Impact of the introduction and withdrawal of financial incentives on the delivery of alcohol screening and brief advice in English primary health care: an interrupted time series analysis

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ABSTRACT

Aim

To evaluate the impact of the introduction and withdrawal of financial incentives on alcohol screening and brief advice delivery in English primary care.

Design

Interrupted time series using data from The Health Improvement Network (THIN) database. Data were split into three periods: 1) before the introduction of financial incentives (1st January 2006 to 31st March 2008); 2) during the implementation of financial incentives (1st April 2008 to 31st March 2015); and 3) after the withdrawal of financial incentives (1st April 2015 to 31st December 2016). Segmented regression models were fitted, with slope and step change coefficients at both intervention points.

Setting

England.

Participants

Newly-registered patients (16+) in 500 primary care practices for 2006-2016 (N=4,278,723).

Measurements

The outcome measures were percentage of patients each month who: 1) were screened for alcohol use; 2) screened-positive for higher-risk drinking; 3) were reported as having received brief advice on alcohol consumption.

Findings

There was no significant change in the percentage of newly-registered patients who were screened for alcohol use when financial incentives were introduced. However, the percentage fell (p<0.001) immediately when incentives were withdrawn, and fell by a further 2.96 (95% CI 2.21-3.70) patients per 1,000 each month thereafter. After the introduction of incentives, there was an immediate increase of 9.05 (95% CI 3.87-14.23) per 1,000 patients screening positive for higher-risk drinking, but no significant further change over time. Withdrawal of financial incentives was associated with an immediate fall in

screen-positive rates of 29.96 (95% CI 19.56-40.35) per 1,000 patients, followed by a rise each month thereafter of 2.14 (95% CI 1.51-2.77) per 1,000. Screen-positive patients recorded as receiving alcohol brief advice increased by 20.15 (95% CI 12.30-28.00) per 1,000 following the introduction of financial incentives, and continued to increase by 0.39 (95% CI 0.26-0.53) per 1,000 monthly until withdrawal. At this point, delivery of brief advice fell by 18.33 (95% CI 11.97-24.69) per 1,000 patients and continued to fall by a further 0.70 (95% CI 0.28-1.12) per 1,000 per month.

Conclusions

Removing a financial incentive for alcohol prevention in English primary care was associated with an immediate and sustained reduction in the rate of screening for alcohol use and brief advice provision. This contrasts with no, or limited, increase in screening and brief advice delivery rates following the introduction of the scheme.

Keywords

Alcohol prevention; interrupted time series; financial incentives; primary healthcare; screening; intervention; policy.

INTRODUCTION

Alcohol is the seventh leading global risk factor for premature death and disability, and causally related to over 60 different medical conditions, including liver cirrhosis, cancer and cardiovascular disease (1-4). In a multi-stranded approach to tackling higher-risk drinking, primary care is ideally placed for the prevention and early detection of alcohol-related problems, due to its high population coverage, accessibility, and the frequency with which higher-risk drinkers present to clinicians (5-8). Brief advice in primary care has been shown to reduce heavy drinking, alcohol-related problems, healthcare utilization and mortality (9-11). Yet despite this evidence, which is endorsed by the World Health Organisation (12) and embedded in clinical guidelines across Europe, Australasia and the USA (13-16), delivery of brief alcohol advice across global health systems remains low (17-19).

Using financial incentives to boost the delivery of evidence-based interventions in routine clinical practice is a common policy strategy in many countries. However, evidence of their impact on the quality and efficiency of healthcare remains inconclusive, particularly where long-term patient outcomes are concerned (20-23). There is also limited understanding of the impact of withdrawing incentives, although data from both the USA and United Kingdom (UK) suggest that performance levels are likely to decline, especially for quality indicators relating to the provision of health advice (24-26).

Introduced in 2004, the Quality and Outcomes Framework (QOF) is the primary system for the performance management and payment of General Practitioners (GPs) in the UK National Health Service (NHS) (27). QOF covers a range of smoking prevention indicators, however whilst practices are required to record the alcohol status of targeted patient groups, such as those with serious mental health conditions, routine implementation of alcohol screening and brief advice is excluded. In England, additional priority areas of practice not covered by the QOF are incentivised by a further set of opt-in payment schemes; the national Directed Enhanced Services (DES) (28). Reflecting their focus on preventative care (29), and in response to disappointing rates of alcohol screening and brief advice delivery achieved in England (30, 31), in 2008 the Enhanced Services were extended to cover higher-risk drinking (32).

Under the alcohol DES, participating practices were paid a small fee of £2.38 (approximately $3.04 or €2.71) for each newly-registered adult patient they screened to identify higher-risk drinking using a validated self-report questionnaire (33). This compares to £140.00 ($176.19 or €157.08) paid per patient to practices for delivering health checks to people aged 14+ with learning disabilities (DES also introduced in 2008), and to a maximum of £11,472.64 ($14,436.29 or €12,872.39) per practice for implementing various smoking identification and treatment services. The alcohol DES was withdrawn in April 2015, replaced by a requirement for practices to identify newly-registered adult patients drinking above recommended levels under the General Medical Services contract (34). Thus whilst GPs are still legally obliged to identify and support higher-risk drinkers in England, they are no longer specifically financially rewarded for carrying out this work.

There are few published data on the impact of the DES on alcohol prevention work in English primary care. One small study conducted in Northern England found that practices receiving financial incentives for alcohol work during 2010-2011 recorded higher rates of alcohol screening and brief advice delivery compared to those not receiving additional payments, although overall, rates remained low (35). However, there has been no nationally representative evaluation of either the impact of financial incentives on the full alcohol prevention pathway from identification (screening) to intervention (advice), or any potential effect of withdrawing the alcohol DES on overall delivery rates.

We sought to assess the impact of the introduction and subsequent withdrawal of financial incentives on recorded rates of: 1) newly-registered patients screened for higher-risk alcohol consumption; 2) patients screening positive; and 3) delivery of brief alcohol advice in English primary care.

METHODS

Data source

We used data from The Health Improvement Network (THIN); a primary care database containing electronic patient records from 500+ general practices, approximately six per cent of UK patients. It is broadly representative of the national population in terms of age, sex, deprivation, and geographical distribution (36). THIN contains details of symptoms,

diagnoses, prescriptions, test results, health indicators and the Townsend deprivation index; a composite measure of social deprivation presented as quintiles (37). Information can be entered by practitioners into the database as free text or codified using alpha-numeric Read Codes. Until replaced by SNOMED CT (Systematized Nomenclature of Medicine - Clinical Terms) on 1st April 2018, Read Codes were the standard clinical terminology used to record care in electronic patient records across all UK general practices (38, 39).

