

RESEARCH

Feasibility and effectiveness of a low cost campaign on antibiotic prescribing in Italy: community level, controlled, non-randomised trial

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Abstract

Objectives To test the hypothesis that a multifaceted, local public campaign could be feasible and influence antibiotic prescribing for outpatients.

Design Community level, controlled, non-randomised trial.

Setting Provinces of Modena and Parma in Emilia-Romagna, northern Italy, November 2011 to February 2012.

Population 1 150 000 residents of Modena and Parma (intervention group) and 3 250 000 residents in provinces in the same region but where no campaign had been implemented (control group).

Interventions Campaign materials (mainly posters, brochures, and advertisements on local media, plus a newsletter on local antibiotic resistance targeted at doctors and pharmacists). General practitioners and paediatricians in the intervention area participated in designing the campaign messages.

Main outcomes measures Primary outcome was the average change in prescribing rates of antibiotics for outpatient in five months, measured as defined daily doses per 1000 inhabitants/day, using health districts as the unit of analysis.

Results Antibiotic prescribing was reduced in the intervention area compared with control area (−4.3%, 95% confidence interval −7.1% to −1.5%). This result was robust to “sensitivity analysis” modifying the baseline period from two months (main analysis) to one month. A higher decrease was observed for penicillins resistant to β lactamase and a lower decrease for penicillins susceptible to β lactamase, consistent with the content of the newsletter on antibiotic resistance directed at health professionals. The decrease in expenditure on antibiotics was not statistically significant in a district level analysis with a two month baseline period (main analysis), but was statistically significant in sensitivity analyses using either a one month baseline period or a more powered

doctor level analysis. Knowledge and attitudes of the target population about the correct use of antibiotics did not differ between the intervention and control areas.

Conclusions A local low cost information campaign targeted at citizens, combined with a newsletter on local antibiotic resistance targeted at doctors and pharmacists, was associated with significantly decreased total rates of antibiotic prescribing but did not affect the population’s knowledge and attitudes about antibiotic resistance.

Trial registration ClinicalTrials.gov NCT01604096.

Introduction

Public health information campaigns are used as policy instruments to influence change in behaviour.^{1 2} Multifaceted approaches using different tools for channelling information and different strategies for creating a favourable environment are often key elements of such campaigns. Depending on specific topics, involvement of health professionals may be particularly relevant too. Appropriate use of antibiotics has been frequently addressed by health information campaigns, especially in high income countries,³ as is also recommended by the European Commission.⁴ The excessive use of antibiotics is associated with antimicrobial resistance, a worldwide problem and an increasing threat to global health.⁵⁻⁷ Antibiotics are often unnecessarily and inappropriately prescribed, especially for upper respiratory tract infections and for urinary tract infections in women.³ The objective of campaigns is to raise public awareness of this problem and to affect doctors’ prescribing behaviours, while considering the influence citizens may exert on their doctors either directly (when patients request the filling of a prescription)⁸ or indirectly (when doctors think their patients expect a prescription).^{9 10}

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Supplementary material

In Europe, threefold differences in antibiotic prescribing exist between countries with the highest use of antibiotics compared with the lowest use (generally southern versus northern European countries, respectively).¹¹ Cultural factors seem important for explaining these differences,¹² and organisational factors related to health services may also play a role.¹³ Up to threefold variations in antibiotic prescribing also exist among southern and northern regions in Italy,¹⁴ where antibiotic use (as well as resistance of different bacteria to antibiotics¹⁵) is among the highest in Europe, although a 5.3% decrease was observed in 2010 compared with the preceding year to coincide with two national information campaigns carried out during the winter seasons of 2009 and 2010,¹⁶ with national media coverage but without direct involvement of health professionals. The campaigns mainly used posters/billboards in streets, public spaces, and health service facilities, and on public transport, and public service announcements on national television.

