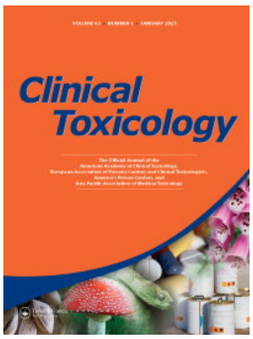

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POISON CENTRE RESEARCH

Barriers to the performance of timely hemodialysis when recommended by one United States poison center: a retrospective review

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ABSTRACT

Introduction: Hemodialysis has an essential role in the treatment of certain poisoned patients, both by enhancing the elimination of select poisons and correcting underlying fluid, electrolyte, and acid-base disturbances. We sought to identify barriers to the performance of hemodialysis when it was recommended by our poison center.

Methods: Data from a single United States poison center were retrospectively queried for adult patients for whom the poison center recommended intermittent hemodialysis for poison removal. The primary outcome was the performance of intermittent hemodialysis within 12 h of the poison center recommendation, which we defined as timely hemodialysis. Univariable and multivariable logistic regressions were performed to assess the effect of the following variables on this outcome: age group, patient sex, time of day of the recommendation, day of week of the recommendation, year of the recommendation, hospital location, and poison category.

Results: A total of 535 patient encounters were analyzed. The majority (72%) of patients had intermittent hemodialysis performed within 12 h of when it was recommended. The multivariable analyses showed that the odds of receiving recommended intermittent hemodialysis within 12 h were significantly lower when the recommendation was made during the nighttime (OR: 0.660; 95% CI: 0.442–0.987) compared to daytime and during the weekend (OR: 0.605; 95% CI: 0.398–0.918) compared to weekdays.

Discussion: Intermittent hemodialysis is resource-intensive and requires specialized equipment and personnel, which is likely less available outside of regular business hours. This study is limited by its retrospective nature and may not be generalizable to other poison centers.

Conclusion: Patients for whom our poison center recommended intermittent hemodialysis during non-weekday times had lower odds of receiving timely hemodialysis. Hospital administrators and healthcare providers should be aware of this potential treatment obstacle for poisoned patients and identify the specific barriers involved in order to facilitate timely hemodialysis.

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Elimination; hemodialysis; overdose; poison center; poisoning

Introduction

Hemodialysis has an essential role in the treatment of poisoned patients by enhancing the elimination of select poisons and correcting associated fluid, electrolyte, and acid-base problems. In fact, hemodialysis as a technique has its roots in poison removal: the first successful artificial kidney was constructed in an experiment to remove salicylates from living poisoned animals [1]. In general, xenobiotics with a low volume of distribution, low molecular weight, and low protein binding are amenable to clearance by hemodialysis. Since protein-binding sites may become saturated in overdose, hemodialysis also has a role in the management of overdose of some highly-protein bound xenobiotics (e.g., valproic acid). When employed for extracorporeal poison removal, intermittent hemodialysis is specifically preferred over continuous kidney replacement therapy. Continuous kidney replacement therapy applies the same physiochemical principles as conventional intermittent hemodialysis but uses lower blood and effluent flow rates; while continuous techniques are beneficial for hemodynamically unstable patients who require net ultrafiltration, their benefit is diminished in poisoned patients who usually do not need ultrafiltration, but rather require rapid removal of the offending poison, which cannot be achieved by slower continuous techniques [2,3].

Intermittent hemodialysis is invasive and resource-intensive, requiring specialized vascular access, a hemodialysis machine, and in many centers, a hemodialysis-trained nurse. Continuous kidney replacement therapy similarly requires specialized vascular access but can be performed in critical care units, often without the involvement of a nephrologist or dedicated nurse. In our experience, intermittent hemodialysis is often

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not performed despite being recommended by the poison center. We aimed to identify barriers to the performance of intermittent hemodialysis in poisoned patients referred to our poison center in order to improve patient outcomes.