To ensure that data of an acceptable standard were included for analysis, individual practices were only eligible if their data were published after the Acceptable Mortality Reporting (AMR) (40) and Acceptable Computer Usage (ACU) dates (41). These are THIN-specific quality measures of the extent to which mortality data are entered on the computer (AMR) and the computer is used for general recording of patient information (ACU). Both markers are applied to the data from each general practice.

Newly-registered patients (defined as within the previous twelve-month period) aged 16 to 99 years, and registered with a practice that had been contributing data to THIN for at least two years prior to the patients' registration date, were eligible for inclusion. Owing to low numbers of new registrations, and a small number of patient records suggesting implausibly high ages, patients with recorded ages of 100+ were excluded from analysis.

Use of THIN for scientific research was approved by the NHS South-East Multi-Centre Research Ethics Committee in 2003. Scientific approval to undertake this study was obtained from IQVIA World Publications Scientific Review Committee (SRC) in January 2017 (SRC Reference Number: 16THIN098).

Outcome measures

The following variables comprised the basis of our outcome indicators:

1. Percentage of eligible patients aged 16+ screened for higher-risk drinking using a validated screening questionnaire (42-45) or questions to ascertain their level of alcohol consumption;
2. Percentage of screened patients identified as higher-risk drinkers based on UK guidelines (13);
3. Percentage of screen positive patients who received brief advice about their drinking.

The design of the alcohol DES meant that practices were only required to record their screening of newly-registered patients to qualify for payment. By including recorded rates of screen positives, and rates of those screen-positives subsequently receiving brief advice, we sought to identify whether appropriate patients received support for higher-risk drinking.

Every recorded consultation was compared against a list of Read Codes corresponding to each of the above indicators. This list comprised both the specific Read Codes that practices were required to use in order to trigger alcohol DES payments (32), alongside unrefined, more inclusive lists of Read codes relating to the identification and treatment of higher-risk drinking identified by previous studies (46, 47) and the clinical codes repository (48). A list of all Read Codes used in our analyses is provided in supplementary File 1).

Statistical analysis

We used interrupted time series analysis (ITS), a quasi-experimental study design (49, 50). We calculated monthly rates (%) and 95% confidence intervals for each outcome indicator for the period 1st January 2006 to 31st December 2016. Rates were plotted graphically to allow us to visualise trends over time, including an initial assessment of any change occurring pre- and post- the two intervention points of interest: (1) introduction of the alcohol DES on 1st April 2008; (2) withdrawal of financial incentives on 31st March 2015.

We used segmented regression analysis to quantify the magnitude of the impact of the two interventions on our outcomes of interest. For ease of interpretation of results, we converted outcome measures from proportions to rates per 1,000 patients. Models were specified to allow a linear underlying trend in each outcome, and for each intervention to have both an immediate change in the outcome and to alter the underlying trend (i.e. to change both the intercept and the slope of the fitted trends, see supplementary File 2). We hypothesised that the introduction of incentives in 2008 would increase activity rates, and that withdrawal in 2015 would reduce their delivery. All models were assessed visually for seasonality, and alternative methods to account for these tested (including either harmonic functions of the month variable or separate month dummies in the model). Final model selection was made on the basis of minimising Bayesian and Akaike Information Criteria (51). A Durbin-Watson test (52) suggested some residual autocorrelation, even after controlling for seasonality, and we therefore report Newey-West standard errors. As data

were aggregated across all THIN practices, there was no need to account for clustering of patients within practices in the analysis.

Sensitivity analysis

Initial inspection of the data showed that few consultations had separate Read Codes for both a positive screening score and the delivery of alcohol brief advice. We therefore conducted a sensitivity analysis where we used the proportion of all patients recorded as being screened who had received advice as an outcome, irrespective of whether the screening result itself was recorded. Next, as guidelines recommend that very heavy drinkers are likely to need support beyond simple brief advice (13), in a further sensitivity analysis, we examined the impact of additionally including Read Codes associated with referring patients to specialist alcohol treatment services in the definition of receiving alcohol brief advice.

RESULTS

Table 1 shows demographic characteristics of: all patients aged 16-99 in the full THIN database (age strata based on age at registration); registered with a new practice between 1st January 2006 and 31st December 2016; and recorded as experiencing each of the three outcome measures (screening, screening positive, receiving alcohol brief advice). This shows our patient sample was relatively less deprived but the age spread reflected that found in the national population (53).

INSERT TABLE 1 HERE

Rates for each outcome measure (including 95% confidence intervals) are shown in Figure 1. This shows that the screening rate for newly-registered patients remained relatively stable until the withdrawal of financial incentives in 2015. Rates of newly-registered patients screening positive for higher-risk drinking increased steadily until 2012, then fell back slightly before rising sharply at the start of 2016. However, following a time-limited increase in recorded intervention delivery to screen-positive patients between 2009-11, rates have subsequently declined. In the following section, we assess the significance of these trends.

INSERT FIGURE 1 HERE

Time trends in alcohol screening

Table 2 shows the full results for the final ITS models for all three outcome measures; coefficients represent beta values from the specified linear regression models. Screening rates were the only outcome for which a seasonal adjustment was required, with more than ten additional screenings per 1,000 patients in September and October than in any other month. We speculated that this was potentially related to trends in new registrations amongst higher education students at the start of each academic year. Subsequent analysis appears to corroborate this, showing both higher rates of registration and higher rates of screening in 16-24 year olds in these months compared to the rest of the year, an effect not observed in other age groups (see supplementary File 3).

INSERT TABLE 2 HERE

Newly-registered patients screened for heavy drinking

At the start of the analysis period (1st January 2006), 92 out of every 1,000 eligible patients were screened each month, with the screening rate increasing slowly thereafter. There was no significant change at the point when financial incentives were introduced in April 2008. However, there was a significant (p<0.001) shift in this temporal trend on their withdrawal in March 2015, with rates falling by 2.96 (95% CI 2.21-3.70) patients per 1,000 each month thereafter. These trends are illustrated in Figure 2.

INSERT FIGURE 2 HERE

It should be noted that these data (Figure 2) represent the proportion of eligible patients screened each month during the analysis period. The proportion of patients screened within the eligible window (12 months post-registration) was higher, averaging around 65% of all newly-registered patients during the DES period (see supplementary File 4).

Newly-registered patients screening positive for heavy drinking

At the start of the analysis period, 104 in every 1,000 newly-registered patients who were screened were also recorded as screening positive for higher-risk drinking. As with the screening rate, this increased steadily prior to the introduction of financial incentives. After the introduction of incentives, there was an immediate increase of 9.05 (95% CI 3.87-14.23) per 1,000 in the rate of screen positives; however there was no significant change in the rate at which this increased over time. Withdrawal of financial incentives was associated with a fall in screen positive rates of 29.96 (95% CI 19.56-40.35) per 1,000 patients but a rise in the monthly increase in this rate of 2.14 (95% CI 1.51-2.77) per 1,000. Figure 3 illustrates these trends graphically.