Systematic reviews show that campaigns can be moderately effective in limiting the excessive use of antibiotics,^{3 17-19} especially when local context and barriers are adequately analysed and addressed,¹⁷ although limits in study design (for example, lack of a control group) often make their evaluation difficult. Multifaceted interventions involving both doctors and patients or the public, using written information material, educational meetings, and mass media seem more effective than single interventions.¹⁷ The effectiveness of interventions are widely variable, and this is not surprising: information campaigns contain several interacting components and can be considered, if not “complex interventions,”^{20 21} at least “articulated” ones. Hence, several factors could influence their success, in particular local context and strategy mix. For the same reason the evaluation of such interventions is generally difficult and their generalisability problematic.^{20 21} Data on the reduction in antibiotic resistance after multifaceted strategies are limited,¹⁷ although the link between quantity of antibiotics consumed in human communities and resistance is well known.²² Local implementation of information campaigns may facilitate endorsement and involvement of health professionals, particularly primary care doctors and pharmacists. This may help any messages to “get through,”²³ even in the absence of national media coverage, and may indirectly influence prescribers’ attitudes, and all at sustainable costs. We evaluated the feasibility and effectiveness of a local information campaign aimed at reducing antibiotic prescribing by increasing awareness of the potential threats of unnecessary use.²⁴ This campaign was implemented in Emilia-Romagna (northern Italy) in an area of about 1 150 000 inhabitants, to test the hypothesis that a multifaceted but low cost local campaign could be feasibly implemented within local health authorities and reduce antibiotic prescribing.

Methods

This study was a community level, controlled, non randomised trial. We implemented the information campaign in the provinces of Modena and Parma from November 2011 to February 2012. The control group was provinces in the Emilia-Romagna region where no campaign had been implemented and no information provided to doctors (an area of about 3 250 000 inhabitants).

Study population

The campaign mainly targeted the general population. Since general practitioners and paediatricians received ad hoc information on antibiotic resistance and had an active role in

designing the campaign and in using brochures and posters in their surgeries, they may have been sensitised to appropriate antibiotic prescribing.

Intervention/exposure

The campaign mainly focused on the use of antibiotics in upper respiratory tract infections. Rather than a “top-down” style (pushy messages delivered by health authorities), we sought a social marketing approach using “consumer” research and communication techniques to design messages that could be relevant, acceptable, appealing, and easy to understand and remember and put into practice for the target audience, to eventually influence behaviour.^{25 26} To identify the key messages of the campaign, how best to implement them, and their endorsement by health professionals, we asked a group of 13 doctors representing health districts to assess the context of antibiotic prescribing; patients’ understanding, attitudes, and expectations about antibiotics; and their own difficulties in implementing a delayed or no prescription strategy when appropriate. Specialists in patient counselling coordinated these groups and, in the month preceding the campaign, facilitated meetings set in the 11 health districts to inform the general practitioners and paediatricians about the campaign and to distribute the campaign materials, highlighting how to deal with patients’ expectations (in particular, antibiotic prescribing) during the doctor-patient interaction. The campaign messages, designed with communication specialists, mainly targeted the occurrence of antimicrobial resistance at both population and individual level,²⁷ and of side effects. It was highlighted that antibiotics are necessary in specific circumstances, do not work in case of influenza or colds, and should be used when doctors prescribe. The campaign motto was: “Antibiotics, solution or problem?” A disintegrating antibiotic tablet was used as the campaign’s theme (see supplementary figure 1). The main instruments and elements of the proposed multifaceted intervention are available at http://assr.regione.emilia-romagna.it/it/aree_attivita/valutazione-del-farmaco/ricerca-innovazione/uso-di-antibiotici/campagna-comunicazione-antibiotici and listed in the supplementary boxes 1 and 2.

The costs of the intervention were: €46 000 (£32 210; \$60 800) for acquiring mass media spaces (television, radio, newspapers) and €42 500 for developing and printing written materials (brochures, posters, newsletters).

Survey on knowledge and attitudes of the population

In October 2011 (pre-campaign) and March 2012 (post-campaign) we administered 25 and 30 item questionnaires, respectively, on knowledge about the campaigns’ messages, related attitudes, and reported behaviour in case of fever and colds in the intervention area as well as in three non-neighbouring provinces within the Emilia-Romagna region (Ravenna, Rimini, and Forlì-Cesena). In the post-campaign survey a few items were devoted to assessing the recognisability of the campaign’s messages and graphics. For each survey a polling agency randomly selected samples of 600 citizens in both the intervention area and the control area who responded to the questionnaire, ensuring representativeness for sex, age, education, occupational status, parenthood, and residence (province and population density); about 500 were interviewed by phone and 100 through the internet.

Monitoring relevant policies influencing antibiotic prescribing

During the campaign period we monitored the implementation of local policies that may have directly or indirectly influenced outpatient prescribing of antibiotics in the intervention and control areas (see supplementary table 1). Particular attention was given to financial incentives for doctors related to prescribing performance and to antibiotic prescribing in particular; to audit programmes; and to educational meetings, presentation of clinical practice guidelines, and other educational interventions on antibiotics.

