Implementation of the Nutrition Care Process and International Dietetics and Nutrition Terminology in a Single-Center Hemodialysis Unit: Comparing Paper vs Electronic Records

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ABSTRACT

There is little doubt surrounding the benefits of the Nutrition Care Process and International Dietetics and Nutrition Terminology (IDNT) to dietetics practice; however, evidence to support the most efficient method of incorporating these into practice is lacking. The main objective of our study was to compare the efficiency and effectiveness of an electronic and a manual paper-based system for capturing the Nutrition Care Process and IDNT in a single in-center hemodialysis unit. A cohort of 56 adult patients receiving maintenance hemodialysis were followed for 12 months. During the first 6 months, patients received the usual standard care, with documentation via a manual paper-based system. During the following 6-month period (Months 7 to 12), nutrition care was documented by an electronic system. Workload efficiency, number of IDNT codes used related to nutrition-related diagnoses, interventions, monitoring and evaluation using IDNT, nutritional status using the scored Patient-Generated Subjective Global Assessment Tool of Quality of Life were the main outcome measures. Compared with paper-based documentation of nutrition care, our study demonstrated that an electronic system improved the efficiency of total time spent by the dietitian by 13 minutes per consultation. There were also a greater number of nutrition-related diagnoses resolved using the electronic system compared with the paper-based documentation ($P<0.001$). In conclusion, the implementation of an electronic system compared with a paper-based system in a population receiving hemodialysis resulted in significant improvements in the efficiency of nutrition care and effectiveness related to patient outcomes.
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IMPLEMENTATION OF THE NUTRITION CARE PROCESS (NCP) and International Dietetics and Nutrition Terminology (IDNT) are two essential components to achieving consistent and comprehensive nutrition care and documentation. The need for standardization to accurately describe the broad spectrum of nutrition care and registered dietitians' unique body of knowledge is recognized as a priority for action by the Academy of Nutrition and Dietetics (Academy).[1] The Academy adopted the NCP in 2003, four distinct yet inter-related steps seen as the roadmap to high-quality nutrition care.[2] The first IDNT document was published by the Academy 4 years later, capturing standardized language for each of the four components of the NCP: nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation.

There have since been four editions of the IDNT reference manual, accommodating feedback from international adopters. Today the International Confederation of Dietetics Association[3] and most dietetics bodies around the world have endorsed the use of the NCP and IDNT and promote it as a method to enhance not only communication within and between professions, but to enable practice-based research thereby providing the evidence base for dietetics practice.[1]

There is little doubt surrounding the benefits of the NCP and IDNT to dietetics practice; however, evidence to support the most efficient method of incorporation into practice is lacking.[4] There have been few studies published that report the efficiency and effectiveness of implementing the NCP and IDNT using either a paper-based or electronic system, with no study to date directly comparing the two. A study looking at the benefits of implementing the NCP in paper-based nutrition care reported enhanced productivity and communication with other health professionals.[5] However, resources, including time, were identified as the key barrier by two other studies that looked at the implementation of a subset of IDNT (ie, nutrition diagnosis) using the paper-based method.[4,6] Copes and Ramsay[7] implemented IDNT in an electronic system and found that it provided a good indication of the effect of registered dietitians on patient care. Finally, implementation of the nutrition intervention and monitoring and evaluation steps of the NCP using IDNT in an electronic system highlighted an association between improved nutrition care and outcomes; however, the nutrition diagnosis was not reported.[8]

Outside of the dietetics literature it is well established that electronic systems providing decision support and patient tracking are far superior to paper-based systems. This was identified by a systematic review evaluating health electronic systems that indicated an improved quality of care with increased adherence to guidelines, documentation accuracy, and completeness.[9]

To date, the affect of the NCP and IDNT in electronic systems on clinical and economical end points has not been thoroughly investigated. The aim of our study was to compare an electronic system against a paper-based system for capturing the NCP with IDNT on efficiency and effectiveness of dietetics care in a hemodialysis setting.

