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Original Investigation

Effects of cigarette smoking cessation on breastfeeding duration

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Abstract

Introduction: The purpose of this study was to use data from controlled trials to examine whether smoking cessation increases breastfeeding duration. Correlational studies have confirmed associations between smoking status and breastfeeding duration, but whether smoking cessation increases breastfeeding duration has not been established.

Methods: Participants ($N = 158$) were smokers at the start of prenatal care who participated in controlled trials on smoking cessation. Women were assigned to either an incentive-based intervention wherein they earned vouchers exchangeable for retail items by abstaining from smoking or a control condition where they received comparable vouchers independent of smoking status. Treatments were provided antepartum through 12-week postpartum. Maternal reports of breastfeeding collected at 2-, 4-, 8-, 12-, and 24-week postpartum were compared between treatment conditions. Whether women were exclusively breastfeeding was not investigated.

Results: The incentive-based treatment significantly increased breastfeeding duration compared with rates observed among women receiving the control treatment, with significant differences between treatment conditions observed at 8-week (41% vs. 26%; odds ratio [*OR*] = 2.7, 95% *CI* = 1.3–5.6, $p = .01$) and 12-week (35% vs. 17%; *OR* = 3.4, 95% *CI* = 1.5–7.6, $p = .002$) postpartum. No significant treatment effects on breastfeeding were observed at other assessments. Changes in smoking status mediated the effects of treatment condition on breastfeeding duration.

Conclusions: These results provide evidence from controlled studies that smoking cessation increases breastfeeding duration, which, to our knowledge, has not been previously reported.

Introduction

Breastfeeding improves maternal and infant health (Ip et al., 2007). Maternal health benefits of breastfeeding include a faster return to prepregnancy body weight and a decreased risk of breast and ovarian cancers (Beral, Bull, Doll, Peto, & Reeves, 2002; Dewey, Heinig, & Nommsen, 1993; Rosenblatt & Thomas, 1993), while infant health benefits include a reduced risk of a wide variety of infectious diseases, including otitis media, gastroenteritis, and respiratory infections (Howie, Forsyth, Ogston, Clark, & Florey, 1990; Nafstad, Jaakkola, Hagen, Botten, & Kongerud, 1996; Owen et al., 2005; Sadauskaite-Kuehne, Ludvigsson, Padaiga, Jasinskiene, & Samuelsson, 2004; Sloan, Sneddon, & Iwaniec, 2006).

Despite substantial progress in increasing breastfeeding initiation, inadequate duration of breastfeeding remains a challenge in developing and developed countries (Horta, Kramer, & Platt, 2001; Scott, Binns, Oddy, & Graham, 2006; van Rossem et al., 2009). That challenge has prompted efforts to identify modifiable determinants of breastfeeding duration (Horta, Victora, Menezes, & Barros, 1997; Horta et al., 2001; Scott et al.; Thulier & Mercer, 2009; van Rossem et al.). Numerous determinants have been identified, including individual, family, health care setting, and community factors. Maternal cigarette smoking is among the most consistently identified predictors of early weaning across studies. However, to our knowledge, whether smoking cessation treatment increases breastfeeding duration has not been reported. An obstacle to investigating that question experimentally has been the absence of interventions that produce sufficiently sustained reductions in antepartum and postpartum smoking to allow an assessment of effects on breastfeeding. In the present study, that obstacle was surmounted by using data from controlled studies on smoking cessation involving an intervention wherein pregnant smokers earned monetary incentives in the form of vouchers exchangeable for retail items contingent on biochemically verified smoking abstinence during pregnancy and for 12-week postpartum (Heil et al., 2008; Higgins et al., 2004; Lussier, Heil, Mongeon, Badger, & Higgins, 2006). The intervention produced smoking cessation rates that exceeded those typically observed with pregnant and newly postpartum smokers and hence provided an

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opportunity to investigate potential differences in breastfeeding duration as a function of treatment condition, which is the purpose of the present study.