Primary outcome

The primary outcome was the average prescribing rate of antibiotics to outpatients during five months (corresponding to the campaign period plus the following winter month) expressed as defined daily doses per 1000 inhabitants/day. We chose this outcome measure to facilitate national comparisons. Classes of antibiotics included β lactams, cephalosporins, monobactams, macrolides, lincosamides, quinolones, and glycopeptides (corresponding to J01C, J01D, J01F, J01M, J01XA codes of the Anatomical Therapeutic Chemical Classification System), comprising more than 95% of outpatient prescriptions for antibiotics in Italy in the winter period. We did not include tetracyclines and cotrimoxazole owing to their limited use in Italy.

Secondary outcomes

Secondary outcome measures were the change in? five months in expenditure on outpatient antibiotics per 1000 inhabitants/day; and the knowledge of and attitudes and reported behaviour about the campaign messages. These were evaluated through several items of the surveys carried out before and after implementation of the campaign.

Statistical analysis

We retrieved data on outpatient antibiotic prescriptions from regional outpatient prescribing databases. The Italian National Health Institute provided regional and national data (personal communication). Descriptive analyses included change in the prescription rates compared with the same period in the previous year. We applied generalised linear mixed models using repeated (monthly) prescribing data to evaluate change in prescribing, using the 42 health districts of Emilia-Romagna (11 in the intervention area) as the main units of analysis, clustered into their respective local health authorities. We chose this “macro” level of aggregation to avoid measuring the prescriptions of single paediatricians with defined daily doses, which work better for treatments in adults.²⁸ A sensitivity analysis, limited to expenditure of antibiotics (which can be used to measure paediatric prescriptions), was done using single doctors as the unit of analysis to increase statistical power.

We could relate only prescriptions from general practitioners and paediatricians to the corresponding health districts; however, these prescriptions accounted for the majority (92%) of the total outpatient antibiotic prescribing. Data were adjusted for pre-campaign baseline periods of two months (main analysis) or one month (sensitivity analysis). Because the intervention area, which is inland, has different prescribing patterns in August from that of the control area, which includes coastal provinces, we did not extend this adjustment period.

We used STATA statistical package (version 12) for analyses. A statistical web appendix with a basic description of the data,

the STATA codes used, and the results, is provided in the supplementary statistical appendix.

Power calculations

The average monthly rate of antibiotic prescribing from November 2010 to March 2011 (corresponding to the five month period in the previous year) was 0.575 defined daily doses per inhabitant. Considering that the standard deviation for antibiotic prescribing at district level was 0.06, the correlation between repeated measures in the two month baseline period was 0.8, and assuming that this correlation did not improve after the intervention, a sample of 31 health districts in the control area and 11 in the intervention area would yield a power of 86% to detect a 4% difference in a five month follow-up, with $\alpha=0.05$. The power would increase to 99% if using doctor level prescriptions, considering about 2700 doctors in the control area and 940 in the intervention area, with a standard deviation of 0.28 and baseline correlation among repeated measures of 0.6.

Results

Supplementary table 2 shows the characteristics of the prescribing doctors and assisted populations in the intervention and control areas. In a one year pre-campaign period (October 2010 to September 2011) the ratio of outpatient prescribing rates in the intervention area compared with other provinces in Emilia-Romagna was 0.995, and monthly prescribing rates had been similar between these areas (figure 1) until October 2011 (except August), when the information meetings with doctors took place.

Prescribing rates

During the follow-up period, average prescribing rates were 20.0 and 21.0 defined daily doses per 1000 inhabitants/day in the intervention and control areas, respectively, corresponding to decreases of 11.9% and 7.4% compared with the same five month period in the previous year (table 1). The corresponding decrease in the rest of Italy was 3.2% (just 0.8% in the rest of northern Italy). In local health authorities of Emilia-Romagna there have been few and limited interventions with potential influence on antibiotic prescribing in the five month follow-up period (see supplementary table 1).

Rates in the intervention group, which were slightly higher than in the control group from 2005 (with the exception of August) until the implementation of the campaign, were slightly lower after the five month follow-up until the beginning of 2013 (see supplementary figure 2).

Generalised linear mixed models showed a 4.3%, statistically significant difference in defined daily doses of antibiotics prescribed in the intervention areas compared with control areas. This result was not sensitive to the length of baseline period: the estimate remained the same and the width of confidence intervals showed a slight difference (−7.1% to −1.5% for the main analysis with two months baseline period, $P=0.008$; and −7.3% to −1.3% for the sensitivity analysis with a one month baseline period, $P=0.014$). These differences in prescribing were not linked to any difference in hospital admissions for upper respiratory tract infections (see supplementary figure 3).