METHODS

Patients

A hemodialysis population was selected to undertake this study due to the relatively consistent patient group requiring long-term dietetics-related input; therefore, two different systems (electronic and paper-based) could be compared with fewer confounding factors. In addition, because this population has a high prevalence of nutrition-related problems, they are likely to benefit from a systematic approach to the identification and documentation of nutritional status using IDNT.[10] This was supported by a recent study reporting the practical application of the NCP in a hemodialysis population.[4]

Patients receiving maintenance hemodialysis from a tertiary hospital, with a dialysis vintage of >3 months, aged 18 years and older, and who provided consent were eligible for inclusion. Ninety-one patients met the inclusion criteria and were recruited between September and October 2010. Baseline data collected included cause of end stage renal disease (using Australia and New Zealand Dialysis and Transplant Registry categories), comorbidities, age, sex, dialysis vintage, and medications. The study was approved by the institution's Human Research Ethics Committee (HREC/10/QPAH/145).

Study Design

This was a 12-month longitudinal study. During Months 1 to 6, patients received usual standard of care with documentation of the NCP and IDNT via a manual paper-based system. Nutrition reviews by a qualified renal dietitian[11] were scheduled based on patients' needs after baseline assessment and on a referral basis from nursing and medical staff throughout Months 1 to 6. During Months 7 to 12 documentation of the NCP and IDNT was via an electronic system.

An electronic system was developed to incorporate the following components: automated calculation and alerts for anthropometry and dietary data, download of monthly biochemistry data, IDNT checkboxes with prompts, and graphic tracking of patient data over time (see the Figure).

All data collection throughout the 12 months was undertaken by a single renal dietitian. The data collection used to evaluate the NCP was undertaken at baseline (Month 1), after implementation and use of a paper-based IDNT coding processes (Month 6), and then after implementation and use of an electronic record, which incorporated automated nutrition assessment and IDNT (Month 12). These data collection included each step in the NCP: nutrition assessment (ie, nutritional status, anthropometry, biochemistry, dietary intake, quality of life as measured by the EQ-5D utility index [EuroQol Group]), nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation (ie, IDNT coding). The cost-efficiency variables included productivity (assessed using a validated workload mapping tool[12]) and occasions of service (ie, number of patient consultations). Cost-efficiency was measured during a 6-week period at the end of each intervention; that is, at the end of Month 6 (paper-based) and Month 12 (electronic system), and occasions of service were recorded throughout the full 12-months.

Nutritional status was measured using the scored patient-generated subjective global assessment tool (PG-SGA).[13] PG-SGA is validated for use with patients receiving hemodialysis[14] and provides a global rating of A (well nourished), B (mild to moderately malnourished), or C (severely malnourished).[13] This rating is based upon weight change, dietary intake, gastrointestinal symptoms, a physical examination, and the patient's functional capacity. A PG-SGA score was also calculated, with a higher score reflecting a higher risk of malnutrition and an increased need for nutrition intervention and symptom management.

Body weight was measured using SK-VET calibrated electronic scales (Wedderburn) correct to 0.1 kg. Patients were measured without shoes, before and after dialysis. This was part of standard clinical care and was recorded in the patients' dialysis prescription charts. Body weight was used as an indicator of both fluid (interdialytic weight gain; that is, predialysis weight minus postdialysis weight averaged using the last 6 measurements [in kilograms]) and nutritional status (changes in postdialysis weight [in kilograms]). Height was measured at baseline using a wall-mounted stadiometer. Body mass index was calculated as weight (in kilograms)/height (in meters)^2.

Dietary intake was assessed using a 24-hour food recall according to the US Department of Agriculture multiple pass method, which accounted for both dialysis and nondialysis days.[15] Energy, protein, potassium, phosphate, and sodium intakes were evaluated and compared with each patient's nutrition goals expressed as a percentage. Nutrition goals were determined using the Evidence-Based Practice Guidelines for Nutritional Management of Chronic Kidney Disease.[16]

Biochemical parameters were assessed monthly as part of the dialysis unit's standard protocol, including albumin, C-reactive protein (as a marker of inflammation), urea, potassium, and phosphate status. However, only the biochemical parameters from Month 6 and Month 12 were used for the outcome analysis.