INSERT FIGURE 3 HERE

Delivery of brief alcohol advice to newly-registered screen positive patients

Fewer than 15 in every 1,000 screen positive patients were recorded as receiving brief advice at the start of the analysis period. This rate increased by 20.15 (95% CI 12.30-28.00) per 1000 patients following the introduction of financial incentives in 2008, and continued to increase by 0.39 (95% CI 0.26-0.53) per 1,000 each month thereafter up to the point at which incentives were withdrawn. At this point, delivery of brief advice fell by 18.33 (95% CI 11.97-24.69) per 1,000

patients and continued to fall by a further 0.70 (95% CI 0.28-1.12) per 1,000 per month. Figure 4 shows these trends.

INSERT FIGURE 4 HERE

Between April 2015 and December 2016, our modelling estimates suggest that 36,223 fewer patients were screened, and 1,646 fewer patients received brief advice in our sample THIN population than if the incentives had not been withdrawn.

Sensitivity analyses

Using data on all screened patients who received alcohol brief advice as our denominator, instead of only those recorded as screening positive, substantially reduced overall delivery rates, but made no substantive difference to our findings. Similarly, including Read Codes relating to specialist treatment referrals alongside those for delivery of alcohol brief advice did not meaningfully alter our results (see supplementary File 4).

Exploratory analysis

Across all three outcome measures, particularly receipt of alcohol brief advice, visual inspection of the delivery rates over time suggested that there may have been a delay in the effect of one or both of the interventions (introduction and withdrawal of financial incentives). We therefore used R's *changepoint* package to identify potential turning points in the time series for each outcome (54). This analysis showed some evidence for a lag of around 6 months for the initial effect of the introduction of incentives to affect screen positive and brief advice rates, and a potential lag of 7-10 months for the effect of withdrawing them to be felt (see supplementary File 5).

DISCUSSION

Our analysis of electronic health records shows that the introduction of financial incentives for alcohol prevention work had limited success in improving rates of newly-registered patients screened for higher-risk drinking in English primary care. However, their withdrawal in March 2015 saw an immediate and significant drop in rates of both alcohol screening and the delivery of brief advice; a downward trend that has continued since. At the end of our analysis period (December 2016), although general practices are now contractually required to deliver alcohol screening and brief advice, fewer than three per cent of patients in our sample identified as drinking above

recommended limits were recorded as receiving appropriate support. Scaling-up our findings to the English population would suggest that up until the end of 2016, 603,719 fewer adult patients were screened for higher-risk drinking, and 27,439 fewer patients received brief advice, as a result of terminating the alcohol DES.

This study represents the first large-scale assessment of the impact of financial incentives on alcohol screening and brief advice in primary care. Two studies in England found that using incentives targeted at patients with mental health and/or cardiovascular conditions led to a significant increase in alcohol screening rates (55, 56). Evidence for the effectiveness of financial incentives for alcohol prevention in general primary care populations is more equivocal. The five-country ODHIN trial reported positive impacts of using incentives to encourage implementation of screening and alcohol brief advice (57, 58). However, increases were not fully sustained at the 12-week follow-up after incentives were withdrawn. Previous research suggests that whilst the introduction of financial incentives can stimulate immediate improvements in healthcare, returns are likely to stagnate over time (59, 60). One case study in Northern England detected slightly higher levels of screening and advice delivery in DES-incentivised compared to non-incentivised practices, but found low levels of alcohol prevention activity irrespective of incentive status (35). Whilst our findings suggest that overall, screening rates for newly-registered patients within the full 12 months post-registration period were relatively high, other studies confirm the low levels of screening carried out in the general patient population (19). Further, and importantly, these results highlight the significant decline in screening rates since incentives were withdrawn.

No other study has assessed the impact of withdrawing financial incentives on alcohol prevention in primary care. There is limited published evidence on what happens when financial incentives are removed for healthcare performance in general, and findings to date have conflicted (24-26). On balance, it appears that the risks of withdrawing incentives may be small when specific clinical practices have already achieved high levels of quality, acceptance and adoption amongst providers (26), but outcomes for other aspects of care may be more negative. Two recent evaluations of the retirement of a series of QOF indicators found that performance in all areas fell after the incentive was removed, but the drop was largest for those indicators generally considered less relevant and acceptable to GPs (61), and those associated with the provision of health advice (25). GPs' resistance to routine implementation of alcohol advice in English primary care is well-documented

(19, 35, 62). As such, the sharp downward trend in delivery rates of alcohol screening and brief advice once incentives were withdrawn reported here should have been anticipated.

The main strength of our study was the use of a large dataset representing over four million newly-registered patients, drawn from a representative sample of several hundred practices. Additionally, whilst the randomized controlled trial remains the research 'gold-standard', interrupted time series analysis provides a strong alternative where an experimental study design is infeasible or unethical (49), such as the evaluation of policy initiatives in healthcare (50). Importantly, our data cover multiple time-points over 11 years of electronic health records. At the same time, whilst our analytic approach was pre-specified, we recognise that alternative methods exist for the analysis of time series data. These include more complex approaches, such as Generalised Additive Mixed Models (GAMM), that can account for higher order autocorrelation and more complex seasonal patterns (63).

Some ecological limitations also exist. In particular, the potential impact of additional or competing policies on our outcomes of interest is acknowledged. Between 2006-2016, relevant policies include the publication of NICE guidelines for preventing the development of hazardous and harmful drinking in June 2010 (13), and the 2012 Alcohol Strategy (64), alongside a change in UK Government, and the subsequent reorganisation of primary care and public health in England. Additionally, duty rates for several alcoholic beverages were reduced immediately prior to the withdrawal of financial incentives in March 2015 (65). However, our change point analysis does not provide strong support for a single consistent effect of any of these potentially confounding policies across all outcomes. Next, we focussed on new registrants only so are unable to draw conclusions with regards to any changes in alcohol screening and advice delivery to existing patients. Previous modelling work demonstrates that screening focussed on new registrations represents a cost-saving and cost-effective approach to encouraging alcohol prevention in primary care, which is less resource-intensive than screening existing patients at their next GP consultation (66). Additionally, whilst the THIN dataset is nationally representative, we lack information on which practices in our dataset opted into the alcohol DES during the analysis period. However, other mandatory schemes would have affected alcohol prevention recording, such as NHS Health Checks for patients aged 40-75, irrespective of incentive status. Moreover, since 1st April 2015, all practices are required to screen newly-registered as part of their general contractual obligations (34).