Methods

Study population

Study participants (N = 158) were pregnant cigarette smokers who were enrolled in one of three controlled trials examining the efficacy of monetary-based incentives for smoking cessation conducted in a university-based outpatient research clinic (Heil et al., 2008; Higgins et al., 2004). Each of the trials was approved by the local institutional review board, and all women provided written informed consent. The first 32 subjects in the initial trial were assigned to one of the two treatment conditions described below as consecutive admissions to pilot test the interventions, while the remaining participants were randomly assigned to treatment condition. Women were recruited into the cessation trials from obstetric practices and the Women, Infants, and Children program in the local geographical area (Burlington, VT, USA). In order to be eligible for the cessation trials, women had to self-report smoking at entry into prenatal care, reside within the county in which the study clinic is located, plan to remain in the area for 6 months following delivery, and speak English. Trial exclusion criteria included incarceration, previous participation in a trial on incentives for smoking abstinence during pregnancy, or residing currently with someone who participated in a prior trial on this topic. All women receiving prenatal care at participating clinics completed a brief questionnaire regarding basic sociodemographics and smoking status, including age, race, years of education, estimated gestational age, and smoking frequency in the past 7 days. Those who endorsed smoking in the past 7 days were invited to complete a detailed assessment evaluating inclusion and exclusion criteria and biochemical verification of smoking status. All trial participants who delivered a live infant (N = 171) were eligible for the current study, but 13 women had to be excluded due to missing breastfeeding data. All but four of the participants delivered in the same hospital, known to be highly supportive of breastfeeding. There was no systematic tracking of what advice women may have received regarding smoking and breastfeeding before, during, or following their hospital stay.

Assessments

At the trial intake assessment and all subsequent assessments, study participants completed questionnaires examining sociodemographics, current smoking status/history, smoking environment and motivation, confidence and intentions to quit smoking, and provided breath and urine specimens. Appropriately modified versions of this battery were completed 1 month after the study intake assessment, at the end of pregnancy (≥28 weeks gestation), and at 2-, 4-, 8-, 12- and 24-week postpartum. At each postpartum assessment, women completed a yes–no self-report item asking whether they were breastfeeding; the item did not ask women about exclusive or other categories of breastfeeding. Smoking status was biochemically verified with urine cotinine testing using enzyme immunoassay (Enzyme Multiplied Immunoassay Technique; Microgenics Corporation, Fremont, CA) run on a Roche Cobas Mira analyzer (distributed by Dade Behring Inc., Deerfield, IL) and a cutpoint of ≤80 ng/ml.

Treatment interventions

All study participants were assigned to one of two treatments: an abstinence–contingent incentive condition or a control condition. In the abstinence–contingent incentive condition, women earned vouchers exchangeable for retail items contingent on biochemically verified abstinence from recent smoking. In the control condition, women received vouchers of comparable monetary value but they were delivered independent of smoking status and in amounts designed to keep the total amount of resources given to the women comparable across treatment conditions. The incentive program was in place from study initiation through 12-week postpartum. Voucher earnings did not differ significantly between treatment conditions and averaged about $450 (range = $0–$1,180) per women. In addition to the voucher-based incentives, participants in both treatment conditions received usual care for smoking cessation provided through their obstetric clinics, which typically involved provider inquiry regarding smoking status and a discussion of the advantages of quitting during pregnancy. Study staff did not attempt to influence those clinic practices.

Statistical methods

Demographic and smoking characteristics were compared between treatment conditions using t tests for continuous measures and chi-square tests for categorical variables. Breastfeeding status was compared across treatment conditions at each postpartum assessment initially based on univariate chi-square tests. Cochran–Mantel–Haenszel tests were performed that utilized Breslow–Day tests to evaluate homogeneity of treatment effects across trials. There was no evidence that odds ratios (*OR*s) associated with treatment condition were trial dependent; thus, data were combined for subsequent analyses. Because education level was significantly different between treatment conditions and predictive of breastfeeding status, logistic regression was used to estimate *OR*s associated with treatment condition that adjusted for differences in education. Figures 1–3 present raw (i.e., unadjusted) percentages of women breastfeeding at each assessment for presentation purposes, while statistical significance and *OR*s corresponding to treatment are adjusted for educational differences. Univariate and multivariate analyses produced consistent results when evaluating the significance of treatment on breastfeeding status across assessments. Logistic regression was also used to evaluate smoking status as a mediator. Breastfeeding status was imputed for one or more assessments for 15 women (8 incentives/7 control) in which prior or subsequent data allowed for reasonable estimation. No woman was observed to stop breastfeeding and start at a later date; thus, women were assumed not to be breastfeeding when missing assessments followed assessments where they reported discontinuing breastfeeding. In those instances where missing assessments were followed by a subsequent assessment where women reported breastfeeding, they were assumed to be breastfeeding at the earlier assessments. The number of breastfeeding datapoints imputed were 3/158 (1.8%) at 2 weeks, 3/158 (1.8%) at 4 weeks, 11/158 (6.9%) at 8 weeks, 9/158 (5.6%) at 12 weeks, and 11/158 (6.9%) at 24 weeks. All analyses were performed using SAS v. 9 statistical software (SAS Institute, Cary, NC). Statistical significance was determined based on $\alpha = .05$.