IDNT was used for the diagnosis, intervention, and monitoring and evaluation steps of the NCP from the *American Dietetic Association (ADA) International Dietetics and Nutrition Terminology (IDNT) Reference Manual, 3rd edition*.[17] During the first 6 months, the coding of IDNT was performed manually and recorded. During the following 6 months, the intervention period, IDNT was coded using the electronic system. Nutrition assessment was undertaken at each consultation but not reported using IDNT coding system for the purpose of this article.

Nutrition Care Process component	Manual-paper based system	Innovative electronic system
Nutrition assessment		
Anthropometry	• Retrieved and transferred by hand • Manual calculation	• Imported directly from institution's database • Automated calculations and alerts for increased risk (eg, weight reduction >2.5%)
Medical history/ medications, biochemistry, and clinical information	• Retrieved and transferred by hand into medical record	• Imported directly from the institution's database • Prepopulated options prompted (eg, common symptoms to check)
Dietary intake data	• Manual calculation and comparison of nutrition goals compared with actual intakes	• Automated calculations using an electronic nutrition database (ie, energy, protein, and mineral counter) • Automated calculations of nutrition goals compared with actual intakes
Nutrition diagnosis		
	• Manual retrieval of IDNT codes from IDNT reference manual • Manual coding	• Electronic coding with diagnosis prompts based on assessment
Nutrition intervention		
	• Manual retrieval of IDNT codes from IDNT reference manual • Manual coding	• Electronic coding with intervention prompts based on diagnosis
Nutrition monitoring and evaluation		
	• Manual retrieval of IDNT codes from IDNT reference manual • Manual coding • Manual tracking	• Prompts for scale-specific IDNT codes (eg, adherence [FH-5.1] [within the behavior class] with a scale of 1-10, where 1=not adherent and 10=completely adherent) • Automated monthly tracking with prompts (e-mail alerts) given to those at nutritional risk

Figure. Comparison of the Nutrition Care Process using a manual paper-based system and an electronic system in a 12-month longitudinal study in a chronic hemodialysis population. Use of International Dietetic and Nutrition Terminology (IDNT) for nutrition assessment was outside the scope of this study.

Diagnostic codes were assigned based on the nutrition and biochemical targets described in the Evidence-Based Practice Guidelines for Nutritional Management of Chronic Kidney Disease[16] and Caring for Australasians with Renal Impairment chronic kidney disease guidelines.[18] Diagnostic code Excessive fluid intake (ie, NI-3.2) was assigned based on expert opinion classified as interdialytic weight gains ≥3% body weight. Diagnostic codes for underweight (ie, NC-3.1) and obesity (ie, NC-3.3) were assigned based on body mass index <20 and ≥30, respectively.[19] The number of times a specific nutrition diagnosis was used and resolved was reported in addition to the total number of diagnostic codes used and resolved per patient during Months 1 to 6 (paper-based system) and Months 7 to 12 (electronic system).

Productivity was assessed using a validated workload mapping tool that captured each task undertaken daily.[12] The aim of this tool is to identify work patterns where clinical time is spent relating to patient care, meetings, and other activities of a clinician. The tasks were divided into defined classification from National Allied Health Casemix Committee Healthy Activity Classification,[20] which incorporates time spent face-to-face in patient consultations, defined as direct patient time (DPT) and time spent on meetings, professional development, teaching, and training, defined as non-direct patient time (NDPT). The renal dietitian reported time spent directly with patients (DPT) and other activities (NDPT) during a 6-week period coinciding with data collection at the end of each of the study periods (Months 6 and 12). Occasions of service (ie, number of patient consultations) were recorded for the full 12 months from clinical statistics.

Quality of life was measured using the EQ-5D questionnaire. Three components of the EQ-5D were reported: EQ-5D descriptive system (five questions), EQ visual analogue scale of overall health state, and EQ-5D index descriptive system.[21]

The EQ-5D descriptive system consisted of five questions in five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has three levels: no problems (score=1), some problems (score=2), and severe problems (score=3), which formed the descriptive system. The visual analogue component involved patients' self-assessment of their overall health state on a 20-cm visual scale, where 100 was "best imaginable" and zero was "worst imaginable" health state. The EQ-5D index descriptive system was used to create a weighted summary index incorporating five dimensions of functioning and well-being using the reference data from the United Kingdom to determine the weighted index.[21]