There are also limitations of using routine clinical datasets, such as Read Code data, for research and evaluation purposes (67). Although UK guidelines require that every clinical encounter is recorded on the computer system in primary care (68), there is evidence that the use of pay-for-performance can distort recoding practice, with clinicians tending to prioritise recording of data corresponding to delivery of incentivised areas of care (69). In the case of alcohol screening and brief advice, previous research suggests that concerns around the adverse social and legal consequences of identifying patients with socially stigmatised conditions (70), and the low priority accorded to recording preventative interventions such as alcohol advice (71), has more generally resulted in under-coding of care (35). Changes in the Read Codes available for recording alcohol activity, such as the introduction of new codes in 2008 as part of the DES specification, also affect our ability to evaluate delivery rates accurately (72). However, by employing a comprehensive approach to generate lists of Read Codes to assess performance against our outcome measures, we sought to minimise the impact of such coding artefacts on analysis. Importantly, publicly available data on the delivery of GP Contract Services for the period 2013 to 2018 further corroborates the fall we have identified in alcohol screening rates. NHS Digital data show that 74% of newly-registered patients were recorded as being screened within 12 months of registration in 2014-15, but this fell to 48% in 2015-16 after financial incentives were withdrawn (73).

Several factors may have contributed to the low delivery of alcohol screening and brief advice delivery in English primary care. First, limited take-up could be linked to the design of the alcohol incentive scheme itself. Other studies have reported that the low remuneration levels associated with the alcohol DES meant that screening and advice were given lower priority compared to other more lucrative areas of primary care, such as those covered by the QOF (35, 62). Further, as clinicians were incentivised for screening patients alone, subsequent delivery of alcohol advice may have been under-recorded and less prioritised. The distorting effects of incentivising process as opposed to outcomes in healthcare have been criticised, including by the current UK Government (74). From a public health perspective, there is limited value in rewarding clinicians for identifying heavy drinkers if those patients are not subsequently offered appropriate support.

Second, systematic review findings also suggest that financial incentives are more likely to have a positive and sustained impact when they target practices: where a robust evidence base exists; that align with organisational goals; and have strong provider support (20, 75, 76). In the case of alcohol prevention, although more than 70 RCTs have shown that primary care-based screening

and brief advice is clinically- and cost-effective (9), there is less evidence that clinicians themselves are willing to devote limited consultation time to their provision (77). Moreover, even in areas of practice that have strong support, evidence from behavioral economics highlights the risk that using extrinsic (monetary) incentives to encourage performance may conversely reduce ('crowd-out') a clinician's intrinsic motivation to deliver care, particularly over the longer-term (78-80).

Third and finally, for policymakers considering using short-term incentives to boost clinicians' delivery of preventative healthcare practices, our study further highlights the potential for substantial adverse effects on service provision once payments are withdrawn (81). Adding such practices to clinicians' contractual obligations to ensure their continued delivery is an important first step, but must be closely monitored thereafter, with clear penalties enforced for under-performance. In England, the government introduced another time-limited pay-for-performance scheme for screening and brief advice provision in secondary care via the NHS Commissioning for Quality and Innovation (CQUIN) alcohol indicator (82), despite less clear evidence for effectiveness compared to primary care settings (83). Until March 2020, secondary care providers will receive a payment based on the percentage of eligible adult patients admitted for at least one night and asked about their alcohol use, and subsequently given advice or offered specialist support as appropriate. Given the results reported here, we suggest any future changes to the alcohol CQUIN are implemented with care.

CONCLUSION

Removing a financial incentive for alcohol prevention led to an immediate and sustained reduction in recorded rates of screening and brief advice delivered to newly-registered patients in English primary care. This contrasts with the limited and gradual gains achieved by the original introduction of the scheme. These findings highlight the potential adverse consequences of using short-term financial incentives to boost implementation of alcohol prevention in primary healthcare.

Declarations of interest

REFERENCES

1. GBD 2016 Alcohol Collaborators. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet. 2018.
2. Rehm J, Mathers C, Popova S, Thavorncharoensap M, Teerawattananon Y, Patra J. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. The Lancet.373(9682):2223-33.
3. Goldstein MG, Whitlock EP, DePue J. Multiple behavioral risk factor interventions in primary care: Summary of research evidence. Am J Prev Med. 2004;27(2, Supplement):61-79.
4. Steel N, Ford JA, Newton JN, Davis ACJ, Vos T, Naghavi M, et al. Changes in health in the countries of the UK and 150 English Local Authority areas 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet.
5. Whitlock EP, Orleans CT, Pender N, Allan J. Evaluating primary care behavioral counseling interventions: An evidence-based approach 1. Am J Prev Med. 2002;22(4):267-84.
6. Walker A, Maher J, Coulthard M, Goddard E, M T. Living in Britain. Results from the 2000/01 General Household Survey. London: Office for National Statistics; 2001.
7. Hippisley-Cox J, Vinogradova Y. Trends in consultation rates in general practice 1995/1996 to 2007/2008: analysis of the QRESEARCH database. London: NHS Information Centre,; 2008.
8. Funk M, Wutzke S, Kaner E, Anderson P, Pas L, McCormick R, et al. A multicountry controlled trial of strategies to promote dissemination and implementation of brief alcohol intervention in primary health care: Findings of a world health organization collaborative study. J Stud Alcohol. 2005;66(3):379-88.
9. Kaner EFS, Beyer FR, Muirhead C, Campbell F, Pienaar ED, Bertholet N, et al. Effectiveness of brief alcohol interventions in primary care populations. Cochrane Database Syst Rev. 2018;Issue 2. Art. No.: CD004148. DOI: 10.1002/14651858.CD004148.pub4.
10. Bray JW, Zarkin GA, Davis KL, Mitra D, Higgins-Biddle JC, Babor TF. The effect of screening and brief intervention for risky drinking on health care utilization in managed care organizations. Medical Care. 2007;45(2):177-82.
11. Cuijpers P, Riper H, Lemmers L. The effects on mortality of brief interventions for problem drinking: a meta-analysis. Addiction. 2004;99(7):839-45.
12. Babor T, Higgins-Biddle J. Brief Intervention for Hazardous and Harmful Drinking: A Manual for Use in Primary Care. Geneva: World Health Organization: Department of Mental Health and Substance Dependence; 2001.
13. NICE. Alcohol-use disorders: preventing the development of hazardous and harmful drinking: NICE public health guidance 24. London: National Institute for Health and Clinical Excellence; 2010 June 2010.
14. Swedish National Institute of Public Health. Alcohol issues in daily healthcare. The Risk Drinking Project - background strategy and results. . Ostersund: Swedish National Institute of Public Health.; 2010.