Methods

This was a retrospective chart review from a single poison center. This poison center provides toxicology consultation services to a catchment area encompassing greater than 12 million people and 140 hospitals. Recommendations are provided by trained specialists in poison information, with involvement of a backup medical toxicologist for critically ill patients or those requiring invasive procedures such as extracorporeal poison removal. Since 1 January 2000, cases have been entered into an electronic database, ToxiCall®. Cases are coded in standardized fields for basic demographics of the patients and callers, as well as information about the case, including clinical effects, treatments recommended and provided, and outcome. There is also a free-text narrative portion allowing for documentation of the patients' clinical course. Cases are updated until the plateau of the clinical course, discharge, or transfer to psychiatric care.

A pilot study analyzing coded data alone from 2000 to 2015 indicated that the odds of receiving hemodialysis were lower when recommended "outside of regular business hours" (i.e., nighttime and weekends) [4]. A spot check comparing coded data to data extracted from a review of the free text narrative portion found a high rate of inconsistencies, with coded data misrepresenting what was written in the free text. Furthermore, this pilot analysis did not provide granularity on intermittent hemodialysis versus continuous kidney replacement therapy, nor on the timing of these interventions with respect to the recommendation. The present study thus aimed to update and improve this pilot analysis by expanding the dataset and by manually reviewing charts to address the limitations of the coding documentation. The study protocol was reviewed by the New York City Department of Health and Mental Hygiene Institutional Review Board (study #20-066) and deemed exempt from consent pursuant to secondary research recorded in a de-identified manner.

A structured query language keyword search (Supplementary Table 1) of the poison center database identified all cases from 1 January 2000 through 31 December 2019 for which hemodialysis was either recommended or performed. All adults aged 18 years or older for whom intermittent hemodialysis was recommended for poison removal were included. Cases were excluded if they failed inclusion criteria; intermittent hemodialysis was initiated or completed prior to poison center involvement; the decision for intermittent hemodialysis or continuous kidney replacement therapy was made independently of or against poison center recommendations; intermittent hemodialysis or continuous kidney replacement therapy was performed for purposes other than poison removal; the patient or the patient's proxy refused intermittent hemodialysis or continuous kidney replacement therapy; intermittent hemodialysis was conditionally recommended, and those conditions were not met; charts were incomplete with respect to the outcome or variables; or if they were duplicate charts.

Charts were manually reviewed by one author (MG), and the following data were extracted: patient information (age, sex), hospital location, recommendation for intermittent hemodialysis (date and time of recommendation, poison for which intermittent hemodialysis was recommended), and performance of extracorporeal poison removal (intermittent hemodialysis or continuous kidney replacement therapy, timing of extracorporeal poison removal relative to recommendation). When coded data conflicted with the narrative account, the narrative account was considered authoritative.

The primary outcome was intermittent hemodialysis performed within 12 h of poison center recommendation for intermittent hemodialysis (i.e., timely hemodialysis). The 12 h definition of "timely hemodialysis" was selected by internal consensus as a relatively liberal cut-off to allow for the many steps required from the moment of poison center recommendation until the performance of hemodialysis, but after which further delay would not be acceptable in most practice scenarios. The patients included in the study were divided into two groups: those who met the primary outcome and those who did not. Univariable logistic regression was performed, with receiving intermittent hemodialysis within 12 h of poison center recommendation as the outcome on each of the following variables: "age group," "patient sex," "time of day of recommendation," "day of week of recommendation," "year of recommendation," "hospital location," and "toxin category." The continuous variable "age" was converted into a categorical variable "age group" in which the age groups were defined as: 18–24 years old; 25–44 years old; 45–64 years old; 65 or greater years old. "Time of day of recommendation" was converted into a binary categorical variable of "daytime," defined as 06:00 to 17:59, and "nighttime," defined as 18:00 to 05:59. "Day of week of recommendation" was converted into a binary categorical variable of "weekday," defined as Monday 06:00 to Friday 23:59, and "weekend," defined as Friday Midnight to Monday 05:59. "Hospital location" was categorized as "within the city limits of the poison center catchment area" (and henceforth referred to as "urban"), versus "outside the city limits of the poison center catchment area" (and henceforth referred to as "suburban"). "Poison category" groups were defined as "salicylates," "lithium," "metformin," "toxic alcohols," and "other," representing the most common indications for intermittent hemodialysis. Multivariable logistic regression was then performed on the outcome, adjusting for the previous variables. A P-value <0.05 was considered statistically significant. The data analysis was conducted using SAS/STAT 15.2 (SAS 9.4M7) software.

