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Some Recent Developments on Financial Incentives for Smoking Cessation Among Pregnant and Newly Postpartum Women

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Abstract Smoking during pregnancy is a leading preventable cause of poor pregnancy outcomes and immediate and longer-term adverse health outcomes among exposed offspring. Developing more effective smoking cessation interventions for pregnant women has been a public health priority for more than 30 years. We review developments over the past 3 years (2012–2015) on the use of financial incentives to promote smoking cessation among pregnant women. We searched the literature for reports on primary and secondary analyses and reviews of controlled trials on this topic published in peer-reviewed journals using the search engine PubMed, reviewed bibliographies of published articles, and consulted expert colleagues. The search revealed several important developments, with the following three being especially noteworthy. First, the review identified four new randomized controlled trials, three of which further supported the efficacy of this treatment approach. One of the three trials supporting efficacy also included the first econometric analysis of this treatment approach showing financial incentives with pregnant smokers to be highly cost-effective. Second, two Cochrane reviews were published during this 3-year period covering the more recent and earlier efficacy trials. Meta-analyses in both reviews supported the efficacy of the approach. Lastly, the first effectiveness trial was reported demonstrating that financial incentives increased abstinence rates above control levels when implemented by obstetrical clinic staff in a large urban hospital working with community tobacco interventionists. Overall, there is a growing and compelling body of evidence supporting the efficacy and cost-effectiveness of financial incentives for smoking cessation among pregnant women.

Keywords Pregnancy · Cigarette smoking · Smoking cessation · Financial incentives · Contingency management · Efficacy · Cost-effectiveness

Introduction

Cigarette smoking during pregnancy continues to represent a serious public health problem. While prevalence of smoking during pregnancy has decreased over time in developed countries, that progress has been unevenly distributed with economically disadvantaged pregnant women continuing to smoke at much higher rates than more affluent women [1, 2]. Also concerning is evidence suggesting that prevalence of smoking during pregnancy may be increasing in low- and middle-income countries [3, 4•]. Smoking during pregnancy causes numerous and serious maternal and infant adverse health effects, including catastrophic pregnancy complications and adverse effects on fetal development that a growing body of evidence suggests compromise health and increase disease risk throughout the lifespan [5•, 6, 7, 8•, 9•, 10•]. Smoking during pregnancy also has serious adverse economic impacts. In the USA, for example, costs related only to the delivery for smoke-exposed neonates were estimated at $122

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million annually in 2004 dollars [11]. While that cost alone is concerning, the emerging evidence on the longer-term adverse health effects of in utero smoke exposure suggest that the economic impacts are considerably larger than were envisioned even just a few years ago.

Efforts to develop effective cessation interventions for this population have been ongoing since the mid-1980s, involving more than 77 controlled trials and 29,000 women [4•]. Meta-analyses of this large literature have shown that financial incentives produce the largest effect sizes by several orders of magnitude compared to pharmacological or other psychosocial interventions investigated in controlled studies with this population [4•, 12]. The purpose of the present report is to review and discuss developments during the past 3 years (2012–2015) related to the use of financial incentives for smoking cessation during pregnancy.

Before turning to this more recent literature, however, it is important to place this area of treatment development into a broader context that is too often ignored. Use of financial incentives in the form of vouchers exchangeable for retail items, cash, or other monetary incentives to change health-related behavior began during the US cocaine epidemic of the 1980s and 1990s when controlled trials showed them to be highly efficacious with outpatient cocaine-dependent individuals when virtually all other treatments investigated with that population were failing miserably [13, 14]. Thereafter, a large body of experimental evidence began accumulating in the form of rigorously controlled experimental studies and meta-analyses supporting the efficacy of this treatment approach (referred to as contingency management in the substance abuse field) for reducing use of a wide range of different abused drugs including cocaine, marijuana, methamphetamine, opioids, and tobacco—as well as other health-related behaviors [15•]. A programmatic series of literature reviews on the use of financial incentives with substance use disorders provide a continuous record from the seminal reports through the present [16–18]. Between 1991 and 2015, 177 controlled studies were published in peer-reviewed journals examining the efficacy of systematically delivered vouchers or related monetary incentives for reducing drug use (vast majority of studies) or increasing adherence with other treatment regimens such as clinic attendance or medication adherence. Results in 88 % (156/177) of those studies demonstrated efficacy. Put simply, there is an enormous experimental literature demonstrating that systematically delivered financial incentives effectively reduce drug use and improve other therapeutic targets. Also important to note is that there are basic methodological components to an effective incentive program [19]. Often these components are not included in community-wide incentive programs and as such that literature should be considered separately as is being done in recent reviews [20••].