Statistical Analysis

All data were assessed for normality and the summary statistics were expressed as mean±standard deviation for normally distributed measures, median and minimum-maximum for the one non-normally distributed measure (PG-SGA score), and frequency and percent for categorical data. Only the nutrition-related diagnoses with a point prevalence of ≥5% were reported. Comparisons of mean values at Months 6 and 12 (independent samples) for the whole population were made using *t* test for normally distributed data, Mann-Whitney *U* test for non-normally distributed data, and χ^2 test for categorical data. Comparisons of means in the cohort of participants who remained under this service for the full 12 months (dependent samples) were made using paired *t* test for normally distributed data, Wilcoxon signed-ranked test for non-normally distributed data, and McNemar test for categorical data. The null hypothesis was rejected at the 0.05 level. All of the statistical analyses were performed using Stata (version 11.1, 2010, Statacorp).

RESULTS

Study Population

Ninety-two patients were invited into the study at baseline and only one patient declined consent. There was a 62% (n=56) completion rate at Month 12, with reasons for discharge from the study including dialysis relocation (n=15), mortality (n=10), acutely unwell requiring hospitalization (n=5), transplantation (n=4), and refusal (n=1).

The cohort (N=91) was 55% men with a mean age of 58±15 years. The main cause of end stage renal failure was diabetic nephropathy (32%), followed by glomerulonephritics (20%) and the median dialysis vintage was 46.5 months (minimum 3 months and maximum 236 months). There were no significant differences in patient demographics or baseline prevalence of nutrition diagnoses between patients who completed the full 12 months (included in analysis) (n=56) and those who discontinued the study before 12 months (not included in the analysis) (n=35).

Nutrition-Related Diagnosis

There was no significant difference in the number of times a specific diagnosis was used between the paper-based system (Months 1 to 6) and the electronic system (Months 7 to 12) (Table 1).

Nutrition Interventions and Monitoring and Evaluation

The most common nutrition intervention codes, defined as those that were applied in >50% of the occasions of service, included specific foods/beverages or groups (ie, ND-1.3), medications (phosphate binders) (ie, ND-6.1), priority modification (ie, E-1.2), transtheoretical model/stages of change (ie, C-1.4), and motivational interviewing (ie, C-2.1). There was no significant difference in the nutrition interventions delivered in the study between the paper-based and electronic system. However, the number of times a specific monitoring and evaluation code was used highlighted a significant difference between the use of three codes within the knowledge/beliefs/attitudes (ie, FH-4) and behaviors (ie, FH-5) class; specifically, area and level of knowledge (ie, FH-4.1.1), readiness to change nutrition-related behaviors (ie, FH-4.2.7), and self-reported adherence score (ie, FH-5.1.1). These three codes showed a statistically significant increase in use during the electronic system intervention (Months 7 to 12) ($P<0.001$).

Clinical Outcomes

The mean number of nutrition diagnoses resolved during the electronic system period (Months 7 to 12) was significantly greater compared with the paper-based system (Months 1 to 6) (1.5±1.0 vs 0.7±0.8 resolutions/patient; $P<0.05$). There were no other significant differences in clinical outcomes at Months 6 and 12 (see Table 2). However, there was a trend for an improvement in the number of patients meeting the serum phosphate recommendations following the 6-month electronic system intervention. The number of patients meeting the phosphate guideline increased from 25% to 39% following implementation of the electronic system; however, this did not reach statistical significance ($P=0.074$).

There was some improvement in the reported quality of life of the patients (pain and discomfort; $P=0.039$), although there was no significant difference in visual analogue scale or EQ-5D index between the paper-based and electronic system (Table 2).

Cost Outcomes

The productivity of dietetics-related care using the electronic system was significantly enhanced. Total time spent by the renal dietitian undertaking a full nutrition assessment with the patient was less using the electronic system compared with the paper-based system (57 minutes/patient vs 70 minutes/patient; $P<0.001$). This time saving came from both DPT (7 minutes less [reduced 14%]; $P<0.001$) and NDPT (6 minutes less [reduced 29%]; $P<0.001$). There was no difference in the occasions of service between the two systems (2.3 service occasions per patient).