15. McCormick R, Docherty B, Segura L, Colom J, Gual A, Cassidy P, et al. The research translation problem: Alcohol screening and brief intervention in primary care – Real world evidence supports theory. Drugs: Education, Prevention and Policy. 2010;17(6):732-48.

16. Moyer VA, on behalf of the USPSTF. Screening and behavioral counseling interventions in primary care to reduce alcohol misuse: U.s. preventive services task force recommendation statement. Annals of Internal Medicine. 2013;159(3):210-8.

17. van Beurden I, Anderson P, Akkermans RP, Grol RP, Wensing M, Laurant MG. Involvement of general practitioners in managing alcohol problems: a randomized controlled trial of a tailored improvement programme. Addiction. 2012;107(9):1601-11.

18. Seppanen KK, Aalto M, Seppa K. Institutionalization of brief alcohol intervention in primary health care-the Finnish case. Alcohol Clin Exp Res. 2012;36(8):1456-61.

19. Brown J, West R, Angus C, Beard E, Brennan A, Drummond C, et al. Comparison of brief interventions in primary care on smoking and excessive alcohol consumption: a population survey in England. Br J Gen Pract. 2016;66(642):e1-e9.

20. Mendelson A, Kondo K, Damberg C, et al. The effects of pay-for-performance programs on health, health care use, and processes of care: A systematic review. Annals of Internal Medicine. 2017;166(5):341-53.

21. Flodgren G, Eccles M, Shepperd S, Scott A, Parmelli E, FR B. An overview of reviews evaluating the effectiveness of financial incentives in changing healthcare professional behaviours and patient outcomes (Review). Cochrane Database of Systematic Reviews; 2011.

22. Ogundeji YK, Bland JM, Sheldon TA. The effectiveness of payment for performance in health care: A meta-analysis and exploration of variation in outcomes. Health Policy. 2016;120(10):1141-50.

23. Mandavia R, Mehta N, Schilder A, Mossialos E. Effectiveness of UK provider financial incentives on quality of care: a systematic review. Br J Gen Pract. 2017.

24. Lester H, Schmittdiel J, Selby J, Fireman B, Campbell S, Lee J, et al. The impact of removing financial incentives from clinical quality indicators: longitudinal analysis of four Kaiser Permanente indicators. Br Med J (Clin Res Ed). 2010;340.

25. Minchin M, Roland M, Richardson J, Rowark S, Guthrie B. Quality of care in the United Kingdom after removal of financial incentives. New England Journal of Medicine. 2018;379(10):948-57.

26. Kontopantelis E, Springate D, Reeves D, Ashcroft DM, Valderas JM, Doran T. Withdrawing performance indicators: retrospective analysis of general practice performance under UK Quality and Outcomes Framework. BMJ : British Medical Journal. 2014;348.

27. Doran T, Fullwood C, Gravelle H, Reeves D, Kontopantlis E, Hiroeh U, et al. Pay-for-Performance Programs in Family Practices in the United Kingdom. The New England Journal of Medicine. 2006;355(4):375-84.

28. Gregory S. General practice in England: An overview. London: The King's Fund,; 2009.

29. Marks L, Cave S, Wallace A, Mason A, Hunter DJ, Mason JM, et al. Incentivizing preventive services in primary care: perspectives on Local Enhanced Services. Journal of Public Health. 2011;33(4):556-64.

30. Cabinet Office. Alcohol Harm Reduction Strategy for England. London: Prime Minister's Strategy Unit; 2004.

31. Dept. of Health, Home Office, Skills. DfEa, Dept. for Culture MaS. Safe. Sensible.Social. The next steps in the National Alcohol Strategy. London: HM Government; 2007.

32. British Medical Association, National Health Service. Clinical directed enhanced services (DESs) for GMS contract 2008/09. London: BMA & NHS Employers; 2009.

33. NHS Employers. General Medical Services Contract 2014/15: Guidance and Audit Requirements. . London: BMA, NHS England & NHS Employers; 2014. Contract No.: NHS England Gateway reference: 01347.

34. NHS Employers, BMA, NHS England. TECHNICAL REQUIREMENTS FOR 2014/15 GMS CONTRACT CHANGES. NHS England Gateway reference: 02000. London: NHS Employers; 2014.

35. O'Donnell A, Haighton K, Chappel D, Shevills C, Kaner E. Impact of financial incentives on alcohol intervention delivery in primary care: a mixed-methods study. BMC Fam Pract. 2016;17(165):DOI: 10.1186/s12875-016-0561-5.

36. Blak BT, Thompson M, Dattani H, Bourke A. Generalisability of The Health Improvement Network (THIN) database: demographics, chronic disease prevalence and mortality rates. Inform Prim Care. 2011;19(4):251-5.

37. Townsend P, Phillimore P, Beattie A. Health and Deprivation: Inequality and the North. London: Croom Helm; 1988.

38. Chisholm J. The Read clinical classification. British Medical Journal. 1990;300(6732):1092.

39. Davé S, Petersen I. Creating medical and drug code lists to identify cases in primary care databases. Pharmacoepidemiology and Drug Safety. 2009;18(8):704-7.

40. Maguire A, Blak BT, Thompson M. The importance of defining periods of complete mortality reporting for research using automated data from primary care. Pharmacoepidemioly and Drug Safety. 2009;18(1):76-83.

41. Horsfall L, Walters K, Petersen I. Identifying periods of acceptable computer usage in primary care research databases. Pharmacoepidemiol Drug Saf. 2013;22(1):64-9.

42. Hodgson RJ, Alwyn T, John B, Thom B, Smith A. The FAST Alcohol Screening Test. Alcohol & Alcoholism. 2002;37:61-6.

43. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA, for the Ambulatory Care Quality Improvement P. The audit alcohol consumption questions (audit-c): An effective brief screening test for problem drinking. Archives of Internal Medicine. 1998;158(16):1789-95.

44. O'Donnell A, Kaner A. Chapter 39: Screening of High Risk Drinkers. In: Boyle B, Zatonski, Lowenfels, Brawley, Burns and Rehm,, editor. Alcohol, Science, Policy and Public Health. Oxford: Oxford University Press; 2013.

45. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption II. Addiction. 1993;88:791-804.

46. Khadjesari Z, Marston L, Petersen I, Nazareth I, Walters K. Alcohol consumption screening of newly-registered patients in primary care: a cross-sectional analysis. Br J Gen Pract. 2013;63(615):706-12.

47. O'Donnell A, Haighton K, Chappel D, Shevills C, Kaner E. Can routine data help evaluate the implementation of a brief alcohol intervention in primary health care? Alcoholism: Clinical and Experimental Research 2013;35(S6)(149A).

