Whose butt is it? tobacco industry research about smokers and cigarette butt waste

Elizabeth A Smith,1 Thomas E Novotny2

ABSTRACT
Background Cigarette filters are made of non-biodegradable cellulose acetate. As much as 766 571 metric tons of butts wind up as litter worldwide per year. Numerous proposals have been made to prevent or mitigate cigarette butt pollution, but none has been effective; cigarette butts are consistently found to be the single most collected item in beach clean-ups and litter surveys.

Methods We searched the Legacy Tobacco Documents Library (http://legacy.library.ucsf.edu) and http://tobaccodocuments.org using a snowball strategy beginning with keywords (eg, ‘filter’, ‘biodegradable’, ‘butts’). Data from approximately 680 documents, dated 1959—2006, were analysed using an interpretive approach.

Results The tobacco industry has feared being held responsible for cigarette litter for more than 20 years. Their efforts to avoid this responsibility included developing biodegradable filters, creating anti-litter campaigns, and distributing portable and permanent ashtrays. They concluded that biodegradable filters would probably encourage littering and would not be marketable, and that smokers were defensive about discarding their tobacco butts and not amenable to anti-litter efforts.

Conclusions Tobacco control and environmental advocates should develop partnerships to compel the industry to take financial and practical responsibility for cigarette butt waste.

INTRODUCTION
The health consequences of tobacco use are well known: tobacco use causes many cancers, as well as heart disease, emphyema and many other illnesses.1 If current trends continue, tobacco use will kill 1 billion people worldwide in the 21st century.1 In addition to direct health effects, tobacco growing and curing has environmental impacts resulting from deforestation2-3 and water contamination due to pesticide use.4 Other such harms are just beginning to be understood,5 and among these is the environmental damage that littered cigarette butt waste may cause.

The cigarette butt problem
Cigarette filters are a marketing tool,6 originally intended to keep loose tobacco out of the smoker’s mouth,7 not to protect the health of smokers. Indeed, filters have been implicated in increased rates of adenocarcinoma.8 Filters are made of cellulose acetate, which is photodegradable,9 but not biodegradable; they trap residues from smoking including arsenic, cadmium and toluene.1 In beach clean-up campaigns cigarette butts are consistently found to be the single most collected item.10 As many as 5.6 trillion cigarettes or 766 571 metric tons of butts are deposited into the environment worldwide every year.11 Whether they cause significant environmental damage is unknown, but municipalities and other entities incur substantial costs to clean them up. The city of San Francisco, California, USA, estimates this cost at $7.4 million annually.12

Numerous proposals have been made to prevent or mitigate cigarette butt pollution, including labelling filters as non-biodegradable, deposit/return programmes, waste fees, litigation against the tobacco industry to recover clean-up costs, fines levied against consumers or tobacco companies, mandated filter biodegradability, a ban on filters and consumer education.5 To date, only consumer education has been used with any consistency, although San Francisco recently imposed a waste fee of $0.20 per pack to cigarettes sold within the city.13

Littering behaviour
Why some individuals litter and others do not is not well understood, although it is thought that young adults litter more than other age groups.14-16 Littering behaviour can be affected by item type (eg, cigarette butt vs beverage container) and by location (eg, street vs park).17 Litterers may not recognise their own behaviour as littering,18 making it difficult to target. Most of the literature on littering dates from the 1970s and 1980s, and none deals specifically with cigarette butt waste. It is possible that changing smoking prevalence rates and social attitudes towards smoking have affected cigarette butt littering. The passage of clean indoor air laws may exacerbate the butt waste problem as more cigarettes are smoked outdoors19; this hypothesis remains untested.

Nearly every aspect of smoking has been the subject of extensive research by the tobacco industry, frequently years or decades in advance of the published scientific literature.18-20 Industry research can help advocates design and implement effective tobacco control policy.21-23 Previous studies have shown that the industry has been concerned for decades that cigarette litter might increase the social unacceptability of smoking, inspire support for tobacco control, or result in legislation requiring them to take financial or practical responsibility for cigarette waste disposal. As a policy response, the industry has sponsored anti-littering groups, distributed portable ashtrays (frequently branded) and
installed permanent ashtrays in downtown areas of numerous cities.24 None of these has solved the problem. This study seeks to illuminate some reasons for this failure by examining tobacco industry research relating to smokers’ littering beliefs and behaviours.