Methods

We reviewed the literature between 2012 and 2015 using (1) PubMed, the search engine of the US National Library of Medicine, and search terms "financial incentives," "pregnant women," and "cigarette smoking," (2) reference sections of published reports, and (3) consultation with expert colleagues. The review was limited to full reports (not abstracts) of main findings from controlled studies published in peer-reviewed journals examining the efficacy or effectiveness of financial incentives for smoking cessation among pregnant women and secondary analyses from those trials. Reviewing the time period of 2012–2015 dovetails well with an earlier review of this literature that covered contributions through 2011 [21••]. Among the articles reviewed are two Cochrane reviews that were published during the 2012–2015 time period [4•, 20••].

Results

Efficacy Testing

Results from four randomized controlled efficacy trials were published during 2012–2015 [22••, 23, 24••, 25••]. We comment on each below. These four efficacy trials are accompanied by six others published between 2000 and 2011 for a total of ten controlled efficacy trials (Table 1).

Tuten et al. (2012) trial [22••] This trial is seminal in extending this treatment approach to opioid-dependent pregnant smokers. This is an especially important subgroup to investigate as cigarette smoking likely exacerbates the already considerable adverse neonatal health outcomes and hospital costs related to in utero opioid exposure [32•].

As detailed in the Table 1, 102 methadone-maintained pregnant cigarette smokers were randomly assigned to one of three 12-week treatment conditions: (1) incentives delivered contingent on predetermined reductions in breath carbon monoxide (CO) levels, (2) incentives delivered independent of smoking status, and (3) usual care. Incentive values started at a relatively low value, escalated in value with each consecutive negative toxicology test result, and reset back to lower values for positive test results. A notable modification in this incentives intervention was rather than target complete abstinence starting at the quit date, incentives were provided for graded reductions relative to baseline breath CO levels: any reduction (week 1), 10 % reduction (weeks 2–4), 25 % reduction (weeks 5–7), 50 % reduction (weeks 8–9), 75 % reduction (week 10–11), and complete abstinence (CO <4 ppm; week 12 until delivery).

The results were quite encouraging. Women in the incentives condition submitted significantly lower mean CO values than those in both control conditions over the course of the

Table 1 Smoking cessation outcomes in randomized trials using financial incentives with pregnant smokers