In addition to the analysis of the primary outcome, three sensitivity analyses were performed. In the first, hemodialysis-dependent patients with end-stage kidney disease were excluded to assess if the presence of previously established vascular access impacted the odds of receiving timely intermittent hemodialysis. In the second and third, the outcome was broadened to include receipt of intermittent hemodialysis or continuous kidney replacement therapy within 12 h of the poison center recommendation for intermittent hemodialysis, to evaluate for potential differences in the barriers to receiving these two modalities of extracorporeal poison removal. Specifically, the outcomes were:

1. Receipt of intermittent hemodialysis or continuous kidney replacement therapy within 12 h of poison center recommendation for intermittent hemodialysis when continuous kidney replacement therapy was performed instead of intermittent hemodialysis for reasons of hemodynamic instability; and
2. Receipt of intermittent hemodialysis or continuous kidney replacement therapy within 12 h of poison center recommendation for intermittent hemodialysis when continuous kidney replacement therapy was performed instead of intermittent hemodialysis for any reason.

Results

The structured query language keyword search identified 1,302 patient encounters. A total of 767 cases failed the inclusion and exclusion criteria, leaving 535 cases for primary analysis (Figure 1). Table 1 describes the baseline characteristics of patients recommended by the poison center to have intermittent hemodialysis for poison removal. Forty-eight percent had intermittent hemodialysis recommended during the "daytime" (06:00 to 17:59), and 71% had hemodialysis recommended on "weekdays" (Monday 06:00 to Friday 23:59). The most common poisons for which intermittent hemodialysis was recommended were lithium and toxic alcohols, followed by salicylates and metformin. All salicylate cases involved acetylsalicytic acid. The majority (74%) of patients had intermittent hemodialysis performed within 12 h when recommended by the poison center. The univariable analyses showed that the odds of receiving recommended intermittent hemodialysis within 12 h were significantly lower when recommended during the "nighttime" (OR: 0.641; 95% CI: 0.434–0.946) compared to "daytime", during the "weekend" (OR: 0.573; 95% CI: 0.381–0.862) compared to "weekdays", and to "urban" hospitals (OR: 0.588; 95% CI: 0.359–0.963) compared to "suburban" hospitals. There were no statistically significant differences in odds of receiving recommended intermittent hemodialysis among the most common poisons for which intermittent hemodialysis was recommended. After controlling for other variables in the multivariable logistic regression analysis, "nighttime" (OR: 0.660; 95% CI: 0.442–0.987) and "weekend" (OR: 0.605; 95% CI: 0.398–0.918) remained significant factors; "hospital location" (OR: 0.594; 95% CI: 0.353–1.002) was no longer significant after adjustment (Table 2).

Sensitivity analyses

Seventeen of the 535 patients had hemodialysis-dependent end-stage kidney disease. When these patients were excluded, characteristics remained similar (Supplementary Table 2). Univariable analyses found that the odds of receiving recommended intermittent hemodialysis within 12 h of poison center recommendation remained significantly lower when recommended during the "nighttime" (OR: 0.642; 95% CI: 0.433–0.951) compared to "daytime," during the "weekend" (OR: 0.560; 95% CI: 0.370–0.848) compared to "weekdays," and to "urban" hospitals (OR: 0.584; 95% CI: 0.356–0.959) compared to "suburban" hospitals. After controlling for other variables, "nighttime" (OR: 0.657; 95% CI: 0.438–0.987), "weekend" (OR: 0.590; 95% CI: 0.386–0.903), and "urban" hospital location (OR: 0.581; 95% CI: 0.343–0.98) remained significant (Supplementary Table 3).

