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Direct costs of a home parenteral nutrition programme

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SUMMARY

Background & aims: Home parenteral nutrition (HPN) is a lifesaving treatment for people with chronic intestinal failure and its cost has been reported to be very high. The purpose of the present paper was to study the direct healthcare and non-healthcare costs associated with the HPN programme managed by a tertiary hospital.

Methods: Observational, retrospective study of all adult patients on HPN from 11.1.2014 to 10.31.2015 treated at Gregorio Marañón University Hospital (Madrid, Spain). An economic evaluation was undertaken to calculate the direct healthcare (HPN provision, outpatient monitoring and management of complications) and non-healthcare costs (transportation process) of the HPN programme. The variables were collected from medical records, the dispensary and the hospital's financial services. The unit costs were taken from official price lists.

Results: Thirty-two patients met the inclusion criteria. Total direct healthcare and non-healthcare costs amounted to €13,363.53 per patient (€124.02 per patient per day). The direct healthcare costs accounted for 98.32% of overall costs, while the non-healthcare costs accounted for the remaining 1.68%. HPN provision accounted for the majority of the costs (74.25%), followed by management of complications (21.85%) and outpatient monitoring (2.23%).

Conclusions: The direct healthcare costs accounted for the majority of HPN expenditure, specifically HPN provision was the category with the highest percentage.

1. Introduction

Home parenteral nutrition (HPN) allows the administration of parenteral nutrition at home. It provides nutrition and hydration through an intravenous route to patients unable to maintain an adequate nutritional status through oral feeding or enteral nutrition and it is a life support therapy for these patients [1]. The prevalence of HPN across Europe ranges from 2 to 40 per million [2], in adult patients, while in the United States the estimated prevalence is 79 per million [3], in children and adult patients. In Spain, according to the most recent voluntary registry of the Working Group on Home and Outpatient Artificial Nutrition of the Spanish Society for Parenteral and Enteral Nutrition (NADYA-SENPE), HPN prevalence in both adults and children has been increasing in the last few years reaching 5.08 patients per million in the year 2015 [4], however this figure may be underestimated. Traditionally, the cost of illness studies categorised the costs of disease as direct, indirect, and intangible. The direct costs include both healthcare and non-healthcare costs. The first refer to the medical expenditure for institutional inpatient and outpatient care, physician, ancillary, nurses and dieticians services, home healthcare, medication, patient training, monitoring, etc., while the second include the transportation process of patients or supplies, certain household expenses and so on. Indirect costs refer to productivity losses in terms of morbidity and mortality, impairment and job absenteeism. Lastly, intangible costs include those related to the psychological discomfort of the patients and due to measurement difficulties have frequently been excluded from cost of illness studies [5]. Although there are recent works that address the issue [6], these were based on the voluntary record and not on an actual sample of cases and also, they did not include direct non-healthcare costs or cost of outpatient monitoring. The purpose of

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the present paper was to study from our hospital's point of view the direct healthcare and non-healthcare costs associated with the HPN programme.

2. Patients and methods

2.1. Patients

This observational, retrospective study was approved by the Ethical Committee of Gregorio Marañón University Hospital (HGUGM) (Madrid, Spain). The study has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) [7] for experiments involving humans. We included all adult patients on HPN treated at HGUGM, which is a tertiary referral hospital, from November 1, 2014, to October 31, 2015, after giving their informed consent. The patients met the specific criteria for HPN indication from the National Health System Guidelines [1].

2.2. Variables and costs

The total direct costs associated with HPN in our hospital were obtained by the sum of the direct healthcare and non-healthcare costs. The direct healthcare costs were divided into three categories: HPN provision, outpatient monitoring and management of complications. The direct non-healthcare costs included the transport process of HPN bags and consumables to the patients' home.

2.2.1. Direct healthcare costs

2.2.1.1. HPN provision. The HPN provision included catheter insertion, in-hospital training, catheters, HPN bags, consumables and structural expenditure.