Reference	Sample Size	Experimental Incentives Intervention(s)	Comparison Intervention	% Biochemically-confirmed Point-prevalent Abstinent End of Pregnancy	Mean (± SEM) % Antepartum Visits Biochemically-confirmed Abstinent	% Biochemically-confirmed Point-prevalent Abstinence Postpartum
Donatelle et al., 2000 [26]	E[a] = 112 C[a] = 108	Visit frequency: monthly Voucher magnitude/visit: $50 for pregnant women $25 for social supporter Reset contingency: no	• Usual care • Pregnancy-specific smoking cessation self-help kit	E = 32 % C = 9 % $p < .0001$	NA[b]	2 months: E = 21 % C = 6 % $p < .001$
Donatelle et al., 2000 [27] reported in Donatelle et al., 2004 [28]	E = 62 C = 108	Visit frequency: monthly Voucher magnitude/visit: $50 Reset contingency: no	• Historical control (same as above)	E = 28 % C = 9 %	NA	NA
Donatelle et al., 2000 [27] reported in Donatelle et al., 2004 [28]	E1 = 67 E2 = 59 C = 60	*E1: Incentive Only Condition* Visit frequency: monthly Voucher magnitude/visit: $25 Reset contingency: no *E2: Incentive + CO Feed-back Condition* All same as above + CO feedback	• Best-practice 5A's (Ask, Advise, Assess, Assist, Arrange)	E1 = 19 % E2 = 22 % C = 12 %	NA	NA
Higgins et al., 2004 [29]	E = 30 C = 23	Visit frequency:[c] • Antepartum Week 1 = daily Weeks 2–8 = 2× weekly Weeks 9–12 = 1× weekly Weeks 13-delivery = 2× monthly • Postpartum Weeks 1–4 = 1× weekly Weeks 5–12 = 2× monthly Voucher magnitude/visit: Began at $6.25, escalated by $1.25 for each cotinine-negative specimen to $45 maximum Reset contingency: yes	• Usual care • Pregnancy-specific smoking cessation pamphlets • Non-contingent vouchers	E = 37 % C = 9 % $p < .05$	E = 46.8 ± 7.7 % C = 19 ± 4.9 % $p < .01$	3 months: E = 33 % C = 0 % $p < .05$ 6 months: E = 27 % C = 0 % $p < .05$
Higgins et al., unpublished [30]	E = 21 C = 20		(Same as above)	E = 10 % C = 0 % p = ns	E = 15.6 ± 5.2 % C = 3.8 ± 1.0 % $p < .05$	3 months: E = 5 % C = 5 % p = ns 6 months: E = 5 % C = 0 % p = ns
Heil et al., 2008 [31]	E = 37 C = 40		(Same as above)	E = 41 % C = 10 % $p < .01$	E = 56.3 ± 7.1 % C = 17.0 ± 3.4 % $p < .0001$	3 months: E = 24 % C = 3 % $p < .01$ 6 months: E = 8 % C = 3 % p = ns
Higgins et al., 2014 [24••]	E1 = 39 E2 = 40 C = 39	*E1: Same as E above* *E2: Revised Contingent Voucher* Same visit frequency and overall potential earnings, but amounts front-loaded:	(Same as above)	E1 = 36 % E2 = 45 % C = 18 % $p < .05$	E1 = 55 % E2 = 56 % C = 31 % $p < .005$	3 months: E1 = 23 % E2 = 18 % C = 18 %

Table 1 (continued)

Reference	Sample Size	Experimental Incentives Intervention(s)	Comparison Intervention	% Biochemically-confirmed Point-prevalent Abstinent End of Pregnancy	Mean (± SEM) % Antepartum Visits Biochemically-confirmed Abstinent	% Biochemically-confirmed Point-prevalent Abstinence Postpartum
		Began at $18.75, escalated by $3.75 during Week 1 and bonuses for cotinine-negative specimen during Weeks 2–6.				p = ns 6 months: E1 = 15 % E2 = 18 % C = 8 % p = ns
Ondersma et al., 2012 [23]	E1 = 23 E2 = 22 E1xE2 = 26 C = 23	*E1: Computer Delivered 5A's* (Ask, Advise, Assess, Assist, Arrange) *E2: Contingency Manage-Lite.* Patient-initiated opportunity to verify smoking abstinence for $50 gift card at up to 5 prenatal care visits. *E1xE2: Both of the above*	• Usual care • Time-matched, computer-based activity	E1 = 30 % E2 = 9 % E1xE2 = 19 % C = 9 %	NA	NA
Tuten et al., 2012 [22••]	E = 42 C1 = 28 C2 = 32	Visit frequency: 3×/week for 12+ weeks. Vouchers contingent upon escalating reduction in CO. Voucher Magnitude: $7.50 for 1st reduction target, increased by $1.00 for each subsequent reduction target to $41.50 maximum. Reset contingency: Yes	C1: Usual care plus yoked non-contingent earnings for 12 weeks. C2: Usual care including brief motivational interviewing and educational materials on risks on smoking.	E = 31 % C1 = 0 % C2 = 0 %	NA	NA
Tappin et al., 2015 [25••]	E = 306 C = 303	Usual care plus $75 incentive for attendance and setting quit date; escalating incentives for confirmed abstinence at 4 and 12 weeks post-quit date and at end of pregnancy. Maximum total value = $600.	• Usual care • Offer of nicotine replacement and 4 weekly support phone calls	E = 23 % C = 9 % Relative risk of not smoking = 2.63 p < .001	NA	NA

[a] E = Experimental incentives interventions; C = Comparison interventions

[b] NA = not assessed

[c] Same experimental intervention for all Higgins et al. studies & Heil et al. study in this table, except for E2 (revised contigent voucher condition)

intervention. Approximately one third (31 %) of women in the incentives condition met the abstinence target of breath CO ≤4 ppm at week 12 compared to none of the women in the control conditions. Mean incentive earnings in the incentive condition across the 12-week intervention were $156.85 ±30.7. No significant differences in birth outcomes or postpartum abstinence levels were noted.