In the intervention area a higher decrease was observed for prescription of penicillins resistant to β lactamase (−13.5% v −2.6% in the control area) and a lower decrease for penicillins susceptible to β lactamase (−4.7% v −12.3% in the control area, see supplementary figure 4), consistently with contents of the newsletter on antibiotic resistance given to health professionals.

Conversely, even if the overall decrease in the prescription of fluoroquinolones (also dealt with in the newsletter on resistance) was slight, it seemed more pronounced in the control group (−3.9% v −2.2%).

Expenditure on antibiotics

Reductions in expenditure on antibiotics compared with the same period in the preceding year were large in both intervention and control areas, respectively 25.1% (corresponding to €1 525 000) and 21.8% (table 1), probably because of patent losses and reduced prices compared with the previous year. Such reductions were larger than in the rest of Italy (−16.7%, table 1), even if expenditure in the preceding year was already lower. The net difference between intervention and control areas was narrower for expenditure (−3.3%) than for prescribing (−4.5%).

The results from statistical models on expenditure were sensitive to the length of the baseline period and to the level of aggregation (unit of analysis): the difference between intervention and control areas during follow-up was non-significant if a two month baseline period was used in the statistical model (main analysis, −3.8%, 95% confidence interval −8.5% to 0.9%, $P=0.109$), but significant if a one month baseline period was used (sensitivity analysis, −4.7%, −6.5% to −0.6%, $P=0.019$); in two more sensitivity analyses using single doctors as the unit of analysis to increase statistical power, expenditure was estimated to be lower in the intervention area for both the two month baseline period (−6.7%, −9.6% to −3.8%, $P<0.001$) and one month baseline period (−6.9%, −9.8% to −4.0%, $P<0.01$). Since antibiotic expenditure for the same five month period of the previous year amounted to €6 075 000, an estimate of the possible savings from using the intervention may range from €200 000 (if a 3.3% net difference is considered between intervention and control areas before and after the campaign, as seen before) to €406 000 (if a 6.7% reduction was applied from the latter model considering a two month baseline period), corresponding to €0.17–€0.35 per resident.

Knowledge and attitudes of the population

People surveyed in the intervention and control areas were reasonably similar at baseline for personal characteristics (see supplementary table 3), knowledge about the contents of the campaign (except for the presumptive antiviral activity of antibiotics), and attitudes and reported behaviour in cases of fever and colds. Baseline knowledge and attitudes were already consistent with the campaign messages. After the intervention, consistency with campaign messages worsened (or did not improve) similarly in both intervention and control areas, the only exception being knowledge on the presumptive antiviral activity of antibiotics, worsening in the intervention area more than control area (table 2↓). Recall of campaign slogans and graphics did not differ between the two areas (22% v 21%). Respondents recognised television as the most important form of media for exposure to information about antibiotics (54% of those who remembered receiving such information).

Discussion

This study shows the effectiveness of a local, small scale information campaign on antibiotics carried out by local health authorities, and the potential advantages of local implementation such as involving doctors and pharmacists and adapting messages and tools to the local context, within a sustainable framework of needed resources (see supplementary figure 5).

Antibiotic prescribing

For the primary outcome—the average change in prescribing rates of antibiotics for outpatients in five months—the observed difference was in the expected direction and was consistent with decreased rates as observed during the implementation of other information campaigns (see supplementary table 4).^{29–34} Caution is necessary when comparing results from different campaigns, implemented in different contexts (for example, national or local), and evaluated through different designs (uncontrolled or controlled),³⁵ using administrative databases. However, a common lesson may be that large reductions in antibiotic prescribing should not be expected, especially if a decreasing trend was already apparent since the previous years, as was the case in Emilia-Romagna and in the rest of Italy, where recent national campaigns may have also lessened the potential impact of the new campaign.^{16, 36} It is reassuring that, even if antibiotic prescribing in the study area is historically lower than in the rest of Italy¹⁴ (and already closer to that in northern Europe¹¹), the decrease in prescribing was more pronounced than in the remaining parts of the country. Looking at comparisons within the study, the decrease in the control group was larger than in the rest of Italy, and this may have also reduced the potential of the campaign. A substantially lower rate of prescribing in the intervention area beyond the influenza season may suggest a sustained effect. Unfortunately, we do not have data to assess whether our campaign affected the private purchase of antibiotics in the intervention area, a weakness of our study.