Twenty-two patients had continuous kidney replacement therapy instead of recommended intermittent hemodialysis due to hemodynamic instability (Supplementary Table 4). Univariable analyses showed that the odds of receiving intermittent hemodialysis or continuous kidney replacement therapy in cases of hemodynamic instability within 12 h of poison center recommendation for intermittent hemodialysis remained significantly lower during the "nighttime" (OR: 0.630; 95% CI: 0.424–0.935)

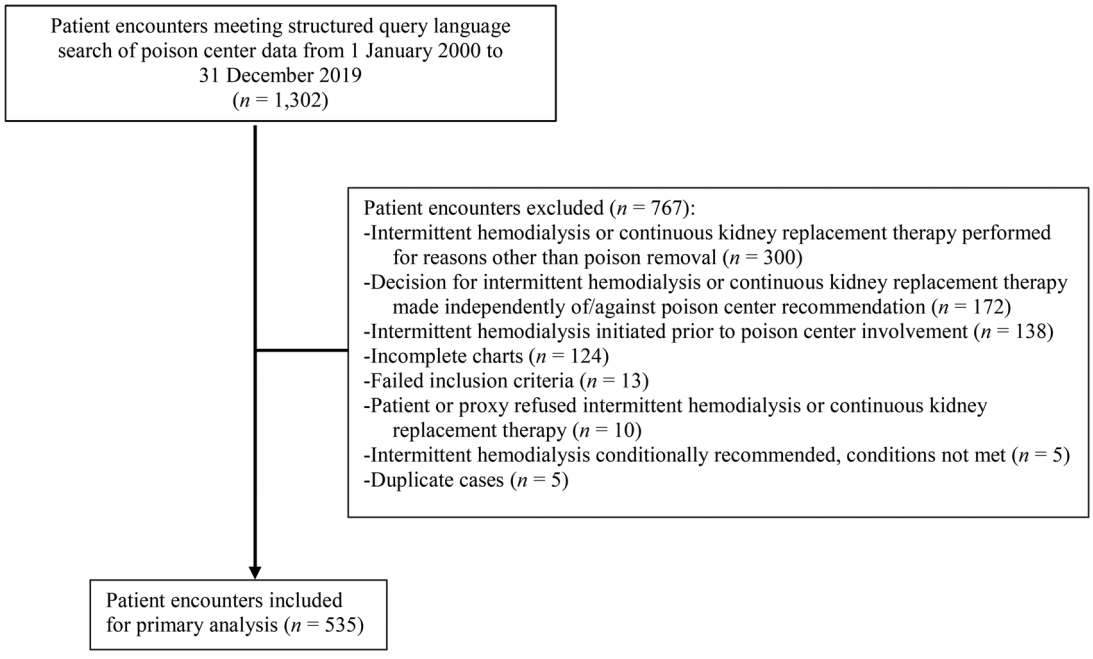

Figure 1. Study inclusion flowchart.

Table 1. Characteristics of patients who were recommended to have intermittent hemodialysis by the poison center.

Characteristics		Total sample	Intermittent hemodialysis performed with 12 h	Intermittent hemodialysis not performed within 12 h
Study population		*n* = 535	*n* = 393 (73.5%)	*n* = 142 (26.5%)
Age group, years	18–24	34 (6.4%)	26 (6.7%)	8 (5.6%)
	25–44	146 (27.3%)	107 (27.1%)	39 (27.5%)
	45–64	251 (46.9%)	185 (47.1%)	66 (46.5%)
	≥65	104 (19.4%)	75 (19.1%)	29 (20.4%)
Sex	Male	285 (53.3%)	212 (53.9%)	73 (51.4%)
	Female	250 (46.7%)	181 (46.1%)	69 (48.6%)
Hour of recommendation	Daytime[a]	258 (48.2%)	201 (51.2%)	57 (40.1%)
	Nighttime[b]	277 (51.8%)	192 (48.9%)	85 (59.9%)
Day of week of recommendation	Weekday[c]	382 (71.4%)	293 (74.6%)	89 (62.7%)
	Weekend[d]	153 (28.6%)	100 (25.5%)	53 (37.3%)
Hospital location	Urban[e]	410 (76.6%)	292 (74.3%)	118 (83.1%)
	Suburban[f]	125 (23.4%)	101 (25.7%)	24 (16.9%)
Year of recommendation	2000–2010	257 (48.0%)	186 (47.3%)	71 (50.0%)
	2011–2019	278 (52.0%)	207 (52.7%)	71 (50.0%)
Poison category	Salicylates	102 (19.1%)	70 (17.3%)	34 (23.9%)
	Lithium	188 (35.1%)	138 (35.1%)	138 (35.2%)
	Metformin	70 (13.1%)	45 (12.2%)	61 (15.5%)
	Toxic alcohols	127 (23.7%)	101 (25.7%)[e]	72 (18.3%)
	Other	48 (9.0%)	38 (9.7%)	9.9 (7.0%)