The overwhelming majority of opioid-dependent pregnant women smoke, and evidence suggests numerous potential neonatal health benefits and cost reductions might follow from getting them to quit [32•]. These encouraging results with incentives for smoking cessation among pregnant opioid-dependent women are also consistent with recent positive outcomes with incentives for smoking cessation in non-pregnant opioid-dependent populations [33].

Ondersma et al. (2012) trial [23] This trial was designed to provide a technology-based smoking cessation intervention that could be delivered with minimal effort and as part of routine obstetrical care. As detailed in the Table 1, 110 pregnant smokers were randomly assigned to one of four treatment conditions in an 8-week trial: (1) treatment as usual, (2) an interactive computer-delivered brief intervention based on the 5As that includes a 4–6-min professionally produced video wherein an obstetrician advises women to quit smoking accompanied by testimonials from women who have done so; (3) an incentives intervention wherein women could ask to have their smoking status tested at routine prenatal care visits up to a maximum of five times with a minimum of 1 week between tests; those with a breath CO ≤4 ppm could earn $50/negative test; and (3) combined computer-delivered brief intervention plus the incentives.

No significant differences between treatment conditions were noted in biochemically verified 7-day point prevalence smoking abstinence (8.7, 30.4, 9.1, and 19.2 % for usual care, CD-based 5As only, incentives only, and CD-based 5As plus incentives, respectively; the CD-based 5As was reported to have a higher percentage of cotinine-negative urine toxicology tests at that 8-week assessment than the three other treatment conditions (17.4, 43.5, 13.6, and 15.4 % for usual care, CD-based 5As only, incentives only, and CD-based 5As plus incentives, respectively).

There are several peculiar aspects to these results including the much larger-than-expected positive response to the 5As. Leaving the timing of smoking status testing and other aspects of engaging with the incentive program unstructured and up to the discretion of the women is unprecedented and may have undermined efficacy by fostering procrastination or perhaps ambiguity about the purpose of the incentive program. To our knowledge, the unusually high success obtained with the CD-delivered version of the 5As in this trial remains to be replicated.

Higgins et al. (2014) trial [24••] This trial was designed to examine whether outcomes achieved with a previously validated schedule of voucher-based financial incentives intervention (see trials by Heil et al. [33] and Higgins et al. [29] in Table 1) could be improved without increasing overall costs. To accomplish that goal, the schedule of potential earnings was modified so that higher value incentives were available earlier in the quit attempt. Abstinence in the initial weeks of a quit attempt is a robust predictor of late-pregnancy outcomes in this treatment approach [34].

As detailed in the Table 1, 118 women were randomly assigned to (1) the previously validated schedule of incentives delivered contingent on biochemically verified smoking abstinence, (2) the revised schedule condition of incentives, or (3) a control condition wherein vouchers were provided independent of smoking status. In the previously validated schedule, voucher value started at $6.25 for the first negative tests and then escalated by $1.25 for each consecutive negative test to a maximum of $39.00 where it remained unless there was a positive test result. Positive test results reset voucher value to initial low levels; two consecutive negative tests following a reset increased voucher values back to the value prior to the reset. Testing of smoking status was daily for the first five days of the quit attempt, tapered gradually over the antepartum period, increased in frequency again in initial weeks postpartum, and then tapered again until incentives were finally terminated at the end of week 12. The frequency and schedule of testing remained the same in the revised schedule as did total possible earnings. What changed was that potential earnings in the initial 6 weeks of the intervention were increased by a total of approximately $300 by reducing values available later in the intervention period.