METHODS
Over 10 million tobacco industry internal documents have been released through litigation.25 We searched the Legacy Tobacco Documents Library (http://legacy.library.ucsf.edu) using a snowball strategy26 beginning with keywords (e.g., ‘filter’, ‘biodegradable’, ‘butts’). Data from approximately 680 documents, dated 1959–2006, were analysed using an interpretive approach27–30 in which, ‘Each document (is) reviewed carefully and the ‘taken for granted’ assumptions and viewpoints of the author(s) drawn out’.31

Many of the documents referenced are focus groups or interviews the tobacco industry commissioned to better inform themselves of smokers’ feelings and opinions about cigarette butts and littering (details about focus groups are given in table 1). Focus groups are not intended to be representative and statistically generalisable; rather, they are used to gather impressions about the range of opinions on a given subject49; however, the fact that multiple focus groups reported similar ideas suggests that the focus group findings are not entirely anomalous. Most of these focus groups were performed in the late 1990s or early 21st century. Some were specifically designed to give the industry guidance about how to address the cigarette litter problem; in others, the issue was raised by smokers as one of the problems of smoking.

RESULTS
The industry’s consistent position has been that ‘the responsibility for proper disposal’ of cigarette waste belongs to the smoker.24 50–53 In hope of persuading them to take that responsibility, the tobacco companies studied smokers’ attitudes, beliefs and desires about cigarette butts in inquiries about smokers’ ideas for new products, specific studies about litter and tests of marketing material. Common themes emerging from these materials reveal the human element of the butt waste problem.

Smoker beliefs and behaviours
Beliefs about filters

Most smokers realised that filters were not biodegradable32; however, there were some smokers who did not.32 Some ‘rejected, or were unaware, of any environmental impact of butts’.54 (Some also believed that Camels in particular had ‘cotton, biodegradable’ filters55—a perception that continues today.)55

The potential toxicity of cigarette filters was noticeably absent from industry discussions of the problem, and smokers appeared oblivious to it. RJ Reynolds (RJR) held a number of ‘product ideation’ sessions with smokers,33 in which smokers suggested solutions to the butt litter problem, including creating edible filters, made of ‘mint candy’ or ‘crackers’.33 Other suggestions included using the filters as compost or mulch: ‘make it work with nature instead of against it’.33 One group discussed the idea of dissolving filters, but was concerned about possible harm to the water system.34 These focus groups were not designed to constrain ideas to the realistic or feasible; however, even the industry report noted that although smokers said they disliked ‘seeing butts in their own yards and in their own ashtrays’, they were not ‘worried about what butts do to the soil, landfills or rivers’.34

Smokers’ behaviour and attitudes about butts

RJR research found that ‘Most smokers say they hate to see cigarette litter’.34 They disliked seeing others empty ashtrays in parking lots or on the street.34 They also found butts repugnant when disposed of appropriately, commenting that an ashtray full of butts was ‘disgusting’,35 that they didn’t want to ‘clutter up’ ashtrays by using them for cigarettes,35 and preferred not to dispose of butts in their cars.36

Although a Philip Morris (PM) study found that ‘virtually all respondents’ felt that litter was a consequence of ‘apathy, laziness, and insensitivity’, they nonetheless ‘admitted that they do litter with cigarette butts’.32 Some studies quantified the number of smokers that littered: estimates ranged from 45%36 to 75%37 to 92% of smokers aged 21–25.37 Only slightly more than half of smokers surveyed in the UK had ever used a waste bin for their cigarette butts.37

Smokers gave various reasons for littering. Tossing a butt to the ground and stepping on it was felt by some to be a ‘natural extension of the defiant/rebellious smoking ritual’.52 By contrast, other smokers believed that it was ‘a conscientious thing to do’,32 since it eliminated the risk of fire. This logic was particularly prevalent in British studies; over half the respondents in one study,57 and over a quarter in another,58 mentioned fire risk as a reason for not putting butts in waste bins.56