Population knowledge and attitudes

Reduced prescribing of antibiotics was not related to changes in knowledge and attitudes of the population and started to become apparent from October 2011, when the information meetings with doctors took place. We could assume (as we were actually expecting)²⁴ that reduced prescribing was mediated by doctors' endorsement of the campaign goals or by an "awareness of the campaign" factor,³⁰ rather than by a decrease in pressure from patients to get antibiotics or to patients' participation in a "wait and see" decision. The decrease in prescriptions for penicillins resistant to β lactamase in the intervention area, apparent when compared with the control area, suggests that local data on antimicrobial resistance provided to prescribers, highlighting among other things that resistance to pneumococci is not mediated by β lactamase, may have also played a relevant role.

Population knowledge and attitudes became slightly worse after the campaign in both the intervention and the control areas: answers to the survey may depend on the season such that people in winter, when they are more exposed to the risk of respiratory tract conditions, may have more favourable opinions about antibiotic use. In particular, answers on the presumptive antiviral activity of antibiotics, which worsened in the intervention area more than in the control area, may be a sign of how complicated, and maybe useless, it is to highlight the difference between bacteria and viruses, although the latter result may be related to a chance variation owing to a relatively high number of survey items. Change in people's knowledge and attitudes may require longer term exposure and more intensive campaigns. Of course we cannot exclude that people's attention had not been well captured by key messages and accompanying graphics, considering lack of difference in their recognisability between intervention and control areas.

Expenditure

The difference between intervention and control areas was sensitive to the choice of baseline periods and level of aggregation—specifically, results were not robust in aggregated analyses at district level (statistically significant for the baseline period of one month but not two months), but were robust (and statistically significant, irrespective of the baseline period chosen) if a more powered doctor level analysis was conducted. Since no contraindications are known (and likely) for using individual level analyses when assessing expenditure in mixed populations of paediatricians and general practitioners (differently from defined daily doses, measuring adult doses and for this reason not working well when assessing prescriptions from paediatricians),²⁸ the latter more powered analysis may suggest that the intervention could be associated with a reduction in antibiotic expenditure: estimated savings could more than offset the resources needed to develop and implement the campaign, even if considering the opportunity costs of human resources needed (available within the national health service, though) in addition to about €90 000 of out of pocket costs. Although caution is necessary in reaching any definite conclusion, such local intervention may thus be economically feasible.

Study validity

Since information campaigns have different components, their evaluation and the generalisation of their results may be somehow complex (see supplementary figure 4). However, we think a thorough description of both intervention and context and a controlled design can provide a useful framework for effective implementation.^{20 21} Available data on the effectiveness of previous population campaigns often lack relevant information on the specific elements of the intervention and on the context where campaigns have been implemented. Moreover, a control area is often not available.

While the presence of a control group is certainly a strength of this campaign, the non-randomised design (which was considered appropriate for a public campaign in so few provinces) is one more reason suggesting caution in the interpretation of our results. However, a few elements can be reassuring: intervention and control areas were in the same Italian region, where more pronounced decreases in antibiotic prescribing were registered than in the rest of Italy; they were similar at baseline; and the analysis of external factors suggests that these are unlikely to have affected the two areas differently.

Conclusions

A local, small scale information campaign, involving health and communication professionals and tailored to the local context, using a social marketing approach, can have an impact on antibiotic prescribing. In addition, data on antimicrobial resistance, which are often locally available, can directly affect doctors' knowledge, attitudes, and prescribing behaviour. Given the lack of impact of media and printed materials on the knowledge and attitudes of the population, the question of whether an educational intervention exclusively directed at doctors would have been more or less effective than this population campaign remains open. However, if we acknowledge an indirect effect on doctors, the rationale for such a campaign is maintained, although budget allocation should be considered carefully to achieve a balanced media mix: either to reduce costs as much as possible while promoting doctors' perception that a campaign "is on the air" (by limiting the quantity of printed materials, disproportionately used in this

campaign); or, to get what has not been achieved by our intervention—that is, improving population knowledge and attitudes towards more appropriate behaviours on antibiotic use, which could favour a further decrease in antibiotic prescribing for outpatient. In this regard television seems to be a potentially key media, as suggested by our survey and by other campaigns,³⁷ although a limited degree of penetration of local stations (depending on local contexts) may reduce its impact. The use of web based social networks, inexpensive but not used in this local campaign (as a control group was necessary), may also help this kind of intervention to reach its goals,³⁸ although limited experience exists on their use in health information campaigns, whereas their potential has been fully exploited in other promotional campaigns (for example, political elections).