Both incentive schedules increased the primary outcome of late-pregnancy 7-day point prevalence abstinence rates above control levels by twofold or more (Table 1), but there were no significant schedule differences in that regard. The two incentive conditions also differed from controls but not each other in the overall percentage of all antepartum negative toxicology tests for smoking. The usual incentive schedule but not the revised schedule significantly increased fetal growth above control levels in serial ultrasound testing, replicating results from a prior trial using that same incentive schedule [31]. No significant differences between treatment conditions were noted in birth outcomes or postpartum abstinence rates. Women in the revised and previously validated incentive conditions earned $557.08 ± 64.54 and $443.65 ± 73.69, respectively, in vouchers, with maximal earnings possible being ~$1180 from the start of prenatal care (~10 weeks of gestation) to 12-weeks postpartum.

The efficacy of both incentive schedules for promoting antepartum smoking abstinence is consistent with the results reported in prior trials by this group of investigators [29–31]. Moreover, keeping two of the treatment conditions in this trial (usual incentive schedule and the non-contingent voucher control condition) largely identical with prior trials has

allowed for collapsing data across trials for greater power to examine treatment effects on other outcomes. That strategy was used in studies demonstrating improvements in birth outcomes [35] and breastfeeding duration [36] with the incentives intervention and in the studies discussed below examining depressive symptoms and impulsivity [37••, 38•]. Worth mentioning is that trends in the current trial favoring improved birth outcomes among infants born to mothers in the usual incentives condition are consistent with those earlier findings, although not so with breastfeeding. Tracking such outcomes within and across these trials on incentives with pregnant smokers is very important. Lastly, the failure to discern significant treatment effects of incentives on abstinence at 12-weeks postpartum in the present trial is inconsistent with prior results. Interestingly, the abstinence levels in the two incentive groups in this most recent trial are consistent with results reported by this group previously. It is the levels in the control group at 12-weeks postpartum that were higher than in the prior studies. Abstinence levels among controls dropped off by the 24-week postpartum assessment to where results were in the direction of favoring the incentives condition, which aligns well with earlier results reported by these investigators and those reported by Tappin et al. [25••] discussed below.

Tappin et al. (2015) trial [25••] This trial was designed to test the efficacy of this incentives approach in (1) a larger study sample to begin assessing how scalable the model is and (b) to extend the treatment to populations outside the USA (i.e., Glasgow, Scotland). Prior trials were conducted in the USA.

As detailed in the Table 1, 612 pregnant smokers were randomly assigned to usual care (in-person appointment to discuss smoking and cessation, free nicotine replacement therapy for 10 weeks, and four weekly support phone calls) or usual care plus a maximum of £400 (~$603) in voucher-based incentives. An initial incentive (£50) was delivered contingent on attending an initial in-person meeting and setting a quit date. Additional incentives (£50, £100, and £200, vouchers) were earned for biochemically verified abstinence (breath CO <10 ppm) at assessments conducted at 4, 12, and 34–38 weeks following the quit date, respectively.

The primary outcome was urine-cotinine-verified late-pregnancy point prevalence abstinence, which was 2.6-fold greater in the incentives than control condition (22.5 vs. 8.6 %). Average vouchers earned in the incentives condition was not reported with the main trial results but based on information reported with the economic analysis described below was ~£135. There were no significant differences in birth outcomes; a larger percentage of women in the incentives compared to the control condition self-reported abstinence from smoking at a phone assessment conducted 1-year after the quit date or approximately 24 weeks postpartum (15 % vs. 4 %).

This trial provides compelling evidence for the scalability of this treatment approach and its generality to populations outside of the USA. The failure to discern any impact of the relatively sizeable antepartum treatment effects on birth outcomes is somewhat perplexing and can only be sorted out through further study. It is inconsistent with the pattern of results observed in the trials by Higgins and colleagues where improvements in fetal growth and birth outcomes have been seen in the incentives condition when analyzed with sufficient power by collapsing across trials. The Tappin et al. [25••] intervention involves considerably less frequent monitoring of antepartum smoking status and reinforcement of abstinence than in the Higgins et al. [24••] model, which could be important in terms of impacting fetal growth and birth outcomes.