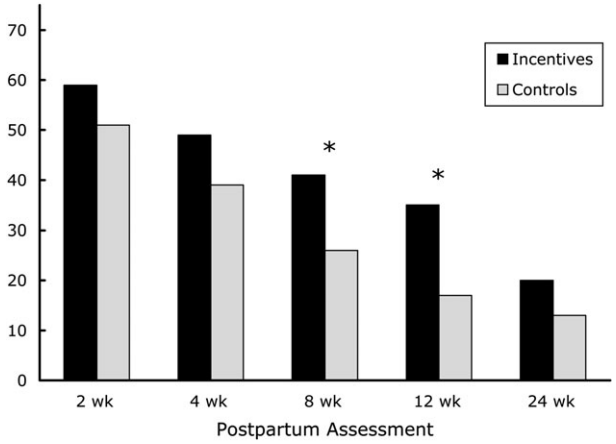

Figure 1. Percentage of women who reported breastfeeding at the 2-, 4-,8-, 12-, and 24-week postpartum assessments in the incentives and control conditions. Asterisks denote significant differences between treatment conditions with $p \leq .05$.

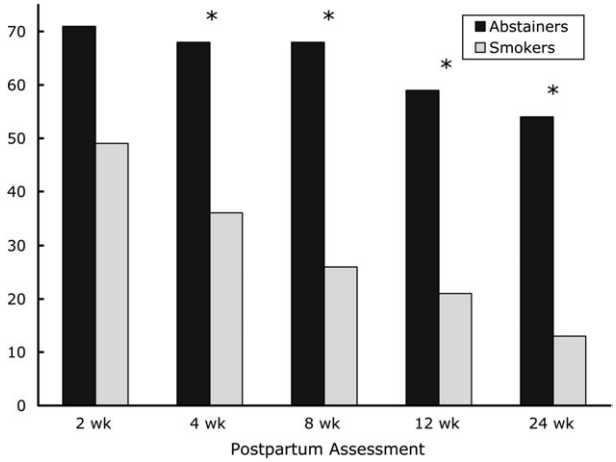

Figure 3. Percentage of women reporting breastfeeding at the 2-, 4-, 8-, 12-, and 24-week postpartum assessments among those classified as abstainers or smokers at the designated assessment periods. Asterisks denote significant differences between abstainers and smokers with $p \leq .05$.

Results

Participant characteristics

Study participants were largely socioeconomically disadvantaged young women, with the majority being less than 25 years of age, completing 12 or fewer years of education, without private health insurance, unmarried, and without employment outside of the home (Table 1). Regarding smoking characteristics, study participants started smoking at an average age of about 14 years, smoked about a pack per day prepregnancy, and most lived with other smokers. Only two baseline characteristics differed significantly between those assigned to the incentives and control treatment conditions and both would be expected to predict better smoking cessation and breastfeeding duration outcomes in the control condition: The incentives condition included more women with less than 12 years of education and fewer with 12 years compared with the control condition, and more women in the incentives condition reported that smoking was allowed in their homes. Only educational attainment was significantly associated with breastfeeding duration (negative association) and was subsequently used as a covariate when evaluating treatment effects on outcome measures reported below.

