 2002 to 2006 inclusive in the UK Renal Registry linked to hospitalization data. Higher admission rates were seen after the 2-day gap irrespective of whether thrice-weekly dialysis sequence commenced on a Monday or Tuesday (2.4 per year after the 2-day gap vs. 1.4 for the rest of the week, rate ratio 1.7). The greatest differences in admission rates were seen in patients admitted with fluid overload or with conditions associated with a high risk of fluid overload. Increased mortality following the 2-day gap was similarly independent of session pattern (20.5 vs. 16.7 per 100 patient years, rate ratio 1.22), with these increases being driven by out-of-hospital death (rate ratio 1.59 vs. 1.06 for in-hospital death). Non-white patients had an overall survival advantage, with the increased mortality after the 2-day gap being found only in whites. Thus, fluid overload may increase the risk of hospital admission after the 2-day gap and that the increased out-of-hospital mortality may relate to a higher incidence of sudden death. Future work should focus on exploring interventions in these subgroups.

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Excess admissions and deaths have been identified after the 2-day break (long interdialytic gap) in three times a week hemodialysis (HD).[1–4] Increases in mortality of between 20 and 40% compared with the rest of the week have been described, although the findings vary from country to country. For instance in the Dialysis Outcomes and Practice Patterns (DOPPS) analysis,[2] the greatest increases in mortality in European patients dialyzing Tuesday/Thursday/Saturday (Tue/Thu/Sat) were on Saturdays, whereas Japanese patients dialyzing Monday/Wednesday/Friday (Mon/Wed/Fri) had highest mortality on Fridays. Possible explanations for the weakening of the association outside of the USA may relate to the longer dialysis treatment times routinely employed in these countries compared with the USA during the respective study periods.[5] Fluid retention and hyperkalemia are associated with a higher incidence of cardiac death in HD patients,[6,7] and increased interdialytic intervals would be likely to enhance this risk.

Increased hospitalization rates(~60 to 90%) after the long gap are best described in US cohorts with greater increases noted for cardiovascular admissions.[1] However, given the variations identified in mortality patterns internationally, it may not be safe to assume that this problem also exists in other health-care systems. Patients with other chronic conditions are more likely to be hospitalized after the weekend, making it important to distinguish between this phenomenon and any variations driven by dialysis session patterns.[8–10] The simultaneous increase in hospitalization and mortality after the 2-day gap may be a manifestation of the heightened workload on admitting hospitals and their staff.[11]

If current dialysis sessional patterns are genuinely associated with increased risks of hospitalization and death then there is a need to find solutions. We aimed to clarify, in a large incident cohort of patients from a single country, whether dialysis pattern (Mon/Wed/Fri or Tue/Thu/Sat) is associated with an increase in admissions and deaths after the long break. We also aimed to understand the factors associated with hospitalization and death in these circumstances and the demographic and clinical characteristics of affected patients.

RESULTS

Following the exclusion of patients receiving HD in centers that did not employ hospital episode statistics (HES) to code dialysis attendance (68%) and extended periods of time admitted while coded as being on the HD modality (8%), 5864 incident HD patients from 36 centers accounting for 10,878 patient years were available for analysis. Median time available for analysis per patient was 1.3 years. HD patterns were broken down as follows: Mon/Wed/Fri—6816 treatment years (50.2%), Tue/Thu/Sat—6274 treatment years (47.3%), and Tuesday/Thursday/Sunday (Tue/Thu/Sun)—322 treatment years (2.5%). Overall, 13.5% of patients moved from one dialysis pattern to another for >5% of their treatment time. The demography of the patients when first observed is detailed in Table 1. The lower mortality rate in most deprived was attenuated by direct standardization with age (rate per 100 patient years, most to least deprived: 16.9, 17.0, and 17.7) and has been fully reversed following comprehensive adjustment in previous analyses.[12]

Admissions after the long break

The mean emergency admission rate was 1.54 admissions per patient year, and this was highest after commencement of regular HD as renal replacement therapy (RRT; 2.52 annualized admissions for the first 3 months, 1.69 for the subsequent 9 months, $P<0.001$). For those who died, admissions increased exponentially toward death. There was an increase in admissions after the long break (2.38 per year for the first HD session of the week, HD1 vs. 1.40 per patient year for the rest of the week; ratio of admission rates (RR) 1.69, 95% confidence interval (CI) 1.63-1.76: $P<0.001$), which was observed for both Mon/Wed/Fri, Tue/Thu/Sat, and Tue/Thu/Sun patients (Figure 1). Admission rates for HD3 for Mon/Wed/Fri (Friday) and Tue/Thu/Sat (Sat) patients were similar (1.67 and 1.71 admissions per year, $P=0.4995$).