Cochrane Reviews As noted above, two reviews were reported during 2012–2015 [4•, 20••]. A review by Chamberlain and colleagues [4•] covered incentives with pregnant smokers as part of a larger review on psychosocial interventions for smoking cessation in that population. A more recent review by Cahill and colleagues [20••] covered incentives with pregnant smokers as part of a larger review on incentives for smoking cessation generally and, of course, was more comprehensive. As mentioned above, the Chamberlain et al. review [4•] examining psychosocial interventions with pregnant smokers concluded that incentives produced the largest overall treatment effects among the psychosocial interventions reviewed, consistent with conclusions in an earlier review [12]. The Cahill et al. review [20••] included eight of the ten trials shown in the Table 1 for the present review [22••, 23, 24••, 25••, 26, 29–31, 35, 36, 37••, 38• and one of the two studies in 27 were excluded]. The review supported the efficacy of incentives based on late-pregnancy outcomes and the longest follow-up outcomes reported which was 24-weeks postpartum in the vast majority of trials. Shown in Fig. 1 are late-pregnancy outcomes for individual trials and overall based on 1297 women (675 treated with incentives and 622 without incentives). Those treated with incentives had 3.79 (95 % confidence interval (CI) 2.74–525) greater odds of abstaining from smoking than controls. With regard to longest follow-up outcomes reported, those treated with incentives had 3.61 (95 % CI 2.60–5.02) greater odds of abstaining from smoking than controls.

Effectiveness Studies

Boyd et al. (2015) [39••] This report details what to our knowledge is the seminal prospective economic analysis on the use of financial incentives with pregnant smokers based on the Tappin et al. trial [25••] discussed above. The investigators examined incremental cost per late pregnancy quitter in the incentives versus usual care treatment conditions. They compared results against standardized incremental cost-effectiveness ratio (ICER) tables for smoking cessation from the general population of smokers [40]. The average

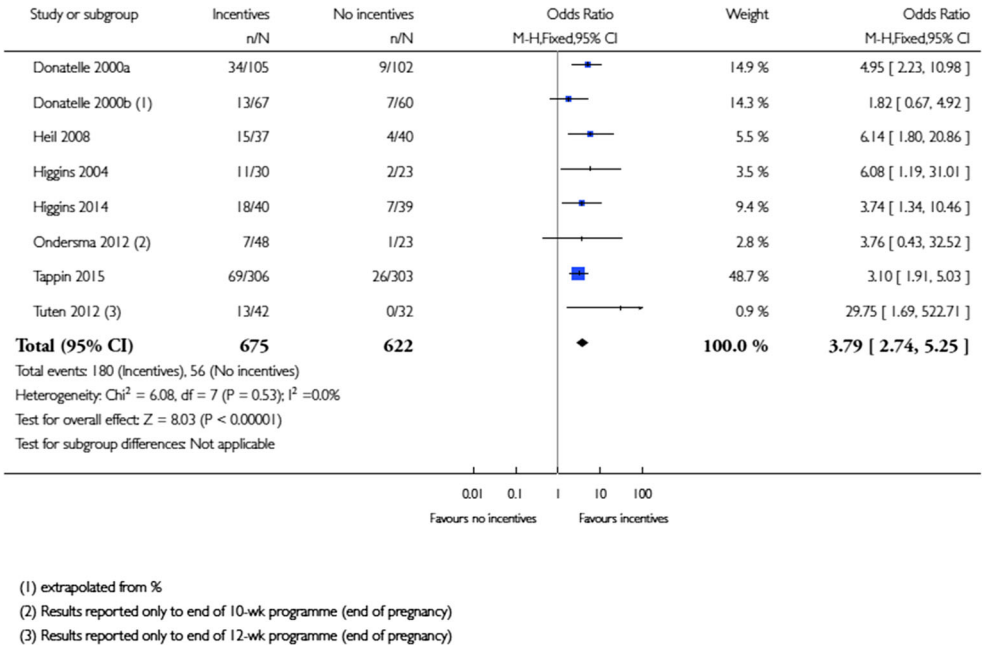

Fig. 1 Odds ratios and 95 % CIs for late-pregnancy point-prevalence abstinence among women treated with financial incentives versus control treatments. Results are shown separately for individual randomized controlled trials and with total results collapsed across trials. Reprinted with permission from Cahill et al. (2015) [20••]

incremental cost per quitter in the incentives conditions was estimated at £158. With late-pregnancy cessation rate of .14 above controls at an incremental cost of £158, the ICER was £1129, which fell below the Standardized ICER of £1390 for a 6-month follow-up outcome difference of 0.14. They also examined incremental quality-adjusted life years (QALY) gained using a Markov model designed to simulate the lifetime likelihood and impact of cessation among those still abstinent at the 6-month postpartum assessment. The incremental cost per QALY gained was estimated at £482, which is well below the £20,000–30,000 standard per QALY gained. While acknowledging the need for further research, the authors concluded that financial incentives for smoking cessation in pregnancy are highly cost-effective.