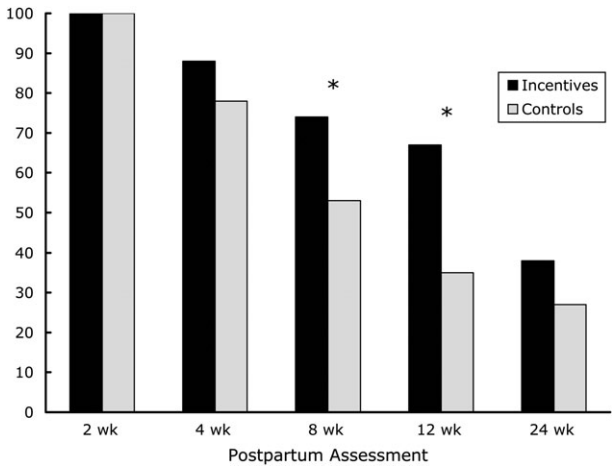

Figure 2. Percentage of women who reported breastfeeding at 4-, 8-, 12-, and 24-week postpartum assessments among those who reported breastfeeding at the 2-week assessment in the incentives and control conditions. Asterisks denote significant differences between treatment conditions with $p \leq .05$.

Treatment effects on breastfeeding

There were no significant treatment effects on the percentage of women reporting breastfeeding at the 2-week (*OR* = 1.8, 95% *CI* = 0.9–3.6, *p* = .11) or 4-week (*OR* = 1.9, 95% *CI* = 1.1–3.9, *p* = .07) assessments, although trends in that direction are evident (Figure 1). Significant differences between treatment conditions emerged at the 8-week assessment, with 41% in the incentives condition versus 26% in the control condition reporting breastfeeding (*OR* = 2.7, 95% *CI* = 1.3–5.6, *p* = .01), and remained discernible at the 12-week assessment, with 35% in the incentives condition versus 17% of women in the control condition reporting breastfeeding (*OR* = 3.4, 95% *CI* = 1.5–7.6, *p* = .002). By the 24-week assessment, 12 weeks following termination of the smoking cessation intervention, treatment effects on breastfeeding were no longer significant, although again a trend in that direction was discernible, with 20% in the incentives condition versus 13% of women in the control condition reporting breastfeeding (*OR* = 2.1, 95% *CI* = 0.9–5.2, *p* = .10).

To focus exclusively on breastfeeding duration, this same analysis was repeated using only those women who reported breastfeeding at the 2-week assessment (Figure 2). Breastfeeding rates declined at approximately one half the rate in the incentives compared with the control condition between the 2- and 12-week assessments, with significant effects of treatment condition on breastfeeding rates observed at the 8-week (*OR* = 3.4, 95% *CI* = 1.2–9.4, *p* = .02) and 12-week assessments (*OR* = 4.3, 95% *CI* = 1.6–11.5, *p* = .004). This pattern of less weaning in the incentives condition did not continue between the 12- and 24-week assessments, and effects of treatment condition were no longer significant at the 24-week assessment (*OR* = 1.9, 95% *CI* = 0.7–5.2, *p* = .19).

Table 1. Participant baseline characteristics

	Incentives ($n = 81$)	Control ($n = 77$)	p Values
Demographics			
Age (years)	24.0 (5.6)	23.3 (4.7)	.39
% Caucasian	93	96	.34
Education (%)			
>12 years of education	16	16	**.04**
12 years of education	38	57	
<12 years of education	46	28	
Weeks pregnant at baseline	9.9 (3.8)	9.3 (3.4)	.38
% Primagravida	48	52	.63
% Married	20	18	.80
% With private insurance	19	16	.62
% Working for pay outside of home	43	45	.78
Smoking characteristics			
Age first started smoking cigarettes	14.0 (2.5)	13.9 (2.5)	.74
Cigarettes per day prepregnancy	20.4 (10.3)	21.0 (8.5)	.73
% Living with another smoker	77	77	.99
% With no smoking allowed in home	26	43	**.02**
% With none or few friends/ family who smoke	19	17	.79
% Attempted to quit prepregnancy	58	70	.11
Number of quit attempts during pregnancy	1.2 (2.7)	0.8 (2.4)	.37
Nicotine withdrawal questionnaire total score	1.8 (0.9)	1.5 (0.8)	.14
Psychiatric symptoms			
Stress rating	5.6 (2.6)	5.5 (2.5)	.89
Beck Depression Inventory	10.3 (6.9)	10.5 (6.6)	.86
% History of depressive symptoms	38	36	.80

Note. Values represent means (*SD*) unless otherwise indicated. p Values correspond to t tests for comparisons with means and chi-square tests for comparisons with proportions (percents). p values < .05 are shown in bold.