DISCUSSION

Compared with the paper-based system, the electronic documentation resulted in enhanced productivity without compromising patient outcomes. The benefits of standardizing the framework and documentation of nutrition care through implementation of the NCP and IDNT is well recognized[2]; however, the method of implementation—paper-based or electronic system—has not been evaluated in detail

Table 1. Comparison of the number of times a specific nutrition-related diagnostic code was used and resolved using a paper-based vs an electronic system, in 56 patients undergoing chronic hemodialysis treatment in a single Australian center

	Paper-Based Standard Care (Months 1-6) (n=56)				Electronic System (Months 7-12) (n=56)			
	Diagnosis Made		Resolution Achieved		Diagnosis Made		Resolution Achieved*	
Outcome parameter	n	%	n	%	n	%	n	%
Nutrition diagnostic codes								
Intake domain								
NI-3.2: Excessive fluid intake	21	38	2	10	29	52	12	21
NI-5.1: Increased nutrient needs (energy/protein)	4	7	1	25	4	7	1	25
NI-5.2: Malnutrition	6	11	2	33	4	7	1	25
NI-5.3: Inadequate protein-energy	15	27	8	53	9	16	6	67
NI-5.7.1: Inadequate protein	14	25	3	21	16	29	5	31
NI-5.10.2.5: Excessive potassium intake	13	23	4	31	18	32	10	56
NI-5.10.2.6: Excessive phosphate intake	10	18	2	20	9	16	6	67
NI-5.10.2.7: Excessive sodium intake	25	45	3	12	29	52	6	21
Clinical domain								
NC-2.2: Altered nutrition-related laboratory value (phosphate)	40	71	9	23	41	73	20	49
NC-3.1: Underweight	7	13	0	0	6	11	0	0
NC- 3.3: Overweight/obesity	13	23	0	0	13	23	0	0
Behavioral- environmental domain								
NB-1.1: Food-and nutrition-related knowledge deficit	3	5	1	33	6	11	4	67

*$P<0.05$ compared with mean number of nutrition diagnoses resolved during paper-based standard care.

before this study. Our study found that the implementation of an electronic system in a population receiving hemodialysis was most beneficial for the implementation of IDNT compared with a paper-based system.

The cost of dietetics-related care in terms of labor time using the electronic system was significantly decreased (Months 7 to 12) compared with paper-based (Months 1 to 6) with no detrimental effect on patients' quality of life or nutrition-related clinical outcomes. During the routine nutrition assessments total patient time was decreased on average by 13 minutes per patient using the electronic system. If this is applied to a typical renal dietitian's workload in the United States—managing routine monthly assessments on 100 to 150 maintenance patients—this would equate to an annual saving of 260 to 390 hours or $6,500 to $10,000 (based on an hourly rate of $25/h).[22]

The implementation of IDNT into clinical practice was enhanced by the electronic checkbox and nutrition diagnosis features of the electronic system. The enhanced efficiency of IDNT coding using the electronic system, compared with paper-based, was reflected in the decreased NDPT; that is, documentation time during the intervention period (Months 7 to12). This suggests that an electronic system may better facilitate the uptake of IDNT among registered dietitians who are current non-IDNT users and reported time as a barrier to its implementation.[23]

The other key benefit of the electronic system with respect to the implementation of IDNT was the enhanced support to apply the complete list of IDNT codes to the NCP. The use of the electronic system fostered the routine use of monitoring and evaluation indicators that had predefined scales. This was evidenced by the significant increase in the use of three indicators within the knowledge/beliefs/attitudes (ie, FH-4) and behaviors (ie, FH-5) monitoring and evaluation classes, which required further specification/scaling; for example, in area and level of knowledge (ie, FH-4.1.1): classified as inadequate, basic, moderate, and comprehensive. Application of systematic indicators such as these enhance the measurable nature of dietetics practice, linking nutrition care to patient outcomes.

A greater number of nutrition-related diagnoses were resolved using the electronic system compared with Months 1 to 6 using the paper-based system. This suggests there may be an improvement in the delivery of nutrition care using an electronic system. A likely explanation for this increased resolution of nutrition diagnoses was the tracking system built into the electronic system facilitating proactive care and more accurate triaging of dietetics practitioner time to patient need.