Many smokers suggested that they were compelled to litter, asking, ‘What else am I going to do with them?’.30 Smokers said that they wished they didn’t ‘have to bury the butt in the bushes’,35 or ‘have to throw them on the ground’35 when no ashtray was available. Others similarly wished they ‘didn’t have to throw the cigarette butt out the window’ when driving (emphasises added).53

Some who ‘felt guilty’ about smoking ‘were interested in unloading their cigarettes as quickly as possible’,32 and thus disinclined to seek out an ashtray. Similarly, some smokers did not like using ashtrays ‘because they can see how many cigarettes they have smoked’.38 But litter also contributed to guilt. One respondent commented, ‘an ash tray emptied in a parking lot... makes us all look like pigs’.34

Many smokers made a distinction between cigarette butts and other litter. Focus groups said that ‘flicking’ a cigarette was ‘so widespread’ it was ‘almost acceptable’, and smokers and nonsmokers agreed that this ‘was a less flagrant litter violation than tossing a bottle/can’.32 36 Some smokers felt they had permission to litter, because cigarette butts were not ‘viewed as causing significant harm to the environment’.57

Butts and littering annoyed non-smokers.38 39 People associated ‘heaps of cigarette butts [eg, from dumping auto ashtrays] with a lack of concern for other people, selfishness and an almost personal assault’.40 59 Some believed that smokers frustrated by clean indoor air laws were deliberately littering in front of public buildings, to ‘send the establishment a message’,41 or that they littered out of spite.42 A PM executive acknowledged that, ‘Anecdotally, many non-smokers, and smokers, find [litter] the most offensive element of smoking’.60

Changing the product

The simplest way to solve the problem, some tobacco company employees suggested, would be to return to unfiltered
<table>
<thead>
<tr>
<th>Company</th>
<th>Year</th>
<th>Location</th>
<th>Topic/purpose</th>
<th>No. of groups/respondents</th>
<th>Demographics/methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philip Morris (PM)</td>
<td>1986</td>
<td>Six cities</td>
<td>Evaluate 26 novel product ideas</td>
<td>26</td>
<td>Smokers recruited by mall intercept. Men and women, aged 18-55 years old.</td>
</tr>
<tr>
<td>RJ Reynolds (RJR)</td>
<td>1993</td>
<td>Six groups</td>
<td>Evaluate &amp; novel product ideas</td>
<td>6</td>
<td>A combination of managers and clerks from previous Dallas group.</td>
</tr>
<tr>
<td>Tidy Britain Group</td>
<td>1996</td>
<td>UK</td>
<td>Attitudes of smokers towards cigarette disposal and smoking</td>
<td>918 interviews face-to-face</td>
<td>A representative number of smokers in each of the categories of education, age, and sex.</td>
</tr>
<tr>
<td>British American Tobacco (BAT)</td>
<td>1980</td>
<td>UK (national)</td>
<td>To provide information on the likely social pressure, if any, against smoking and what impact anti-smoking feeling had among other social concerns.</td>
<td>4</td>
<td>Four mini groups, four mini groups, two groups men, two groups women, 20-40, ABC.</td>
</tr>
<tr>
<td>Company</td>
<td>Year</td>
<td>Location</td>
<td>Topic/purpose</td>
<td>No. of groups/respondents</td>
<td>Demographics/methods</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>-------------------</td>
<td>---------------------------------------------------------</td>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>RJR</td>
<td>2004</td>
<td>West Coast USA</td>
<td>To meet the group and confirm that the newly formed company (Reynolds American) was committed to continuing the corporate social responsibility engagement and dialogue process[^41]</td>
<td>One group</td>
<td>Members of a western state public health department and tobacco control group. A doctor, a restaurant manager, a police officer, a parent—teacher association representative, a director of a non-profit community organisation, a leader of a local church, a student active in college social and student government affairs and an owner of a local convenience store.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seattle, Washington</td>
<td></td>
<td></td>
<td>Members of the health department.</td>
</tr>
<tr>
<td>brown &amp;</td>
<td>1996</td>
<td>Minneapolis, Minnesota</td>
<td>Identify the most promising selling propositions for 'natural' cigarettes[^43]</td>
<td>14 groups</td>
<td>10 groups of smokers, 21—55</td>
</tr>
<tr>
<td>whitfield &amp;</td>
<td></td>
<td>Los Angeles, California</td>
<td></td>
<td></td>
<td>Two groups of smokers, 21—39</td>
</tr>
<tr>
<td>williamson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Two groups of smokers, 40—55</td>
</tr>
<tr>
<td>brown &amp;</td>
<td>1995</td>
<td>Switzerland</td>
<td>“Ecological” cigarette concept[^46]</td>
<td>Nine groups</td>
<td>Mixed sex group, 18—35; mixed sex smokers, 18—25</td>
</tr>
<tr>
<td>whitfield</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Three groups women smokers 18—35</td>
</tr>
<tr>
<td>williamson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Three groups men smokers 18—35</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>Minneapolis, Minnesota</td>
<td>To explore smokers’ reactions to concepts that build on social responsibility, to aid in the development of direct mail pieces[^49]</td>
<td>Six groups</td>
<td>Six groups: three smoker and three non-smoker. The smoking and non-smoking groups were broken into three age brackets: 18—24; 25—34; 35—50.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Atlanta, Georgia</td>
<td></td>
<td></td>
<td>Two groups of male and female smokers, 25—60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Birmingham, Alabama</td>
<td></td>
<td></td>
<td>Two groups of male smokers, 25—60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Two groups of female smokers, 25—60</td>
</tr>
<tr>
<td>brown &amp;</td>
<td>1996</td>
<td>Minneapolis, Minnesota</td>
<td>Environmentally-friendly cigarette concepts[^49]</td>
<td>Six groups</td>
<td>Two groups of smokers, 21—40</td>
</tr>
<tr>
<td>whitfield &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>One group of smokers, 40—55</td>
</tr>
<tr>
<td>williamson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Three groups of smokers, age unspecified</td>
</tr>
</tbody>
</table>