48. Springate DA, Kontopantelis E, Ashcroft DM, Olier I, Parisi R, Chamapiwa E, et al. ClinicalCodes: An Online Clinical Codes Repository to Improve the Validity and Reproducibility of Research Using Electronic Medical Records. PLoS ONE. 2014;9(6):e99825.

49. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. Journal of Clinical Pharmacy and Therapeutics. 2002;27(4):299-309.

50. Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care quality improvements. Acad Pediatr. 2013;13(6 Suppl):S38-44.

51. H. JR. Bayesian information criterion for longitudinal and clustered data. Stat Med. 2011;30(25):3050-6.

52. Vinod HD. Generalization of the Durbin-Watson Statistic for Higher Order Autoregressive Process. Communication in Statistics. 1973;2:115-44.

53. Blak B, Thompson M, Dattani H, Bourke A. Generalisability of The Health Improvement Network (THIN) database: demographics, chronic disease prevalence and mortality rates. Journal of Innovation in Health Informatics. 2011;19(4):251-5.

54. Killick R, Eckley I. changepoint: An R package for changepoint analysis. Journal of statistical software. 2014;58(3):1-19.

55. Khadjesari Z, Hardoon SL, Petersen I, Hamilton FL, Nazareth I. Impact of Financial Incentives on Alcohol Consumption Recording in Primary Health Care Among Adults with Schizophrenia and

Other Psychoses: A Cross-Sectional and Retrospective Cohort Study. Alcohol Alcohol. 2017;52:197-205.

56. Hamilton FL, Laverty AA, Gluvajic D, Huckvale K, Car J, Majeed A, et al. Effect of financial incentives on delivery of alcohol screening and brief intervention (ASBI) in primary care: longitudinal study. Journal of Public Health. 2014;36(3):450-9.

57. Anderson P, Bendtsen P, Spak F, Reynolds J, Drummond C, Segura L, et al. Improving the delivery of brief interventions for heavy drinking in primary health care: outcome results of the Optimizing Delivery of Health Care Intervention (ODHIN) five-country cluster randomized factorial trial. Addiction. 2016;111(11):1935-45.

58. Anderson P, Coulton S, Kaner E, Bendtsen P, Kłoda K, Reynolds J, et al. Delivery of Brief Interventions for Heavy Drinking in Primary Care: Outcomes of the ODHIN 5-Country Cluster Randomized Trial. The Annals of Family Medicine. 2017;15(4):335-40.

59. Ganz DA, Wenger NS, Roth CP, Kamberg CJ, Chang JT, MacLean CH, et al. The effect of a quality improvement initiative on the quality of other aspects of health care: the law of unintended consequences? Medical care. 2007:8-18.

60. Ryan AM, Krinsky S, Kontopantelis E, Doran T. Long-term evidence for the effect of pay-for-performance in primary care on mortality in the UK: a population study. The Lancet. 2016;388(10041):268-74.

61. Wilding A, Kontopantelis E, Munford L, Sutton M. Impact of removing indicators from the Quality and Outcomes Framework: Retrospective study using individual patient data in England. London: NHS England; 2018.

62. O'Donnell A, Kaner E. Are Brief Alcohol Interventions Adequately Embedded in UK Primary Care? A Qualitative Study Utilising Normalisation Process Theory. Int J Environ Res Public Health. 2017;14(4):350.

63. Beard E, Marsden J, Brown J, Tombor I, Stapleton J, Michie S, et al. Understanding and using time series analyses in addiction research. Addiction.0(ja).

64. Her Majesty's Goverment. The Government's Alcohol Strategy. London: HM Government; 2012.

65. HM Revenue and Customs, HM Treasury. Overview of Tax Legislation and Legislation Rates. London: HM Government; 2015.

66. Purshouse R, Brennan A, Rafia R, Latimer N, Archer R, Angus C, et al. Modelling the Cost-Effectiveness of Alcohol Screening and Brief Interventions in Primary Care in England. Alcohol Alcohol. 2013;48(2):180-8.

67. de Lusignan S, van Weel C. The use of routinely collected computer data for research in primary care: opportunities and challenges. Family Practice. 2006;23(2):253-63.

68. Department of Health, Royal College of General Practitioners, British Medical Association. The Good Practice Guidelines for GP electronic patient records v4. London: Department of Health; 2011.

69. Prytherch D, Briggs J, Weaver P, Schmidt P, Smith G. Measuring clinical performance using routinely collected clinical data. Medical Informatics and the Internet in Medicine. 2005;30(2):151-6.

70. Survjit C, Colin D, Adenekan O, Tom P, Paolo D, Katherine P, et al. Low identification of alcohol use disorders in general practice in England. Addiction. 2008;103(5):766-73.

71. Hrisos S, Eccles M, Francis J, Dickinson H, Kaner E, Beyer F, et al. Are there valid proxy measures of clinical behaviour? A systematic review. Implement Sci. 2009;4(No. 37).

72. de Lusignan S. Using routinely collected GP data for quality improvement and research. BCS HI L&SE Specialist Groups2006.

73. NHS Digital. GP Contract Services. 2018.

74. Department of Health. Equality and excellence: Liberating the NHS. London: Department of Health - The Stationery Office Ltd; 2010.

75. Roland M, Olesen F. Can pay for performance improve the quality of primary care? Br Med J (Clin Res Ed). 2016;354:i4058.

76. Kondo KK, Damberg CL, Mendelson A, Motu'apuaka M, Freeman M, O'Neil M, et al. Implementation Processes and Pay for Performance in Healthcare: A Systematic Review. Journal of General Internal Medicine. 2016;31(1):61-9.

77. Rehm J, Anderson P, Manthey J, Shield KD, Struzzo P, Wojnar M, et al. Alcohol Use Disorders in Primary Health Care: What Do We Know and Where Do We Go? Alcohol Alcohol. 2016;51(4):422-7.

78. Benabou R, Tirole J. Intrinsic and extrinsic motivation. Review of Economic Studies. 2003;70:489-520.

79. Herzog L. Higher and lower virtues in commerical society: Adam Smith and motivation crowding out. Politics, Philosophy and Economics. 2011;10(4):370-95.

80. Deci EL, Koestner R, Ryan RM. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychological bulletin. 1999;125(6):627.

81. Lorincz IS, Lawson BCT, Long JA. Provider and Patient Directed Financial Incentives to Improve Care and Outcomes for Patients with Diabetes. Current Diabetes Reports. 2013;13(2):188-95.

82. NHS England. Commissioning for Quality and Innovation (CQUIN): Guidance for 2017-2019. Publications Gateway Reference 06023. London: NHS England; 2016.