Ierfino et al. (2015) [41••] A critically important question regarding any new treatment approach is whether it will remain effective when moved into clinical practice. To our knowledge, this study reported by Ierfino et al. [41••] is the first addressing this question regarding financial incentives for smoking cessation among pregnant women. These investigators implemented the incentives intervention in the obstetrical service of a large urban hospital in Chesterfield, England. The intervention was designed to parallel the validated schedule outlined above for the Higgins et al. (2014) trial [24••] in terms of the schedule of voucher delivery and maximal potential earnings. Obstetrical service clinic staff and the community Stop Smoking Service staff implemented the intervention across about a 1-year period. Cessation results were compared to historical controls from the prior year.

A total of 2971 women were screened for smoking, with 615 (21 %) testing positive. The opportunity to join the study was offered to all smokers, with 239 (39 %) accepting. Forty-eight of those 239 women (20 %) were biochemically verified to be abstinent from smoking from 6 weeks after the quit date through delivery, and 10 % were still abstinent at 6-months postpartum. Abstinence among the historical controls was 0 % at both assessments. These results provide an important and encouraging demonstration that this treatment model can be effectively implemented in a community treatment setting.

Potential Moderators of Treatment Response

Lopez et al. (2015) [37••] Cigarette smoking is highly associated with depression and other mood disorders in the general population [42] and is a risk factor for postpartum depression as are a history of prior depression and antepartum depressive symptoms. These investigators examined whether the subgroup of pregnant smokers with histories of depression or those reporting current depressive symptoms were benefitting from this incentives-based smoking cessation intervention.

Women in this study were assigned either to an incentives condition or to a control condition wherein they received vouchers of comparable value independent of smoking status. Treatments were provided antepartum through 12-weeks postpartum [24••, 29, 30, 35, 38•]. Depression ratings (Beck Depression Inventory [BDI]-1A) were examined across seven antepartum/postpartum assessments. Women who reported a history of prior depression or who had BDI scores ≥17 at the start of prenatal care were categorized as depression-prone (Dep+), while those meeting neither criterion were categorized as depression-negative (Dep−).

The intervention increased smoking abstinence independent of depression status demonstrating that depression-

prone women benefit from the intervention. An unexpected but potentially important observation was that the incentives intervention also decreased mean postpartum BDI ratings as well as the proportion of women scoring in the clinical range compared with the control treatment. These treatment effects on depression ratings were specific to the Dep + women. Similar reductions in psychiatric symptoms among those receiving incentive-based treatments have been reported for patients with cocaine use disorders [43] and appear to represent another health outcome that is positively impacted by this treatment approach among pregnant smokers. To our knowledge, this outcome has not yet been examined in other trials on incentives among pregnant and newly postpartum smokers but is an important outcome to examine in future trials or to retrospectively investigate in previously published trials where depressive symptoms were assessed.

Lopez et al. (2015) [38•] These investigators examined whether individual differences in baseline delay discounting moderate response to incentives-based treatment for smoking cessation among pregnant smokers. Delay discounting of monetary rewards is a predictor of becoming a smoker among women of reproductive age [44] and moderated spontaneous quitting upon learning of pregnancy among lighter although not heavier smokers [45].

The study was conducted in two steps: First, associations between baseline impulsiveness and abstinence at late pregnancy and 24-weeks-postpartum were examined as part of a component of the Higgins et al. (2014) trial [24••] described above ($N = 118$). Second, to increase statistical power, a second analysis was conducted collapsing results across all prior trials involving the same study conditions and in which delay discounting was included ($N = 236$). Impulsivity was assessed using a delay discounting (DD) of hypothetical monetary rewards task in all three trials and Barratt Impulsiveness Scale (BIS) in the most recent trial. Analyses were conducted using logistic regression.