Treatment effects on breastfeeding are mediated by smoking abstinence

Three lines of evidence indicate that treatment effects on breastfeeding were mediated by smoking abstinence. First, smoking abstinence was greater in the incentives compared with the control condition across all assessments, with 38% (31/81), 35% (28/81), 27% (31/81), 25% (22/81), and 15% (12/81) of women abstinent in the incentive condition at the 2-, 4-, 8-, 12-, and 24-week assessments, respectively, compared with 14% (11/77), 13% (10/77), 8% (6/77) 3% (2/77), and 1% (1/77) in the control condition ($p < .01$ at all assessments).

Second, when treatment condition was ignored and instead breastfeeding rates were compared at each postpartum assessment based on whether women were classified as abstainers or smokers at that assessment, abstainers were significantly more likely than smokers to report continuing to breastfeed at each of the postpartum assessments except at 2 weeks (Figure 3): 2 week ($OR = 2.1$, 95% $CI = 1.0–4.7$, $p = .06$), 4 week ($OR = 3.2$, 95% $CI = 1.4–7.1$, $p = .005$), 8 week ($OR = 6.5$, 95% $CI = 2.5–16.7$, $p < .001$), 12 week ($OR = 5.2$, 95% $CI = 2.0–13.5$, $p < .001$), and 24 week ($OR = 6.5$, 95% $CI = 2.0–21.7$, $p = .003$). Third, including smoking status in the regression model along with treatment condition resulted in treatment condition no longer being a significant predictor of breastfeeding at the 8-week ($OR = 1.4$, 0.7–3.0, $p = .32$) and 12-week ($OR = 2.4$, 95% $CI = 0.9–4.3$, $p = .12$) assessments.

Discussion

Negative associations between cigarette smoking and breastfeeding were noted as early as 1950 (Mills, 1950), and numerous investigators have recommended smoking prevention and cessation interventions as potential methods for increasing breastfeeding duration (Horta et al., 1997, 2001; Scott et al., 2006; Thulier & Mercer, 2009). To our knowledge, the present study provides the first evidence from controlled trials that smoking cessation increases breastfeeding duration. Such evidence is important to documenting a causal relationship between smoking and early weaning. The concern with correlational studies, of course, is potential confounding due to subject self-selection into smoker and abstainer status. That is, rather than differences in smoking status causing the differences observed in breastfeeding duration between abstainers and smokers, there may be a third variable like maternal health knowledge that accounts for both the differences in smoking and breastfeeding. The present results provide evidence consistent with a causal relationship between smoking and early weaning, that smoking cessation treatment can increase breastfeeding duration, and that changes in smoking status mediate the effects of cessation treatment on that outcome.

The magnitudes of the treatment effects observed in the present study were not trivial. Treatment increased the odds of continuing to breastfeed threefold at 12 weeks. Moreover, the population did not have any discernible characteristics that should make them particularly treatment responsive. In addition to smoking, the majority of the study sample also had multiple other risk factors for early weaning, including being young (<25 years), less educated, economically disadvantaged, and unmarried (Horta et al., 2001; Scott et al., 2006; Thulier & Mercer, 2009; van Rossem et al., 2009). Achieving meaningful treatment effects in what would be expected to be a clinically challenging sample is an encouraging sign about the potential of smoking cessation as a method for increasing breastfeeding duration.

Also important to acknowledge is that there is clear room for improvements in the outcomes observed in the present study. While the outcome in the incentive condition of 35% of women continuing to breastfeed at 12 weeks, for example, is preferable to the 17% observed in the control condition, it already falls below the goal of 50% continuing to breastfeed at 24 weeks stipulated in the *Healthy People 2010* initiative (U.S. Department of Health and Human Services, 2000). By 24 weeks, only 20% of women in the incentives condition and 13% in the control condition were still breastfeeding, a difference that was no longer significant. The present results clearly suggest that a key to achieving improvements in that outcome is increasing the efficacy of the smoking cessation intervention. The analysis