83. Schmidt CS, Schulte B, Seo H-N, Kuhn S, O'Donnell A, Kriston L, et al. Meta-analysis on the effectiveness of alcohol screening with brief interventions for patients in emergency care settings. Addiction. 2016;111(5):783-94.

TABLES AND FIGURES

Table 1 - Demographic characteristics of included patients: n(%)

	Newly-registered patients (N=4,278,723)	Patients screened for heavy drinking (N=2,510,055)	Patients screening positive for heavy drinking (N=212,179)	Patients receiving Brief Intervention (N=23,208)
Mean age (SD) *	39.9 (18.8)	37.5 (16.5)	37.9 (14.7)	38.3 (15.7)
16-24	994544 (23.2)%	587707 (23.4)%	44650 (21)%	5023 (21.6)%
25-34	1177382 (27.5)%	789137 (31.4)%	59063 (27.8)%	6527 (28.1)%
35-44	723348 (16.9)%	451124 (18)%	44024 (20.7)%	4374 (18.8)%
45-54	467306 (10.9)%	276422 (11)%	31704 (14.9)%	3335 (14.4)%
55-64	350280 (8.2)%	189885 (7.6)%	20691 (9.8)%	2225 (9.6)%
65-74	250973 (5.9)%	112466 (4.5)%	9066 (4.3)%	1180 (5.1)%
75-99	314890 (7.4)%	103314 (4.1)%	2981 (1.4)%	544 (2.3)%
Female	2322459 (54.3%)	1354510 (54%)	82444 (38.9%)	9855 (42.5%)
Townsend Q1 (least deprived)	709025 (19.4)%	388700 (17.9)%	37388 (20.3)%	2695 (12.7)%
Townsend Q2	715949 (19.6)%	394543 (18.2)%	35551 (19.3)%	3484 (16.5)%
Townsend Q3	827178 (22.7)%	490743 (22.6)%	42017 (22.8)%	4787 (22.6)%
Townsend Q4	802933 (22)%	504983 (23.3)%	39844 (21.6)%	5425 (25.6)%
Townsend Q5 (most deprived)	592206 (16.2)%	389004 (17.9)%	29690 (16.1)%	4786 (22.6)%

* Age at date of registration

Figure 1: Rates of eligible patients a) screened; b) screening positive; c) receiving alcohol brief advice 1st January 2006 – 31st December 2016.

Table 2: Final Interrupted Time Series models for primary outcomes

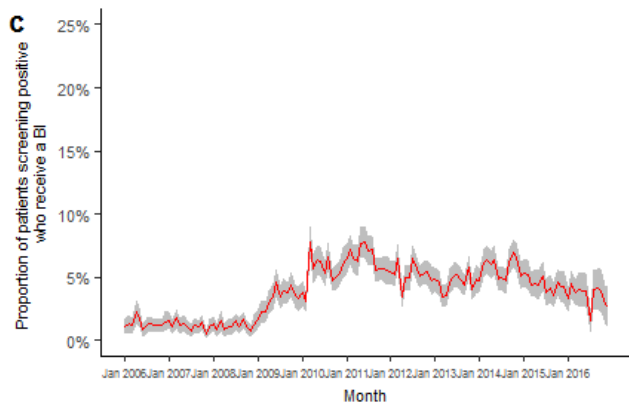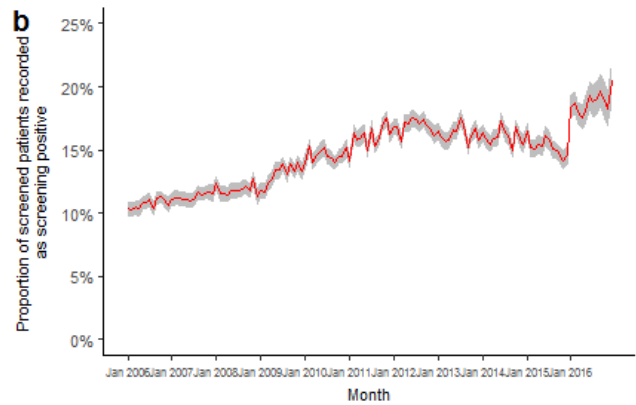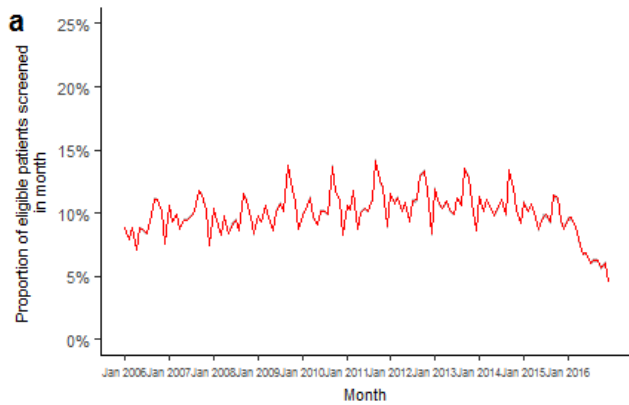|	Eligible patients screened				Screened patients screening positive				Screen positive patients receiving intervention			
	Coefficient	p-value	95% CI		Coefficient	p-value	95% CI		Coefficient	p-value	95% CI	
Months since 1st Jan 2006	0.42	0.045	0.01	0.82	0.53	<0.001	0.40	0.67	-0.13	0.193	-0.32	0.07
Effect of intervention 1	0.82	0.825	-6.51	8.14	9.05	0.001	3.87	14.23	20.15	<0.001	12.30	28.00
Months since intervention 1 introduced	-0.29	0.170	-0.70	0.13	0.03	0.722	-0.14	0.20	0.52	<0.001	0.29	0.76
Effect of intervention 2	-1.19	0.759	-8.84	6.46	-29.96	<0.001	-40.35	-19.56	-18.33	<0.001	-24.69	-11.97
Months since intervention 2 introduced	-2.96	<0.001	-3.70	-2.21	2.14	<0.001	1.51	2.77	-1.10	<0.001	-1.54	-0.66
Intercept	92.49	<0.001	85.98	99.00	104.08	<0.001	102.28	105.89	14.35	<0.001	11.32	17.38
Monthly effects (vs. January)												
February	-6.54	0.026	-12.29	-0.78								
March	-2.04	0.524	-8.37	4.28								
April	-11.24	<0.001	-17.04	-5.44								
May	-12.65	<0.001	-18.54	-6.76								
June	-9.28	<0.001	-14.10	-4.46								
July	-5.40	<0.001	-10.17	-0.62								
August	-6.52	0.027	-12.14	-0.90								
September	18.64	<0.001	11.44	25.83								
October	11.64	<0.001	5.60	17.69								
November	0.17	0.952	-5.42	5.76								
December	-21.00	<0.001	-26.95	-15.06								