[^41]: Bateman et al. 2006.  
[^42]: Brown et al. 1998.  
[^43]: Brown et al. 1996.  
cigarettes. The suggestion was not acted upon; it was believed that it was ‘an easier sell to make [filters] biodegradable’ than to ‘convince people that “unfiltered” cigarettes will still be mild and smooth’. The industry saw several advantages to a biodegradable filter. It might stem the growing disapproval of smokers and of smoking, prepare the industry for future regulation requiring biodegradability, or even ‘pre-empt environmental legislation’—that is, make regulation appear unnecessary. A biodegradable filter might also improve a company’s image, countering the ‘negative public city that the industry receives when litter surveys are published.

By contrast, promoting an ‘ecofriendly’ brand by implication raised questions about the degradability of other cigarettes. Tobacco companies were reluctant to disclose how poorly filters degraded. RJR frequently claimed that filters were degraded in 6 months or ‘less than a year’. The company disingenuously claimed that butts were not a litter problem because ‘practically all the materials we use have a degree of biodegradability’. The companies knew that biodegradable filters might actually encourage littering. British American Tobacco (BAT) suggested that such filters would offer ‘outdoor convenience’ by ‘eliminating’ litter. A focus group participant wanted biodegradable filters because ‘I want to just throw them down, but I don’t want to feel bad about it’. Brown & Williamson concluded that the ‘perceived benefit’ of a biodegradable filter was ‘the ability to litter without guilt’.

A related problem was that biodegradation was not instantaneous. A focus group report acknowledged that biodegradable filters ‘have all of the right buzz-words’, but ‘they may not degrade as quickly as smokers really want’. Smokers wanted a butt that disappeared. A BAT report concluded that ‘it is clear that a cigarette butt that miraculously vanishes, leaving behind it no distasteful sight or smell would represent a huge step forward for both smoker and non-smoker’. The question for the industry was whether anything less would satisfy the claim of biodegradability.

Finally, there was a tension between using biodegradable filter technology to benefit a particular company, and using it to improve the image (and self-image) of smokers. BAT was ‘looking for a market lead and therefore commercial secrecy’ about such technology, but the company also recognised that, ‘When all discarded filter tips look alike to the public the fact that some degrade more quickly than others may be of academic interest only, if the majority do not. For certain it is fanciful to expect gratuitous attribution of success from the public through elimination of only a small part of the problem’.