comparing abstainers with smokers (Figure 3) illustrates what could be accomplished by increasing the efficacy of the smoking cessation treatment. Abstinent mothers slightly exceeded the *Healthy People 2010* goal of 50% breastfeeding at 24 weeks. Of course, the incentive program that increased smoking abstinence and breastfeeding ended at 12 weeks. Keeping that program in place through 24 weeks or beyond would be expected to improve upon these outcomes. Investigating higher value incentives also could be helpful in getting a larger percentage of women to abstain from smoking and hopefully continue breastfeeding as well. Increasing the duration of the intervention and the value of vouchers delivered have each resulted in improved outcomes in incentive-based treatments for other types of substance use disorders and would be expected to improve outcomes with these newly postpartum women as well but that will need to be tested in additional trials (Higgins et al., 2007; Lussier et al., 2006; Silverman, Robles, Mudric, Bigelow, & Stitzer, 2004). Also worth mentioning are the slight trends toward differences in breastfeeding at the 2-week assessment noted in the analysis comparing treatment conditions (Figure 1) and significant differences in the analysis of abstainers with smokers (Figure 3), suggesting that smoking cessation may increase rates of breastfeeding initiation in addition to duration, although increased duration is clearly the more robust effect. Additional studies using an intervention that promotes higher quit rates might be useful to examine whether smoking cessation may indeed increase breastfeeding initiation and duration.

The present findings suggest that increased breastfeeding duration may be added to what is already a long list of health benefits of maternal smoking cessation (Cnattingius, 2004). We previously reported that smoking cessation with this same incentives-based intervention increases fetal growth (Heil et al., 2008). Both outcomes have the potential to contribute long-standing infant/child health benefits. Specifying the reliability and magnitude of those benefits with reasonable precision will require much larger and longer duration trials than have been conducted to date. Such trials certainly seem worth conducting if we are to gain a thorough understanding of the benefits of smoking cessation during pregnancy and early postpartum. Clearly specifying such benefits will be important to an accurate cost-benefit analysis of this incentive-based intervention.

Cost is an obvious practical issue with incentives-based treatments. Important to note with regard to the possibility of extending this treatment approach to developing countries is that one should not assume that the same value incentives as were used in the present study will be necessary in other settings. Incentive values will need to be tailored to the particular economic context and population targeted. The constant in extensions of this kind of treatment should be the use of frequent monetary-based reinforcement of biochemically confirmed smoking abstinence.

Of course, cost must be considered in all settings. We have not yet performed formal cost analyses of this treatment. The cost of the incentives (~$450/women treated) appears reasonable in the U.S. context when considered against the medical and other costs associated with caring for neonates and children adversely affected by exposure to cigarette smoking (Miller, Villa, Hogue, & Sivapathasundaram, 2001). How the present effects of smoking cessation on breastfeeding will factor into cost analyses remains to be determined. At a minimum, the present results illustrate the utility of incentives-based interventions as a research tool for investigating the potential health benefits of smoking cessation during pregnancy and postpartum.

In closing, we want to mention three limitations of this study. First, we studied a largely rural Caucasian population. Whether similar outcomes can be achieved in more diverse or urban populations will have to be investigated. The effects of the intervention on smoking cessation would be expected to have generality to other geographical settings and populations based on prior success in successfully extending incentives-based treatments for other abused substances across diverse settings and populations (Lussier et al., 2006). However, there is no comparable literature of which we are aware to judge the likelihood that smoking cessation in ethnically and geographically diverse samples of newly postpartum women will similarly increase breastfeeding as was observed in the present study. The strong influences that ethnicity and region can have on breastfeeding practices make it imperative to replicate these findings in other settings and populations (Horta et al., 2001; Scott et al., 2006; Thulier & Mercer, 2009; van Rossem et al., 2009). Second, the failure to differentiate between different categories of breastfeeding (e.g., exclusive, predominate, any) is a limitation. Whether smoking cessation enhances breastfeeding generally or only particular categories of breastfeeding will have to be determined in future studies. It seems likely that quitting smoking would increase the odds of continuing all categories of breastfeeding, but that is a question that has to be answered empirically. Third, we did not design the trials involved in this study with an a priori goal of examining treatment effects on breastfeeding. Thus it will be important to replicate these results in a clinical trial with an a priori hypothesis that smoking-cessation increases breastfeeding duration.

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Declaration of Interests

None declared.

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