Table 2. Results of a 12-month comparison between a paper-based and an electronic system on clinical outcomes in 56 patients undergoing chronic hemodialysis in a single Australian center

Outcome parameter	Baseline	Paper-based (Months 1-6)	Electronic (Months 7-12)	*P* value[a]
No. of diagnoses resolved, mean±standard deviation	—	0.7±0.8	1.5±1.0	<0.001
Nutritional status				
Subjective global assessment B (mild to moderate)/C (severe), % (n)	9 (5)	8.5 (3)	6.0 (3)	1.00
Patient-generated subjective global assessment score, median (range)	1 (0-13)	1 (0-14)	1 (0-9)	0.094
Anthropometry				
Body mass index, mean±standard deviation	26.0±5.2	25.7±5.2	25.8±5.2	0.695
6-mo dry weight change (kg), mean %±standard deviation	—	−1.0±3.6	0.6±3.8	0.280
Interdialytic weight gain (kg), mean±standard deviation	2.7±1.3	2.6±1.1	2.9±1.0	0.972
Biochemistry				
Phosphate (mmol/L[b]), mean±standard deviation	1.8±0.5	1.8±0.5	1.8±0.6	0.513
Phosphate ≤1.6 mmol/L[b], % (n)	36 (20)	25 (14)	39 (22)	0.074
Potassium (mmol/L), mean±standard deviation	4.7±0.7	4.7±0.7	5.0±0.7	0.999
Potassium ≤5.5 mmol/L, % (n)	86 (48)	79 (44)	72 (46)	0.875
Dietary intake, mean±standard deviation				
Energy intake, kj/kg body weight	109±25	113±35	115±28	0.827
Protein intake, g/kg body weight	1.1±0.43	1.2±0.4	1.2±0.3	0.693
Quality of life[c]				
Mobility, % (n)	30 (17)	30 (17)	36 (20)	0.508
Self-care, % (n)	13 (7)	13 (7)	13 (7)	1.00
Usual activity, % (n)	39 (22)	39 (22)	34 (19)	0.581
Pain/discomfort, % (n)	50 (28)	50 (28)	38 (21)	0.039
Anxiety/depression, % (n)	16 (9)	14 (8)	18 (13)	0.180
Visual analogue scale score, mean±standard deviation	68±22	72±21	73±19	0.900
EuroQol EQ-5D index score, mean±standard deviation	0.75±0.30	0.74±0.32	0.77±0.29	0.433

[a]*P* Values reflect the comparison between prevalence of clinical outcomes at Months 6 and 12 using paired *t* test for normally distributed data, Wilcoxon signed-rank test for non-normally distributed data, and McNemar test for categorical data.
[b]To convert mmol/L phosphate to mg/dL, multiply mmol/L by 3.09. to convert mg/dL phosphate to mmol/L, multiply mg/dL by 0.323. Phosphate of 1.6 mmol/L=4.94 mg/dL.
[c]Indicated some degree of limitation (score 2 or 3).

The principal limitation of our study was that it was pilot in nature and therefore had a lack of randomization and control group; however, given the issues of being a single site, randomizing and conducting separate models of care within the same facility was not considered feasible.

This research is fundamental to guiding the dietetics profession through the implementation phase of the NCP and IDNT into daily practice. Whether this benefit will be translated into enhanced uptake of the NCP and IDNT by registered dietitians remains to be investigated. There have been limited studies reporting benefits using either electronic systems—such as electronic medical records[7,8]—or paper-based[5,6] methods to implement NCP and or IDNT. The few studies that have evaluated IDNT implementation in EMR identified both potential benefits and limitations of current systems, including the opportunity to evaluate the effectiveness of interventions on nutrition care outcomes[8] and functionality restrictions within the system,[7] respectively. Our study has drawn on these recommendations and extended beyond to ensure more efficient software and early planning preimplementation occurred. This study's holistic approach to IDNT implementation, although as intended by the Academy, is novel in that it has not been previously reported.

CONCLUSIONS

The implementation of an electronic vs paper-based system resulted in improvements in patient outcomes and significant improvements in the efficiency of implementing the NCP and IDNT. This has substantial potential for cost savings and improving patient outcomes. This study supports the implementation of an electronic system to maximize the efficiency and effectiveness of dietetics care.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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