Changing smoker behaviour

Anti-litter campaigns

Several tobacco companies developed anti-litter campaigns, deciding that the solution was ‘education’ not materials science. However, industry research suggested that such a campaign had to be formulated carefully. Smokers feared that an anti-litter campaign could become ‘another thing non-smokers can attack us for’. Thus, although most smokers admitted to littering, they felt defensive since butts were ‘just a small part of a big problem’. Even though the campaigns were supposed to make smokers aware that butts were litter, they could not single out smokers as litterers or equate smoking with littering. Smokers preferred slogans defining the problem ‘as a litter issue rather than a smoking issue’.

Smokers were sensitive to anything that could be interpreted as accusatory or critical, preferring a ‘gentle nudge’ to modify their behaviour. In Australia, smokers accepted a ‘Please bin your butts’ campaign, feeling that it was non-confrontational and acknowledged the right to smoke. However, in the US, although focus group members appreciated being reminded of their ‘rights’, they ‘did not want to be part of ‘another cigarette controversy’.

In the US, smokers liked the slogan, ‘a little thought, a lot less litter’. (A version of this slogan, ‘A Little More Thought—Less Littered Butts!’ can be found on the Keep America Beautiful website.) The request for ‘more thought’ was ‘comfortable and acceptable’. In contrast, slogans suggesting that smokers ‘pick up’ their litter were rejected: although they might be persuaded to dispose appropriately of a butt they were holding, they were unlikely to pick one up once they dropped it.

The imagery accompanying such campaigns was also a matter of concern. Most significantly, images of cigarette butts—the focus of the effort—were ‘extremely uncomfortable for some smokers’ and thus to be avoided. Even the favoured slogan, ‘a little thought, a lot less litter’ was rejected when depicted with cigarette butts.

Portable ashtrays

Smokers were ambivalent about portable ashtrays. Some, ranging from 15% to 53%, and up to 61% of women, said they would find such an item useful. In one test, nearly 60% of those receiving sample ashtrays claimed they used them ‘at least 1—2 times a week’ and some said the ashtrays had ‘made them pay closer attention to cigarette disposal’. Smokers thought the ashtrays would be useful in places such as public parks, golf courses, ‘outside at work, outside the respondent’s home, outside others’ homes, and in the car’. They also said they would use the ashtrays to ‘convey a positive personal image around non-smokers’.

However, some smokers were ‘less enthusiastic’ because they didn’t ‘feel a need to use an ashtray to dispose of cigarette outdoors’. Some claimed they smoked ‘only in places where there are ashtrays’, or disposed of butts in other ways. Other smokers felt they would ‘forget to use or carry it’, especially because ‘the process of flicking a cigarette butt on the ground is a well-ingrained, reflexive habit’. Smokers also worried that the ashtrays would be smelly, ‘messy’ or ‘dirty’ and called carrying butts around in them ‘revolting’. These smokers felt that ‘It would be easier to throw the cigarette on the ground’. In response to these concerns, RJR stressed that the ashtrays were a temporary means of disposal, to be emptied as soon as practicable.

Permanent ashtrays

Tobacco companies and smokers frequently suggested that the cigarette litter problem was the result of clean indoor air laws causing more smoking outdoors, where there were insufficient ashtrays. However, the impact of permanent ashtrays was questionable. Employers who placed them in outdoor smoking areas commented, for example, that ‘There are 30 butts in the ashtray 100s around it’. Studies noted that cigarette butt litter was often found ‘within 5 m of a bin’, and about half of smokers said they would not bother to use an ashtray if it were ‘more than 10 paces’ away; only...
a third said they would walk further. Half of Australian smokers said that if they ‘knew it was a littering problem’ they would ‘make an effort’ to use an ashtray, and 20% said they would use a convenient ashtray, but wouldn’t go out of their way to use one. PM found that although 72% of smokers who noticed the ashtrays they had installed said they used them, only 20% noticed them.

DISCUSSION
This study has limitations. The document set is not comprehensive, but a selection of litigation-related material. There has been no tobacco litigation to date concerning tobacco litter/waste issues, and there may be documents that contain additional information that could be revealed in the discovery process. We also may not have identified all relevant available documents due to the volume of the tobacco documents library.