Due to rounding, values may not sum to 100%.
[a](06:00 to 17:59).
[b](18:00 to 05:59).
[c]Monday 06:00 to Friday 23:59.
[d]Friday Midnight to Monday 05:59.
[e]Within the city limits of the poison center catchment area.
[f]Outside the city limits of the poison center catchment area.

compared to "daytime," "weekend" (OR: 0.598; 95% CI: 0.395–0.906) compared to "weekdays," and to "urban" hospitals (OR: 0.593; 95% CI: 0.359–0.979) compared to "suburban" hospitals. After controlling for other variables, "nighttime" (OR: 0.663; 95% CI: 0.441–0.995), "weekend" (OR: 0.629; 95% CI: 0.412–0.960), and "urban" hospital location (OR: 0.588; 95% CI: 0.347–0.998) remained significant (Supplementary Table 5).

Thirty-two patients had continuous kidney replacement therapy instead of recommended intermittent hemodialysis for any reason (Supplementary Table 6). Reasons other than hemodynamic instability included limited resources, severe weather, and unspecified. In univariable analyses, the odds of receiving intermittent hemodialysis or continuous kidney replacement therapy within 12 h of poison center recommendation for intermittent hemodialysis remained significantly lower when recommended during the "nighttime" (OR: 0.664; 95% CI: 0.443–0.995) compared to "daytime" and during the "weekend" (OR: 0.616; 95% CI: 0.403–0.942) compared to "weekdays." Hospital location was not significant (OR: 0.672; 95% CI: 0.406–1.113). After controlling for other variables, only "weekend" remained significant (OR: 0.635; 95% CI: 0.412–0.981) (Supplementary Table 7).

Discussion

Patients for whom intermittent hemodialysis was recommended by the poison center for poison removal presented in a temporal distribution similar to what would be expected if patients presented at random times, and the majority of patients had intermittent hemodialysis performed within 12 h when recommended by the poison center. The odds of receiving recommended intermittent hemodialysis within 12 h of recommendation were significantly lower when intermittent hemodialysis was recommended outside of regular business hours (i.e., "nighttime" and "weekends"). While this has been our personal observation, in general, there were few data to support this belief until now. Intermittent hemodialysis is resource-intensive and requires specialized equipment and personnel, which is likely less available outside of regular business hours. There was no difference among most common poisons for which intermittent hemodialysis was recommended, suggesting that the lack of performance of intermittent hemodialysis when recommended is not due to discrepancies in the approach to management of specific poisons between toxicologists and nephrologists.

When hemodialysis-dependent patients with end-stage kidney disease were excluded, the proportion of patients who received intermittent hemodialysis remained similar, suggesting that vascular access is not the sole or primary barrier to obtaining timely intermittent hemodialysis when recommended by the poison center. "Urban" hospital location emerged as an additional significant factor in this sensitivity analysis. This finding was surprising, given the relatively higher concentration of dialysis-capable tertiary-care centers within urban settings compared to the suburban setting. The explanation for this finding is unclear. One potential explanation is a tendency of academic, resident- or fellow-run hospitals to defer intermittent hemodialysis to regular business hours when an attending nephrologist is present and available.

Intermittent hemodialysis is preferred to continuous kidney replacement therapy in the treatment of poisoned patients, even in cases of hemodynamic instability, as this instability is usually a result of the poisoning. The Extracorporeal Treatments In Poisoning (EXTRIP) workgroup publishes evidence-based expert recommendations on the indications for hemodialysis and other extracorporeal treatments for pharmacokinetically amenable poisons [5]. Among extracorporeal poison removal modalities, intermittent hemodialysis is specifically preferred in all currently published EXTRIP guidelines [6]. According to all currently published EXTRIP guidelines, continuous kidney replacement therapy is only considered an acceptable alternative when intermittent hemodialysis is not available. The odds of receiving intermittent hemodialysis or continuous kidney replacement therapy in cases of hemodynamic instability within 12 h of recommendation for intermittent hemodialysis were significantly lower when intermittent hemodialysis was recommended outside of regular business hours and to "urban" hospitals. In contrast to intermittent hemodialysis, continuous kidney replacement therapy usually does not require dialysis-trained nurses in our practice setting, yet the emergence of time of day and day of week of recommendation outside regular business hours as a significant variable in this population sample suggests more widespread and/or nonspecific barriers to obtaining extracorporeal poison removal outside of regular business hours. We again note the emergence of "urban" hospital location as a significant factor not seen in