The catheter insertion and in-hospital training when the patient is taught how to care for the central-line and carry out the HPN procedure were done previous to hospital discharge. The cost of the catheter insertion procedure was considered the same for all patients, since it is unchangeable and independent of patient characteristics or days on HPN. In-hospital training included the cost per hour of the healthcare personnel involved, in this case a nurse and a pharmacist and the time (hours) required for training. The unit costs used in the study are shown in Table 1. The catheters used in our hospital were Hickman®, peripherally inserted central catheter (PICC) and PORT-A-CATH®. The cost of catheters included the total number of catheters multiplied by their respective unit cost.

Regarding HPN bags, we discriminated between custom-made bags at the hospital pharmacy and catering by a pharmaceutical company. The elaboration process of custom-made HPN bags, involved an array of steps which go from purchase and stock management, HPN sheet development, HPN preparation, visual and microbiological control and gravimetric control to the handing over of HPN bags. The cost per HPN bag included: 1) the cost per hour of the different healthcare personnel involved (nurses, pharmacists and ancillary) and the time (hours) required to carry out the preparation process, 2) the cost of all the necessary materials, which included: production material (caps, filling devices, needles, syringes, filters, bags, etc.,), hospital clothing (masks, gloves, headwear, etc.,), cleaning and microbiological media and water for injection and 3) the cost of nutrients (amino acids, glucose, lipids, electrolytes, trace elements and vitamins). The cost per HPN bag regarding health personnel and materials was considered the same for all patients, however, the cost per HPN bag regarding nutrients was calculated depending on the content of the HPN bags of each of the patients included in the study. Furthermore, in order to guarantee the variation of the composition and the needs of nutritional support during the HPN period, for each patient, the cost per HPN bag corresponding to its nutrient content was calculated based on the composition of three random dispensations of the HPN bags. The cost of these dispensations was averaged by weekly HPN.

Table 1
Unit costs.

	Unit costs, €
Health personnel cost per hour	
HPN specialist	*
Ancillary	16.60
Nurse	20.29
Pharmacist	27.32
Catheters	
Catheter insertion procedure	1001.82
Hickman®	132
PICC	129.80
PORT-A-CATH®	152.90
Outpatient monitoring	
Scheduled visit to the HPN specialist	78.46
Biochemistry test	90.70
Haematology test	4.16
Hepatic function test	22.67
Renal function test	35.19
Abdominal ultrasound	59.11
Densitometry	80.56
Echo Doppler	78.90
Structural expenditure per year	
Nutrition Unit	66,193.42
Pharmacy Service	225,860.86
Interventional Radiology Unit	142,526.51
Management of complications	
Unscheduled visit to the HPN specialist	209.20
Emergency room visit (1 visit)	181.05
Emergency room stay (1 day)	1730.91
Hospitalization (1 day)	803.10
Transportation cost per km	0.19

*Included in “Scheduled visit to the HPN specialist” and “Unscheduled visit to the HPN specialist”.

On the other hand, the cost of the HPN bags catered by the pharmaceutical company was an agreed fare of €85.80 per HPN bag, for any patient, regardless of the composition.

The dispensation process of consumables includes a series of steps the healthcare personnel has to carry out. These steps go from over-the-phone order, creation of the dispensing order, preparation and order review to dispensing of the products. In order to calculate the cost per dispensation we considered the cost per hour of the different healthcare personnel involved (pharmacists and ancillary) and the time (hours) required for each one of the steps previously mentioned and the number of units dispensed and cost unit of all the materials supplied (syringes, caps, intradermal needles, physiological serum (single-dose), sterile gauze, Mepore® sterile dressings, sterile gloves, Alaris® 1.2 μm filter infusion systems, heparinized solution (Fibrillin 5 mL, 20 U/mL), 75 mL spray of alcoholic 2% chlorhexidine, antiseptic hand soap). The dispensing frequency was once per month.

Structural expenditure associated to HPN per year of the main clinical units involved in HPN management was indicated by the hospital's financial services (Table 1). These units were Nutrition Unit, Pharmacy Service and Interventional Radiology Unit (IRU), the latter being in charge of the catheter insertion procedure.

2.2.1.2. Outpatient monitoring. The cost of outpatient monitoring included scheduled visits to the HPN specialist and the following pathology tests: biochemistry and haematology tests, hepatic and renal function tests, abdominal ultrasound, densitometry and echo Doppler.

2.2.1.3. Management of complications. The cost of management of complications included unscheduled visits to the HPN specialist,

Table 2
Characteristics of the study population.