The tobacco industry’s research shows how much smokers disliked cigarette butts, littered or in ashtrays. Smokers found them smelly and dirty; they were unwilling to put them in their car ashtrays, carry them around in portable ashtrays, or hold them for more than a few steps to discard them appropriately. Creating butt litter made smokers uncomfortable even as they did it. Furthermore, smokers had multiple, sometimes conflicting, reasons for littering their butts: it was conscientious and rebellious, and it minimised their contact with an unpleasant reminder of their addiction. As the industry found, the complex psychology of butt littering made difficult identifying any message that might change the behaviour.

The tobacco companies perceived cigarette butt waste as a vulnerability that tobacco control advocates might exploit. Thus, they were motivated to solve the problem. However, the industry would not promote any messages that criticised smokers or called into question smoking itself. Their efforts—anti-litter campaigns and handheld and permanent ashtrays—did not substantially affect smokers’ entrenched ‘butt flicking’ behaviours. These findings suggest that tobacco control programmes should not attempt to solve the problem by providing ashtrays or enhancing antilittering laws. Attempts to change the behaviour of smokers should focus on cessation.

More to the point, tobacco control should place the burden of cigarette waste on the industry. For more than 30 years the tobacco companies have feared the establishment of legislation or regulation compelling them to take responsibility for cigarette butt waste. Only recently has butt waste been framed as an economic and quality of life issue, as opposed to an aesthetic problem. Such redefinition may encourage efforts to make the industry responsible for the toxic waste produced by smoking cigarettes. In other environmental waste areas, attention is focused on the waste producer. For example, the European Union Waste Electrical and Electronic Equipment directive makes producers and retailers responsible for recycling their products.

Policy makers should be made aware that the presence of filters implies a degree of safety to smokers, but does not reduce smoking-caused disease, and that cigarette butt waste incurs a cost to communities and to the environment. Reconceptualising butt waste as an ‘upstream’ problem created by the tobacco industry may facilitate partnerships between environmental and tobacco control groups, leading to more innovative policy solutions that discourage smoking and place the cost and consequences of filter waste on the tobacco industry.

Funding This research was funded by the California Tobacco-Related Diseases Research Program Grant #177-0014 and National Cancer Institute Grant #CA120138.

Competing interests ES was a consultant for the US Justice Department it its case against the tobacco industry.

Contributors ES performed the research and initial draft of the paper; TN conceptualised the project and participated in the writing of the paper.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES
20. Ling PM, Glantz SA. Tobacco industry consumer research on socially acceptable cigarettes. Tob Control 2005;14:e3.


Whose butt is it? tobacco industry research about smokers and cigarette butt waste

Elizabeth A Smith and Thomas E Novotny

_Tob Control_ 2011 20: i2-i9
doi: 10.1136/tc.2010.040105

Updated information and services can be found at:
[http://tobaccocontrol.bmj.com/content/20/Suppl_1/i2](http://tobaccocontrol.bmj.com/content/20/Suppl_1/i2)

_These include:_

**References**
This article cites 16 articles, 6 of which you can access for free at: [http://tobaccocontrol.bmj.com/content/20/Suppl_1/i2#BIBL](http://tobaccocontrol.bmj.com/content/20/Suppl_1/i2#BIBL)

**Open Access**
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license. See: [http://creativecommons.org/licenses/by-nc/2.0/](http://creativecommons.org/licenses/by-nc/2.0/) and [http://creativecommons.org/licenses/by-nc/2.0/legalcode](http://creativecommons.org/licenses/by-nc/2.0/legalcode).

**Email alerting service**
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Topic Collections**
Articles on similar topics can be found in the following collections

- Open access (258)

**Notes**

To request permissions go to: [http://group.bmj.com/group/rights-licensing/permissions](http://group.bmj.com/group/rights-licensing/permissions)

To order reprints go to: [http://journals.bmj.com/cgi/reprintform](http://journals.bmj.com/cgi/reprintform)

To subscribe to BMJ go to: [http://group.bmj.com/subscribe/](http://group.bmj.com/subscribe/)