Among open questions, we also do not know whether this intervention affected the out of pocket purchase of antibiotics, and whether it helped to reduce antimicrobial resistance, which is favoured but not exclusively determined by antibiotic use in humans.³⁹ However, in the absence of a national campaign with large media coverage, our data show that such a small scale campaign is feasible, is economically sustainable by local health authorities, and may be moderately effective in reducing antibiotic prescribing, with potential savings that may more than offset the initial investment.

Cultural rather than epidemiological reasons seem to be among the key determinants of the large differences in antibiotic prescribing between European countries.¹² There is room to modify these cultural factors, although longer term efforts may be necessary to significantly influence people's attitudes on antibiotic use, whereas a seasonal and small scale information campaign may influence doctors' behaviour towards prescribing antibiotics. Aside from the specific topic addressed in this study a general bottom line may be that the availability of information, put in a proper context, could be a positive element in itself, creating a favourable climate for potentially relevant societal changes or changes in decision making even if that information does not influence the population directly targeted.

We thank Cinzia Del Giovane (University of Modena and Reggio Emilia, Italy) for reassuring us on statistical analysis; Luca Cisbani and Massimiliano Marchi (Emilia Romagna Regional Health and Social Care Agency) for providing data on hospital admissions; Roberto Da Cas (Italian National Health Institute, Rome Italy) for providing national prescribing data on antibiotics; and the six referees, whose suggestions helped us to produce better work.

Contributors: GF wrote the study protocol, coordinated the campaign design and implementation, did the statistical analysis, and drafted and revised the paper. He is guarantor. BP participated in the coordination of the campaign design and implementation and revised the final draft. AMM participated in the coordination of the campaign design and two television shows as part of the campaign, and revised the final draft. CG, AP, OC participated in the campaign design and presentation, and revised the final draft. MLM participated in the campaign design and revised the final draft. NM participated in the coordination of the campaign design and revised the final draft. Other members of the LOCAAL study group participated in the campaign design and implementation.

Funding: This study was funded through an Italian Medicines Agency grant (Bando AIFA 2008), raised through a compulsory contribution requested by law of pharmaceutical companies (5% of total promotional expenses).

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no individual support from any organisation for the submitted work aside from the Italian Medicines Agency grant (Bando AIFA 2008); no financial

What is already known on this topic

Wide differences in antibiotic prescribing, within and among countries, seem to depend on cultural rather than epidemiological factors
Systematic reviews show that multifaceted information campaigns can be moderately effective in limiting the excessive use of antibiotics

What this study adds

A local, low cost information campaign may be moderately effective in reducing antibiotic prescribing and may be economically sustainable
Information on antibiotics mainly targeted at citizens may influence doctors' prescribing behaviour
Providing prescribers with local data on antimicrobial resistance may play a relevant role and may affect the choice of antibiotics prescribed

relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work, which has not been scientifically influenced by the study sponsor in any way as well.

Ethical approval: The protocol was approved by the provincial ethics committees of Modena and Parma and is published in a peer reviewed journal and openly accessible at www.biomedcentral.com/1471-2458/11/816.

Data sharing: The full dataset is available on request from the corresponding author at gformoso@regione.emilia-romagna.it.