Characteristics	Total
Patients included, n	32
Age (years), Mean [Min–Max]	58.9 [32–85]
Sex, n (%)	
Male	12 (37.50)
Female	20 (62.50)
Geographical location, n (%)	
Madrid	27 (84,38)
Valladolid	2 (6.25)
Badajoz	1 (3,12)
Guadalajara	1 (3,12)
Toledo	1 (3,12)
Underlying disease, n (%)	
Neoplasms on palliative care	11 (34.38)
Neoplasms on active treatment	4 (12.50)
Radiation enteritis	4 (12.50)
Mesenteric ischemia	4 (12.50)
Crohn's disease	2 (6.25)
Postsurgical complications	2 (6.25)
Other	5 (15.62)
HPN indication, n (%)	
Short bowel syndrome	15 (45.45)
Intestinal obstruction	7 (21.21)
Intestinal malabsorption	4 (12.12)
Enterocutaneous fistula	3 (9.10)
Other	4 (12.12)

number of emergency room visits and length of stay (days), number of hospitalizations and length of stay (days), number and type of complications (catheter-related bloodstream infections (CRBSIs), catheter occlusion, venous thrombosis, hepatobiliary disease, metabolic bone disease, others) and the subsequent catheter replacement.

2.2.2. Direct non-healthcare costs

2.2.2.1. Transportation process. The transportation process of HPN bags and consumables to the patients' home was managed by the hospital, the catering service or both. In the case of hospital management, the patients have to come to the hospital pharmacy to pick up the HPN bags and the consumable products, while the catering company delivers them to the patients' home. In both cases, the number of pickups of HPN bags was twice per week, while the consumables were collected once per month. For the patients who were managed by both the hospital and the catering service, we calculated the percentage of HPN bags managed by each party. In all cases, the cost per patient was obtained by multiplying the total number of pickups by the transportation unit cost.

2.3. Data collection and unit costs

The variables were collected from medical records, the dispensary and the hospital's financial services. The unit costs were taken from official price lists [8–11]. Data collection was compliant with the Law on Protection of Personal Data (Spanish Organic Law 15/1999). All costs are expressed in Euros (€) for the year 2017. Data are expressed as media and frequencies. The programme used was Microsoft Excel 2013.

3. Results

3.1. Study population and clinical variables

The study included a total of 32 patients treated with HPN and who had a benign or a malignant disease in a proportion of 53.12% and 46.88%, respectively. The indication of HPN was short bowel syndrome (45.45%), followed by intestinal obstruction (21.21%). Table 2 shows the characteristics of the study population. At the time of the inclusion in the study the patients had been on HPN an average of 31.8 months. The mean duration of HPN during the study period was 107.7 days (5.4 days per week per patient).

3.2. Overall costs

Total direct healthcare and non-healthcare costs amounted to €13,363.53 per patient (€124.02 per patient per day). The direct healthcare costs accounted for 98.32% of overall costs, while the non-healthcare costs accounted for the remaining 1.68%. Mean costs per patient, costs per patient per day and their respective percentages of overall costs are listed by expenditure in Table 3.

3.2.1. HPN provision expenditure

The HPN provision was 74.25% of overall costs (€92.08 per patient per day).

3.2.1.1. Catheters and catheter insertion procedure. The sum of the costs of catheters and catheter insertion procedure was 10.82% of overall costs (€8.72 per patient per day). During the study, the

Table 3
Mean costs per patient, costs per patient per day and percentage of overall costs.

Costs	Cost per patient, €	Cost per patient per day, €	% of overall costs
HPN provision	**9921.82**	**92.08**	**74.25**
Catheter insertion	1001.82	9.30	7.50
In-hospital training	122.13	1.13	0.91
Catheters	163.66	1.52	1.22
HPN bags	7619.47	70.71	57.02
Consumables	859.49	7.98	6.43
Structural expenditure	155.26	1.45	1.16
Outpatient monitoring	**297.36**	**2.76**	**2.23**
Scheduled visits to HPN specialist	152.01	1.41	1.14
Pathology tests	145.35	1.35	1.09
Management of complications	**2919.79**	**27.10**	**21.85**
Unscheduled visits to HPN physician	137.30	1.27	1.03
Emergency room visits	45.26	0.42	0.34
Emergency room stay (days)	378.64	3.51	2.83
Hospitalizations	2108.14	19.57	15.78
Subsequent catheter replacement	250.45	2.32	1.87
Total direct healthcare costs	**13,138.97**	**121.94**	**98.32**
Direct non-healthcare costs	224.55	2.08	1.68
Total direct costs	**13,363.53**	**124.02**	**100**

Table 4
Time (hours) and cost per HPN bag regarding healthcare personnel from the Pharmacy Service.