Neither DD nor BIS predicted smoking status in the single or combined trials. Receiving incentives, lower baseline smoking rate, and a history of quit attempts pre-pregnancy predicted greater odds of antepartum abstinence across the single and combined trials. A history of quit attempts prior to entering treatment was the only predictor of 24-week postpartum abstinence in the single trial. In analyses collapsing across trials where there was greater statistical power, having received the incentives intervention was the single significant predictor of 24-weeks postpartum abstinence.

Conclusions

There is a robust and compelling body of evidence supporting the efficacy of financial incentives in promoting smoking cessation among pregnant women that is evident at the level of individual trials and in three Cochrane meta-analyses [4•, 12, 20••]. The evidence supporting antepartum treatment effects is strikingly positive and highly important in light of accumulating evidence regarding the adverse effects of in utero smoke exposure across the life span. Evidence for postpartum is not quite as strong as that for antepartum effects at the level of individual trials, but overall leaves little doubt about efficacy across trials [20••, 21••]. Where the most remains to be learned is efficacy at increasing longer-term maternal cessation rates after the incentives have been discontinued. But, there too, there is a reasonable amount of evidence supporting efficacy out through 24-weeks postpartum, and 12 weeks after discontinuation of incentives, when looked at across trials [20••, 21••]. There is also the larger body of evidence mentioned above on the efficacy of incentives for reducing drug use more generally that should be considered.

The initial evidence on cost-effectiveness is also positive and encouraging. The Boyd et al. [39••] study provides critically important evidence that the costs of this incentives treatment approach align well with those of similarly effective smoking cessation interventions already in use with the general population of smokers. That observation seems quite straightforward and provides a sound basis for moving these interventions into routine care. The longer-term estimates regarding maternal QALY gained are more uncertain but nevertheless encouraging. We certainly see nothing in them that should give policy makers pause. The precision of such estimates will be improved by a more detailed understanding of impacts on birth outcomes, breastfeeding duration, postpartum depression risk, and perhaps still unknown shorter-term positive health impacts. Characterizing these effects and associated costs and benefits needs to be a priority in this area. More precise information on longer-term maternal cessation outcomes will be important as well. There seems little doubt that future trials will address these needs. Perhaps the greatest unknown in terms of a comprehensive economic analysis of this treatment model is whether its robust effects on antepartum smoking are impacting longer-term health outcomes among the offspring. Does this treatment approach protect against the effects of in utero smoke exposure on fetal epigenetic profiles and longer-term behavioral, neurobiological, metabolic, and cardiovascular health risks? If so, what are the associated cost benefits of doing so? We anticipate that these are also questions that investigators are likely to begin addressing in the near future, especially those relating to epigenetic changes.

The Ierfino et al. trial [41••] provides encouraging evidence that the treatment can be disseminated into community clinics while retaining clinical effectiveness. That addresses an important concern about this treatment model. Moreover, it does so in a manner that provides a useful roadmap for other communities to follow. The model of having obstetrical clinic staff coordinate with community-supported smoking cessation

interventionists in implementing the treatment would seem to have potential to transfer to a broad range of communities in developed countries. We know that it does in our home state of Vermont. So at a practical level, there is now a roadmap on how to move this treatment model into implementation.

Will that happen in the near future? It is hard to know. Apparently, this incentives model is now being offered as part of routine care in some parts of Scotland, but we know of no other place where that is the case. One has to wonder where the tipping point is on this topic. That is, when does the discussion shift from being exclusively focused on what more needs to be learned scientifically or economically about this treatment model to why so many communities persist in offering inferior care for such a serious and costly public health problem when an efficacious and cost-effective alternative is available. Those of us who work in this field know that the 0 % cessation rates observed over a 1-year period among historical controls in the Ierfino et al. [41••] study are not far off from the dismal success rates seen among economically disadvantaged pregnant smokers in most of our communities. The seminal paper on incentives with pregnant smokers was published in 2000, which is quickly approaching the 17-year average for dissemination of medical advances into routine care [46]. By that metric, one might expect the tipping point to be coming soon.

Compliance with Ethical Standards

Conflict of Interest Stephen T. Higgins and Laura J. Solomon declare that they have no conflict of interest.

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Human and Animal Rights and Informed Consent Among cited articles where one of the authors of the current report were authors, local Institutional Review Board approval was obtained and maintained for studies where human (or animal) subjects research was performed.

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