Figure 2: Eligible patients screened between 1st January 2006 and 31st December 2016: Observed (black dots) and modelled screening rates with (dashed red line) and without (solid red line) seasonal adjustment
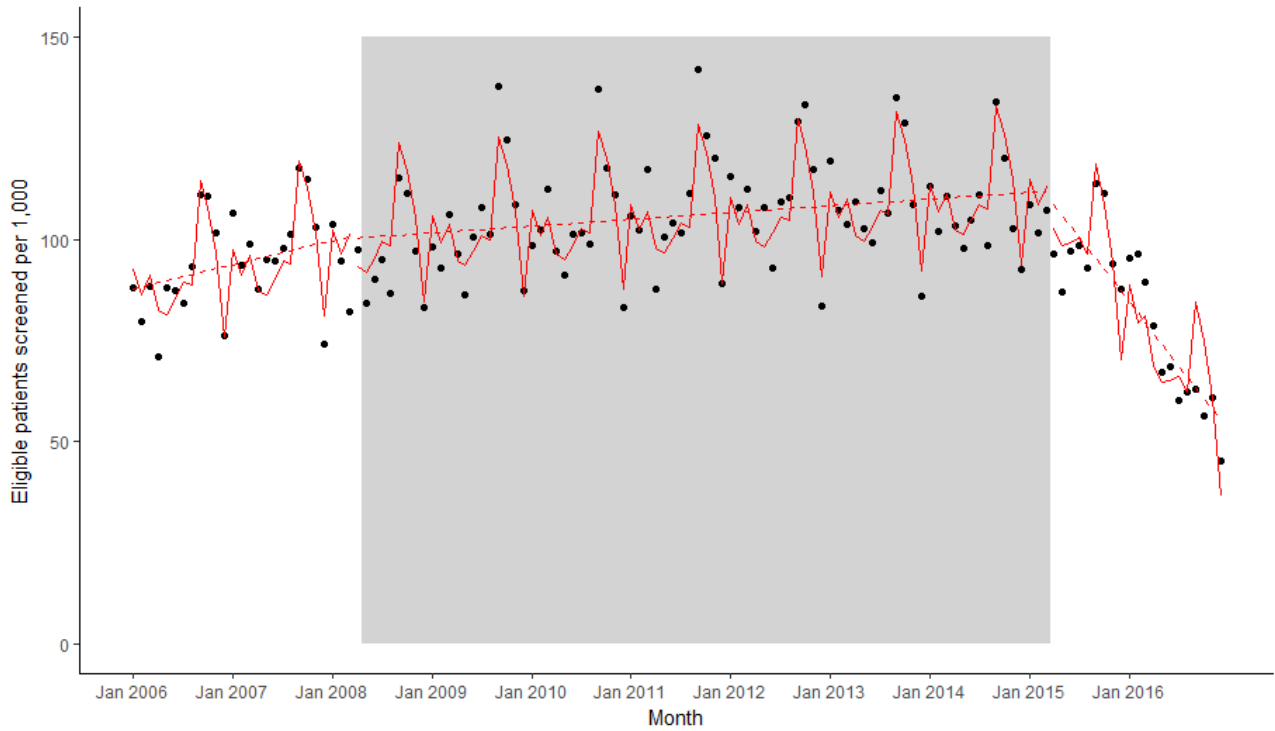

Figure 3: Eligible screen positive patients between 1st January 2006 and 31st December 2016: Observed (black dots) and modelled (red line)
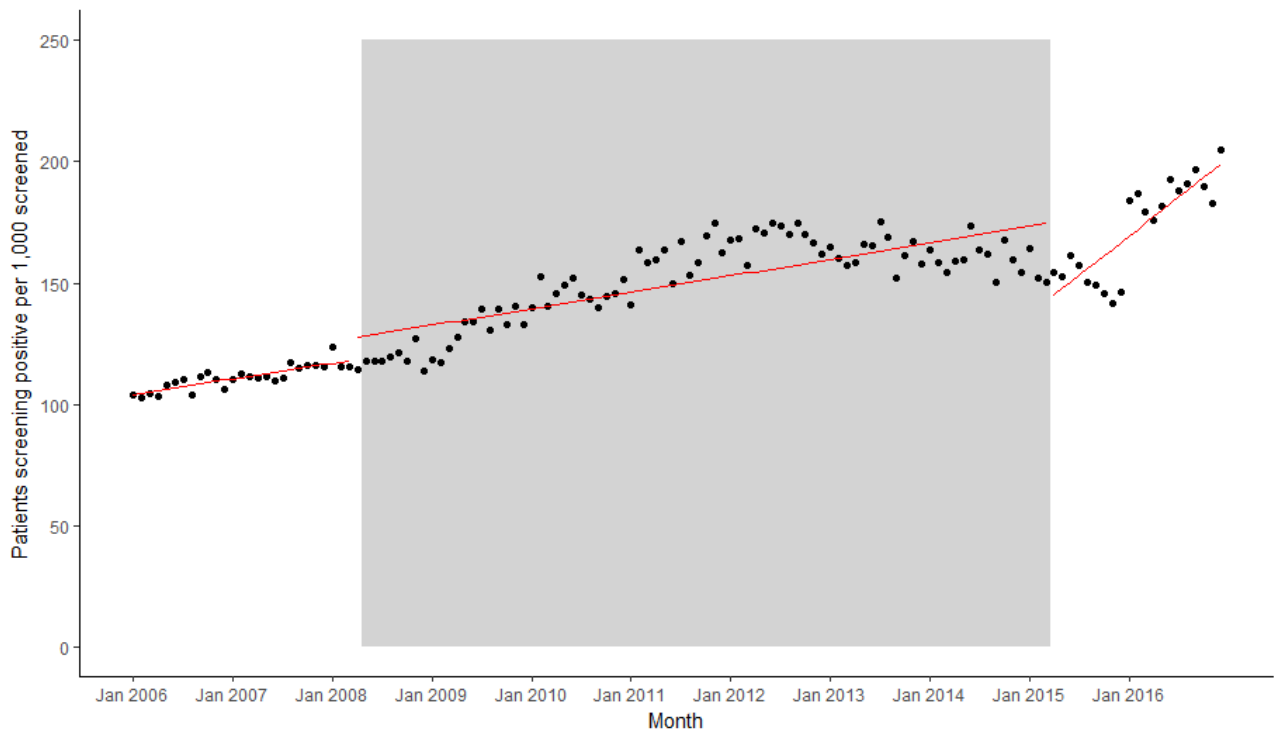
Figure 4: Brief advice delivery to eligible patients between 1ˢᵗ January 2006 and 31ˢᵗ December 2016: Observed (black dots) and modelled (red line) trends