	Time (hours)	Cost per HPN bag, €
Purchase and stock management	***0.11***	***1.80***
Pharmacists	0.01	0.14
Nurses	0.00	0.00
Ancillary	0.10	1.66
HPN sheet development	***0.07***	***1.82***
Pharmacists	0.07	1.82
Nurses	0.00	0.00
Ancillary	0.00	0.00
HPN preparation	***0.20***	***3.81***
Pharmacists	0.00	0.00
Nurses	0.13	2.70
Ancillary	0.07	1.11
Visual and microbiological control	***0.03***	***0.73***
Pharmacists	0.01	0.23
Nurses	0.03	0.51
Ancillary	0.00	0.00
Gravimetric control	***0.06***	***1.12***
Pharmacists	0.01	0.23
Nurses	0.02	0.34
Ancillary	0.03	0.55
HPN bags hand over	***0.07***	***1.39***
Pharmacists	0.02	0.63
Nurses	0.00	0.00
Ancillary	0.05	0.76
Total	***0.53***	***10.67***
Pharmacists	0.11	3.04
Nurses	0.18	3.55
Ancillary	0.25	4.08

patients used a total of 38 catheters, 60.53% being Hickman® catheters, 28.98% PORT-A-CATH® and the remaining 10.52% PICC.

3.2.1.2. In-patient training. Patient training was 0.91% of overall costs (€1.13 per patient per day). The healthcare personnel spent approximately 5.5 h training the patients, throughout 3–4 days.

3.2.1.3. HPN bags. HPN bags represented 57.02% of overall costs (€70.71 per patient per day). During the study period, the patients used a total of 3448 HPN bags (39.39% custom-made). The unit cost of the custom-made bag amounted to €47.50. The cost corresponding to health personnel was €10.67. More information on the cost per HPN bag and the time spent by the health personnel to carry out each step is presented in Table 4. The materials cost €6.53, distributed as follows: production materials (€5.84), hospital clothing, cleaning and microbiological media (€0.48) and water for injection (€0.21). Lastly, the cost of nutrient solutions used in the custom-made bags was €30.30.

Table 5
Time (hours) and cost per dispensation regarding healthcare personnel from the Pharmacy Service.

	Time (hours)	Cost per dispensation, €
Phone order	***0,05***	***1,37***
Pharmacists	0,05	1,37
Ancillary	0,00	0,00
Creation of the dispensing order	***0,03***	***0,91***
Pharmacists	0,03	0,91
Ancillary	0,00	0,00
Preparation	***0,12***	***1,94***
Pharmacists	0,00	0,00
Ancillary	0,12	1,94
Order checking	***0,03***	***0,55***
Pharmacists	0,00	0,00
Ancillary	0,03	0,55
Dispensation	***0,2***	***0,28***
Pharmacists	0,00	0,00
Ancillary	0,02	0,28
Total	***0,25***	***5,04***
Pharmacists	0,08	2,28
Ancillary	0,17	2,77

Table 6
Number of units dispensed and cost per dispensation regarding materials supplied.

Materials supplied	Number of units dispensed	Cost per dispensation, €
Syringes	60	2.87
Caps	30	13.36
Intradermal needles	30	2.90
Physiological serum (single-dose)	30	2.37
Sterile gauze	30	0.21
Mepore® sterile dressings	30	0.86
Sterile gloves	30	23.96
Alaris® 1.2 μm filter infusion systems	30	166.98
Heparinized solution (Fibrillin 5 mL, 20 U/mL)	10	9.16
75 mL spray of alcoholic 2% chlorhexidine	2	5.06
Antiseptic hand soap	1	6.53
Total	-	**234.26**

3.2.1.4. Consumables. Consumables represented 6.43% of overall costs (€7.98 per patient per day). The cost per dispensation of consumables amounted to €239.30, of which €5.04 went to healthcare personnel and the remaining €234.26 was spent on the materials supplied. More information on the cost per dispensation and the time (hours) required for the health personnel to carry out each step and the total units of dispensed materials is offered in Table 5 and Table 6, respectively.