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- Weiss JA, Tschirhart M. Public information campaigns as policy instruments. *J Pol Anal Manage* 1994;13:82-119.
- Wakefield MA, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. *Lancet* 2010;376:1261-71.
- Huttner B, Goossens H, Verheij T, Harbarth S, on behalf of the CHAMP consortium. Characteristics and outcomes of public campaigns aimed at improving the use of antibiotics in outpatients in high-income countries. *Lancet Infect Dis* 2010;10:17-31.
- Second report from the European Commission to the Council of Europe, on the basis of Member States' reports on the implementation of the Council recommendation (2002/77/ec) on the prudent use of antimicrobial agents in human medicine. http://ec.europa.eu/health/antimicrobial_resistance/docs/amr_report2_en.pdf.
- World Health Organization. The evolving threat of antimicrobial resistance. Options for action. WHO Press, 2012. http://whqlibdoc.who.int/publications/2012/9789241503181_eng.pdf.
- ECDC/EMA joint technical report (2009). The bacterial challenge: time to react. www.ema.europa.eu/docs/en_GB/document_library/Report/2009/11/WC500008770.pdf.
- De Kraker MEA, Davey PG, Grundmann H, on behalf of the BURDEN study group. Mortality and hospital stay associated with resistant *Staphylococcus aureus* and *Escherichia coli* bacteremia: estimating the burden of antibiotic resistance in Europe. *PLoS Med* 2011;8:e1001104.
- Domenighetti G, Grilli R, Liberati A. Promoting consumers' demand for evidence-based medicine. *Int J Technol Assess Health Care* 1998;14:97-105.
- Coenen S, Michiels B, Renard D, Denekens J, Van Royen P. Antibiotics prescribing for acute cough: the effect of perceived patient demand. *Br J Gen Pract* 2006;56:183-90.
- Ciofi degli Atti ML, Massari M, Bella A, Boccia D, Filia A, Salmasso S. Clinical, social and relational determinants of paediatric ambulatory drug prescriptions due to respiratory tract infections in Italy. *Eur J Clin Pharmacol* 2006;62:1055-64.
- Muller A, Coenen S, Monnet DL, Goossens H. European Surveillance of Antimicrobial Consumption (ESAC): outpatient antibiotic use in Europe, 1998-2005. *Euro Surveill* 2007;12:pii=3284.
- Huttner B, Harbarth S. Variations in outpatient antimicrobial use between and within countries: an ongoing mystery. *Infection* 2010;38:1-2.
- Masiero G, Filippini M, Ferech M, Goossens H. Socioeconomic determinants of outpatient antibiotic use in Europe. *Int J Public Health* 2010;55:469-78.
- Italian Observatory on Medicines working group. L'uso dei farmaci in Italia. [Use of pharmaceuticals in Italy.] National report January-September, 2011. Rome, December 2011.
- European Centre for Disease Prevention and Control. Antimicrobial resistance surveillance in Europe 2011. Annual Report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). ECDC, 2012. <http://ecdc.europa.eu/en/publications/Publications/antimicrobial-resistance-surveillance-europe-2011.pdf>.
- Italian Observatory on Medicines working group. L'uso dei farmaci in Italia. [Use of pharmaceuticals in Italy.] National report 2010. Rome, July 2011.
- Arnold SR, Straus SE. Interventions to improve antibiotic prescribing practices in ambulatory care. *Cochrane Database Syst Rev* 2005;(4):CD003539.
- Ranji SR, Steinman MA, Shojania KG, Gonzales R. Interventions to reduce unnecessary antibiotic prescribing. A systematic review and quantitative analysis. *Med Care* 2008;46:847-62.
- Filippini M, González Ortiz LG, Masiero G. Assessing the impact of national antibiotic campaigns in Europe. *Eur J Health Econ* 2013;14:587-99.
- Campbell NC, Murray E, Darbyshire J, Emery J, Farmer A, Griffiths F, et al. Designing and evaluating complex interventions to improve health care. *BMJ* 2007;334:455-9.
- Craig P, Dieppe P, Macintyre S, Mitchie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ* 2008;337:979-83.
- Goossens H, Ferech M, Vander SR, Elseviers M. Outpatient antibiotic use in Europe and association with resistance: a cross-national database study. *Lancet* 2005;365:579-87.
- Belongia EA, Schwartz B. Strategies for promoting judicious use of antibiotics by doctors and patients. *BMJ* 1998;317:668-71.
- LOCAAL Study Group. Doctors and local media: a synergy for public health information? A controlled trial to evaluate the effects of a multifaceted campaign on antibiotic prescribing (protocol). *BMC Public Health* 2011;11:816.
- Kotler P, Zaltman G. Social marketing: an approach to planned social change. *J Market* 1971;35:3-12.
- Edgar T, Boyd SD, Palamé MJ. Sustainability for behaviour change in the fight against antibiotic resistance: a social marketing framework. *J Antimicrob Chemother* 2009;63:230-7.
- Costelloe C, Metcalfe C, Lovering A, Mant D, Hay AD. Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis. *BMJ* 2010;340:1120-30.
- Guidelines for ATC classification and DDD assignment 2013. WHO Collaborating Centre for Drug Statistics Methodology, 2012.
- Sabuncu E, David J, Bernède-Bauduin C, Pépin S, Leroy M, Yves Boelle P, et al. Significant reduction of antibiotic use in the community after a nationwide campaign in France, 2002-2007. *PLoS Med* 2009;6:e1000084.
- Wutzke SE, Artist MA, Kehoe LA, Fletcher M, Mackson JM, Weekes LM. Evaluation of a national programme to reduce inappropriate use of antibiotics for upper respiratory tract infections: effects on consumer awareness, beliefs, attitudes and behaviour in Australia. *Health Promot Int* 2006;22:53-64.
- Bauraind I, Lopez-Lozano JM, Beyaert A, Marchal B, Seys F, Yane E, et al. Association between antibiotic sales and public campaigns for their appropriate use. *JAMA* 2004;292:2468-70.
- Lambert MF, Masters GA, Brent SL. Can mass media campaigns change antimicrobial prescribing? A regional evaluation study. *J Antimicrob Chemother* 2007;59:537-43.
- Belongia EA, Knobloch MJ, Kieke BA, Davis JP, Janette C, Besser RE. Impact of statewide program to promote appropriate antimicrobial drug use. *Emerg Infect Dis* 2005;11:912-20.
- Gonzales R, Corbett KK, Wong S, Glazner J, Deas A, Leeman-Castillo B, et al. "Get Smart Colorado." Impact of a mass media campaign to improve community antibiotic use. *Med Care* 2008;46:597-605.
- Shepperd S, Lewin S, Straus S, Clarke M, Eccles MP, Fitzpatrick R, et al. Can we systematically review studies that evaluate complex interventions? *PLoS Med* 2009;6:e1000086.
- Milandrì M, Marchi M, Resi D, Moro ML. Progetto Bambini e antibiotici. I determinanti della prescrizione nelle infezioni delle alte vie respiratorie. [Children and antibiotics project: determinants of antibiotic prescription in upper respiratory infections.] Emilia-Romagna Regional Health Agency. Dossier 115-2005.
- Goossens H, Guillemot D, Ferech M, Schlemmer B, Costers M, van Breda M, et al. National campaigns to improve antibiotic use. *Eur J Clin Pharmacol* 2006;62:373-9.
- Thackeray R, Neiger BL, Keller H. Integrating social media and social marketing: a four-step process. *Health Promot Pract* 2012;13:165-8.
- Scientific Report of EFSA and ECDC. The European Union Summary Report on antimicrobial resistance in zoonotic and indicator bacteria from humans, animals and food in 2010. *EFSA J* 2012;10:2598. www.efsa.europa.eu/en/efsajournal/doc/2598.pdf.