Table 2. Multivariable logistic regression of performance of intermittent hemodialysis within 12 h of recommendation by the poison center.

Characteristics		Unadjusted odds ratio	*P*-value	95% confidence interval	Adjusted odds ratio	*P*-value	95% confidence interval
Age group, years	18–24	Reference	Not applicable	Not applicable	Reference	Not applicable	Not applicable
	25–44	0.836	0.8431	0.349–2.003	0.845	0.9071	0.340–2.100
	45–64	0.862	0.9718	0.372–1.999	0.824	0.7859	0.342–1.990
	≥65	0.785	0.6210	0.319–1.934	0.800	0.7148	0.312–2.048
Sex	Male	1.107	0.6038	0.754–1.626	1.066	0.7552	0.713–1.593
	Female	Reference	Not applicable	Not applicable	Reference	Not applicable	Not applicable
Hour of recommendation	Daytime[a]	Reference	Not applicable	Not applicable	Reference	Not applicable	Not applicable
	Nighttime[b]	0.641*	0.0250	0.434–0.946	0.660*	0.0428	0.442–0.987
Day of week of recommendation	Weekday[c]	Reference	Not applicable	Not applicable	Reference	Not applicable	Not applicable
	Weekend[d]	0.573*	0.0076	0.381–0.862	0.605*	0.0183	0.398–0.918
Hospital location	Urban[e]	0.588*	0.0351	0.359–0.963	0.594	0.0507	0.353–1.002
	Suburban[f]	Reference	Not applicable	Not applicable	Reference	Not applicable	Not applicable
Year of recommendation	2000–2010	Reference	Not applicable	Not applicable	Reference	Not applicable	Not applicable
	2011–2019	1.113	0.5850	0.758–1.634	1.055	0.7988	0.701–1.587
Poison category	Salicylates	Reference	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Lithium	1.380	0.9026	0.818–2.330	1.415	0.8655	0.818–2.450
	Metformin	1.091	0.2630	0.569–2.092	1.082	0.3151	0.545–2.146
	Toxic alcohols	1.942	0.1154	1.070–3.525	1.835	0.1715	0.985–3.418
	Other	1.900	0.3145	0.846–4.267	1.738	0.4420	0.755–3.997

[a](06:00 to 17:59).
[b](18:00 PM to 05:59).
[c]Monday 06:00 to Friday 23:59.
[d]Friday Midnight to Monday 05:59.
[e]Within the city limits of the poison center catchment area.
[f]Outside the city limits of the poison center catchment area.
*Statistically significant ($P < 0.05$).

the primary analysis. The odds of receiving intermittent hemodialysis or continuous kidney replacement therapy for any reason within 12 h of recommendation for intermittent hemodialysis were significantly lower only when intermittent hemodialysis was recommended on weekends. As this was the most striking outcome, this finding suggests that resources are more limited on weekends compared to nighttime.

We acknowledge several limitations to this study. One is its retrospective nature, though there is little reason to think there would be a discrepancy in whether or not intermittent hemodialysis or continuous kidney replacement therapy was performed since this information is routinely collected. This study was based on poison center data, so exposures that were not reported to the poison center would not be captured, and data depend on information reported by clinical care teams to a poison center which may be inaccurate or incomplete. Charts were abstracted by a single investigator who was aware of the study hypothesis. However, we doubt that knowledge of the study hypothesis would affect the interpretation of this straightforward binary outcome of whether intermittent hemodialysis or continuous kidney replacement therapy was performed or not. National holidays, an expected time of decreased staffing, may have occurred on weekdays and were not accounted for. While cases of salicylate and lithium poisoning had confirmatory concentrations, metformin, toxic alcohols, and many "others" did not. However, the study question was performance of intermittent hemodialysis when recommended by the poison center, and intermittent hemodialysis is routinely recommended based on surrogate markers of toxicity for cases in which confirmatory concentrations are not readily available.