3.2.1.5. Structural expenditure. Structural expenditure was divided between the three Units involved in HPN management as follows: 0.47% (€0.59 per patient per day) for the Pharmacy Service, 0.46% (€0.57 per patient per day) for the Nutrition Unit and 0.23% (€0.29 per patient per day) for the Interventional Radiology Unit.

3.2.2. Outpatient monitoring expenditure

Outpatient monitoring was 2.23% of overall costs (€2.76 per patient per day). During the study, 62 scheduled visits to HPN specialist and a total of 110 pathology tests were completed: 37 biochemistry tests, 34 haematology tests, 32 hepatic function tests, 2 renal function tests, 2 abdominal ultrasound tests, 2 densitometry tests and 1 echo Doppler.

3.2.3. Management of complications expenditure

Management of complications was 21.85% of overall costs (€27.10 per patient per day). During the study, the patients attended 21 unscheduled visits to the HPN specialist, went to the emergency room a total of 8 times and were hospitalized 84 days. The causes which motivated emergency room visits and/or hospitalizations were mostly CRBSIs. The rate of CRBSIs per 1000 HPN days was 2.03 (Table 7). None of our patients was treated with

Table 7
Rate of emergency room visits and hospitalizations per patient and per 1000 HPN days.

	Emergency room visits (n)	Emergency room stay (days)	Hospitalizations (n)	Hospitalizations (days)
Event, n	8	7	8	84
Rate per HPN patient	0.25	0.22	0.25	2.63
Rate per 1000 HPN days	2.32	2.03	2.32	24.36

Table 8
Summary of HPN cost studies.

Study	Country	Number of patients included	Variables	Reported results
Burgos et al. [6]	Spain	133 (2007) … 220 (2014)	• HPN bags (HPN bags elaborated at the Hospital pharmacy, ready to use triple chamber bags and catering) • Catheters (Hickman®, PORT-A-CATH® and others) • Complications (metabolic, mechanical or septic)	€8393 per patient per year for benign disease €9261 per patient per year for malignant disease
Tu Duy Khiem-El Aatmani et al. [12]	France	22	• Drugs • Materials • Patient and product transportation • Laboratory tests • Healthcare personnel	€30,232 per patient per year €2519 per month €83 per day
Marshall et al. [13]	Canada	29	• IV solutions, additives and supplies • Community care access center services • Acute care services (hospital readmissions, emergency room visits) • Medications • Other	$567 (cost of last week of hospitalization) vs $406 (cost of first month after discharge on HPN)
Richards et al. [14]	UK	64	• In-hospital stay for training and line insertion (including all staff, hotel and investigation charges for 3 weeks) • In-hospital TPN and disposable charges • Outpatient monitoring (four visits) • Pump, trolley, fridge, drip stand • HPN for 6 nights per week (median) (using a home-care company supplying disposables for 49 weeks) • The subsequent years did not include the costs of the pump, trolley, drip stand, fridge and hospital training.	£44,288 per patient per year (for the first year of HPN) £36,848 per patient per year (for the second year onwards)
Reddy et al. [15]	US	30	• Hospitalization: number of days hospitalized, clinic visits, home nursing visits • Laboratory tests • Drug therapy, including only drugs required to treat the complications of therapy, vitamin and mineral supplements • Parenteral solutions	$70,000 per year ($15,000–$169,000)
Bisset et al. [16]	UK	10	• Parenteral nutrition solutions • Infusion pumps and consumables	£100,000 per patient per year (inpatient) vs £20,000–£30,000 per patient per year (outpatient)
Wateska et al. [17]	US	17	• Patient training • Nondisposable equipment • Maintenance supply • Patient follow-up	$21,465 per patient per year (for the first year of HPN) $19,700 per patient per year (for the second year onwards)

taurolidine lock during the study. Additionally, there were no complications related to catheter occlusion, venous thrombosis, severe hepatobiliary alteration and/or metabolic bone disease.