These increased admission rates are shown according to the reason for admission in Table 2, with the greatest increases being seen for admissions associated with fluid overload. The relationship between admission rates and patient demography is presented in Supplementary Table S2 online.

Table 1 | Demography of patients when first entering the observation period, with emergency admission rate and mortality rate per 100 patient years while observed, stratified by the demographic group

Demography at entry into study	Proportion of cohort	Emergency admission rate (per year; 95% CI)	Crude mortality rate (per 100 patient years)
Age<40 years[a]	11.9%	1.51 (1.44–1.59)	5.53 (4.23–7.00)
Age 40–65 years	37.9%	1.52 (1.48–1.55)	11.98 (10.96–13.07)
Age>65 years	50.2%	1.57 (1.54–1.61)	23.85 (22.57–25.18)
Male	62.3%	1.52 (1.49–1.55)	18.02 (17.01–19.05)
Female	37.7%	1.58 (1.54–1.62)	16.03 (14.83–17.30)
White	83.0%	1.54 (1.52–1.57)	18.82 (17.92–19.74)
Non-white	17.0%	1.62 (1.58–1.66)	9.84 (8.50–11.33)
Least deprived tertile	32.2%	1.62 (1.58–1.66)	19.02 (17.56–20.56)
Intermediate deprivation	32.4%	1.56 (1.51–1.60)	17.39 (16.02–18.80)
Most deprived tertile	34.7%	1.62 (1.58–1.66)	15.66 (14.43–16.94)
Dialysis ⩽1 year[b]	82.2%	1.91 (1.85–1.96)	17.67 (16.19–19.21)
Dialysis >1 year	17.8%	1.41 (1.38–1.43)	17.11 (16.20–18.04)
Arrhythmia	4.7%	2.00 (1.90–2.10)	18.02 (17.01–19.05)
Congestive cardiac failure	19.1%	2.19 (2.13–2.26)	26.15 (22.63–29.91)
Chronic obstructive pulmonary disease	6.7%	2.33 (2.22–2.43)	33.49 (31.09–35.98)
Acute myocardial infarction	14.9%	2.12 (2.06–2.19)	35.78 (31.98–39.90)
Valvular heart disease	5.5%	2.02 (1.92–2.12)	30.69 (28.30–33.18)
Lymphoma/myeloma	4.1%	2.29 (2.12–2.47)	31.11 (27.47–35.09)
Connective tissue disease	3.6%	1.82 (1.68–1.96)	49.61 (42.07–57.75)
Peptic ulcer disease	5.4%	2.13 (2.02–2.24)	23.07 (18.62–28.26)
Neurological disease	4.9%	2.41 (2.29–2.53)	25.55 (21.99–29.52)
Cancer (previous or active)	8.5%	1.82 (1.74–1.90)	30.37 (26.49–34.66)
Vascular intervention/stent	4.6%	2.00 (1.90–2.10)	32.28 (28.93–35.92)
Cerebrovascular accident	9.7%	2.25 (2.17–2.33)	27.27 (23.74–31.18)
Depression	3.0%	2.62 (2.46–2.79)	34.52 (31.53–37.65)
Diabetes	34.1%	1.90 (1.86–1.95)	24.32 (19.61–29.53)
Coronary artery bypass graft	5.8%	1.93 (1.84–2.03)	20.65 (19.23–22.16)
Claudication	8.1%	2.39 (2.30–2.48)	20.68 (17.77–23.93)
Comorbid score 0[c]	33.4%	1.38 (1.33–1.42)	5.17 (4.41–6.02)
Comorbid score 1	28.6%	1.68 (1.62–1.74)	12.75 (11.47–14.09)
Comorbid score 2	17.1%	2.12 (2.04–2.20)	19.39 (17.52–21.41)
Comorbid score 3 or more	20.1%	2.42 (2.36–2.48)	36.37 (34.06–38.75)

Abbreviation: CI, confidence interval.
[a]Mean age 62.7 years (s.d. 15.8 years).
[b]Mean dialysis vintage 6.5 months (s.d. 13.8 months).
[c]Mean comorbid score 1.35 (s.d. 1.39).[12]