Our results are based on a cut-off of 12 h for "timely hemodialysis." We are unaware of any guidelines defining optimal time to perform hemodialysis when recommended for poisoning; in general, the optimal time is as soon as possible following the decision that the procedure is necessary. We selected 12 h by internal consensus as a relatively liberal cut-off to allow for real-world delays in the many steps required from the moment of poison center recommendation until performance of this procedure (e.g., nephrologist consultation, catheter insertion, organization of a suitable bed, hemodialysis machine, and nurse), and because we thought that a longer delay would not be acceptable in most practice scenarios, especially in our urban environment. In certain cases of suspected toxic alcohol poisoning (e.g., patients with normal acid-base status), intermittent hemodialysis does not necessarily have to be urgently performed if there is adequate alcohol dehydrogenase blockade (i.e., ethanol or fomepizole). However, as a delay beyond 12 h requires re-dosing of an expensive antidote (fomepizole), the 12 h cut-off is still meaningful. In many cases, a time to hemodialysis of less than 12 h would be preferable; while the retrospective poison center data was unfortunately not granular enough to perform more detailed hour-by-hour sensitivity analyses, it is noteworthy that significant differences in the odds of receiving hemodialysis emerged even using such a "liberal" cut-off, and it would be interesting to study shorter time frames in future prospective studies. Longer delays may be considered acceptable in more remote or austere settings, and the cost/benefit analysis of prolonged alcohol dehydrogenase blockade may also be different in such settings.

While "business hours" for maintenance hemodialysis centers typically include Saturdays for patients on a Tuesday/Thursday/Saturday dialysis schedule, we chose to define "weekend" as Friday Midnight to Monday 05:59 because hemodialysis for poisoning is usually an emergent in-hospital event which relies on at least partially distinct resources subject to more traditional "business hours." In our area, most chronic

kidney patients are hemodialyzed in privatized clinics that have little or no association with individual hospitals. However, we acknowledge that this might differ in other regions where different definitions of "business hours" might be more appropriate. This study is based on one poison center in one urban center only, which may not be generalizable to other settings.

Conclusion

Patients for whom the poison center recommended intermittent hemodialysis for poison removal during non-weekday hours had lower odds of receiving timely intermittent hemodialysis when recommended by the poison center. Intermittent hemodialysis is an essential treatment modality that should be available irrespective of the time of day when it is clinically indicated. While the precise reasons for why intermittent hemodialysis was done less often during non-business hours are unclear, hospital administrators and health care providers should be aware of this potential treatment obstacle in poisoned patients and identify the specific barriers involved in order to facilitate timely hemodialysis regardless of time of presentation.

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Data availability statement

Source data cannot be shared as it contains protected health information.

References

[1] Abel JJ, Rowntree LG, Turner BB. On the removal of diffusable substances from the circulating blood by means of dialysis. Transactions of the Association of American Physicians, 1913. Transfus Sci. 1990;11(2):164–165.
[2] Ouellet G, Bouchard J, Ghannoum M, et al. Available extracorporeal treatments for poisoning: overview and limitations. Semin Dial. 2014;27(4):342–349. doi:10.1111/sdi.12238.
[3] Goodman JW, Goldfarb DS. The role of continuous renal replacement therapy in the treatment of poisoning. Semin Dial. 2006;19(5):402–407. doi:10.1111/j.1525-139X.2006.00194.x.
[4] Su MK, Hoffman RS, Julie I, et al. Need hemodialysis? Only during business hours!. Clinical Toxicology. 2017;55:511–512.
[5] Ghannoum M, Nolin TD, Lavergne V, et al. Blood purification in toxicology: nephrology's ugly duckling. Adv Chronic Kidney Dis. 2011;18(3):160–166. doi:10.1053/j.ackd.2011.01.008.
[6] Workgroup E. EXTRIP: The Extracorporeal Treatments in Poisoning 2024; 2024. Available from: https://www.extrip-workgroup.org/.