4. Discussion

This study enabled us to carry out an assessment of the direct healthcare and non-healthcare costs of HPN in our hospital. According to the results, HPN costs amounted to €13,363.53 per patient (€124.02 per patient per day). In this study, the direct healthcare costs encompassed HPN provision, outpatient monitoring and management of complications while the direct non-healthcare costs included the delivery process of HPN bags and consumables to the patients' home. Many studies on HPN costs are available in the literature [6,12–17]. Table 8 summarises some of these papers in terms of the country where it was developed, the number of patients and type of costs included and their reported results. However, according to more recent review articles, in the UK the costs of HPN hover around £30,000–40,000 per patient per year, for 5 days per week, if the patient is self-cared and £55,000–65,000 per patient per year if the patient requires nursing support, while in the US, HPN is estimated to cost $64,000 per year [18].

All the costs in the mentioned studies are predominantly higher than those obtained in our study. This may be due to the different organisation of HPN programmes from one country to another and even from one centre to another, which influences the choice of the elements included in HPN expenditure. Additionally, these countries have different healthcare systems, however, when we take away this factor, our study is comparable to the one published by Burgos et al. [6]. In the study by Burgos et al. [6] the cost of HPN was lower (approx. €8000–9000 per patient per year) compared to ours (€13,363.53 per patient). The different methodology between the two studies could explain these results. Firstly, the data in the study by Burgos et al. [6] was gathered from the voluntary NADYA-SENPE registry and obtained cost estimations, while this study collected the real use of resources of a specific cohort of patients followed at our hospital and their unit costs, which allowed us to calculate the actual cost of HPN. Secondly, the rate of complications of Burgos et al. [6] was also based on the voluntary record, which is underestimated, as it is stated in the annual publications of the registry [4]. Since HPN complications can represent more than 20% of the HPN overall expenditure, this underestimation can also explain the cost differences. Thirdly, outpatient monitoring or direct non-healthcare costs were not included in the study by Burgos et al. [6].

Taking into account the percentage of overall costs, the HPN provision was the category with the highest percentage (74.25%), followed by management of complications (21.85%) and, lastly, outpatient monitoring (2.23%). These results are in line with those cited in the literature. For instance, Reddy et al. concluded that the costs of HPN therapy are associated with the direct provision of nutrition [15]. From all the components included in the HPN provision group, HPN bags had the highest costs. In our hospital the bags catered by a pharmaceutical company had an established fee of €85.80 which is comparable with the €82.50 mentioned in other studies [6]. Regarding the management of complications, the CRBSI rate of 2.03 per 1000 HPN days found in our series of patients was in agreement with the literature [19].

The strength of the study comes from the in-depth methodology used to collect the data and to obtain the costs.

The major limitations of this study are related to the small sample of patients, however, it has a similar cohort to previous published studies. Since the study did not include a multicentric design, the generalisation of data to other countries or centres is an additional limitation. Regarding data transfer from one centre to another, it has to be taken into account the fact that hospitals with less experience (less number of HPN patients monitored) could theoretically have higher costs by increasing the number of complications, for example infectious. On top of that, another limitation could be the type of costs studied, since it did not include indirect costs. As it happens in other diseases [20], measuring the social costs in HPN may be relevant for healthcare decision-makers, as it provides useful information to assess the real magnitude of the benefits of different intervention programs that target the disease. Moreover, it offers a baseline for planning, prevention, policies in relation to future and for allocating health and social care and research resources.

Additionally, the study did not include a cost-effectiveness analysis, often used by many health systems. For instance, in the United Kingdom, the National Institute of Health and Clinical Excellence (NICE) uses the incremental cost effectiveness ratio (ICER: extra cost/QALY gained, QALY being the cost adjusted for quality of life) thresholds to identify cost-effective treatments. The threshold ranges from £20,000 to £30,000/QALY. There is great controversy over which limit should be used. For example, a threshold of €100,000/QALY has been proposed in the Netherlands, according to the severity of the disease, however, there is evidence that values above £30,000/QALY have less than 8% chance of being approved [21].

Nevertheless, our study provides useful information regarding any HPN programme similar to ours and can be a head start for future studies.

Statement of authorship

All authors planned and discussed the results of this study. All authors have approved the final article.

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Conflict of interest

None.

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