Accepted: 16 August 2013

Cite this as: *BMJ* 2013;347:f5391

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Tables

Table 1 | Change in antibiotic* consumption and expenditure in intervention and control areas and in rest of Italy, November 2011 to March 2012, compared with same period of previous year

Geographical area	Defined daily doses per 1000 inhabitants/day			€ per 1000 inhabitants/day		
	Nov 2011–Mar 2012	Nov 2010–Mar 2011	% difference	Nov 2011–Mar 2012	Nov 2010–Mar 2011	% difference
Intervention provinces	20.0	22.7	-11.9	24.3	32.5	-25.1
Control provinces	21.0	22.7	-7.4	25.6	33.4	-21.8
Rest of Italy	26.1	27.0	-3.2	40.2	48.2	-16.7

€1.00 (£0.85; \$1.32).

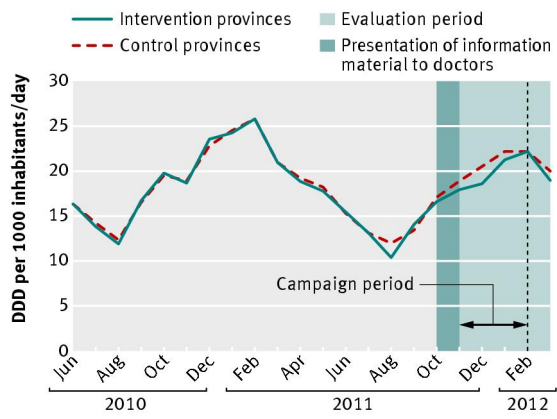
*Penicillins, cephalosporins, monobactams, macrolides, lincosamides, quinolones, and glycopeptides. See text for codes of Anatomical Therapeutic Chemical Classification System.

Table 2| Answering “yes” to questions on knowledge and attitudes on antibiotics (in percentage)

Statements	Pre-campaign (Oct 2011)		Post-campaign (Mar 2012)	
	Intervention area	Control area	Intervention area	Control area
When you think you need antibiotics, you generally ask your doctor	90	88	84	83
When you are prescribed antibiotics, you finish the cure as your doctor told you	93	93	90	90
Antibiotics are effective against viruses*	47	59	62	67
Antibiotics are effective against flu and cold	28	30	32	33
Cure is faster if you use antibiotics	58	62	61	65
Resistant germs are more likely to spread if antibiotics are used excessively	76	73	76	72

*Statistically significant pre-campaign to post-campaign differences compared with control, P<0.05.

Figure



Prescription of antibiotics in intervention and control area from June 2010 to March 2012. DDD=defined daily doses