
Cost-effectiveness of targeted screening for hepatitis C in The Netherlands

C. W. HELSPER^{1*}, B. A. BORKENT-RAVEN¹, N. J. DE WIT¹, G. A. VAN ESSEN¹,
M. J. M. BONTEN^{1,2}, A. I. M. HOEPELMAN², M. P. JANSSEN¹ AND G. A. DE WIT^{1,3}

¹ *Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands*

² *Department of Internal Medicine and Infectious Diseases, University Medical Center Utrecht, The Netherlands*

³ *Centre for Prevention and Health Services Research, National Institute of Public Health and the Environment, Bilthoven, The Netherlands*

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SUMMARY

On account of the serious complications of hepatitis C virus (HCV) infection and the improved treatment possibilities, the need to improve HCV awareness and case-finding is increasingly recognized. To optimize a future national campaign with this objective, three pilot campaigns were executed in three regions in The Netherlands. One campaign was aimed at the general population, a second (similar) campaign was extended with a support programme for primary care and a third campaign was specifically aimed at hard-drug users. Data from the pilot campaigns were used to build a mathematical model to estimate the incremental cost-effectiveness ratio of the different campaigns. The campaign aimed at the general public without support for primary care did not improve case-finding and was therefore not cost-effective. The similar campaign accompanied by additional support for primary care and the campaign aimed at hard-drug users emerged as cost-effective interventions for identification of HCV carriers.

Key words: Cost-effectiveness study, hepatitis C, hepatitis (general), prevention, public health emerging infections.

INTRODUCTION

Infection with hepatitis C virus (HCV) is increasingly being recognized as a serious health threat in today's society, but still remains relatively unknown in the general population and general practitioners (GPs) in low endemic countries. It is estimated that 2–3% of the world's population (123–170 million people) are infected with HCV, of which a large proportion remains undiagnosed [1, 2]. HCV infection may have

serious long-term complications. After about 25 years, 20–30% of the chronic carriers have developed liver cirrhosis and of these patients 1–4% develop a hepatocellular carcinoma each year. Fortunately, treatment possibilities have improved dramatically over the past decade, to a point where up to 51% of HCV-infected patients with genotypes 1 or 4 and up to 90% of HCV-infected patients with genotypes 2 or 3 can be cured after 24–48 weeks of antiviral treatment [3–6].

In The Netherlands, the prevalence of HCV is estimated to be between 0·1% and 0·4% [7, 8].

Because of the lack of clinical symptoms and despite the serious consequences of HCV infection, it is estimated that only one quarter of the carriers in The Netherlands have been diagnosed [8–10]. Since the

* Author for correspondence: C. W. Helsper, M.D., Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Heidelberglaan 100, 3584 CX Utrecht, The Netherlands, PO Box 85500, 3508 GA Utrecht, The Netherlands.
(Email: c.helsper@gmail.com)

virus is transmitted by blood–blood contact, several high-risk groups can be identified. A recent study in The Netherlands shows that 45% of the identified carriers were intravenous drug users (IDUs) and 41% were people with a country of origin other than The Netherlands [11]. Among IDUs in The Netherlands, a HCV prevalence of 47–79% has been found [9]. In immigrants, the prevalence varies up to 21.9% in Egyptian immigrants but is generally much lower than in IDUs [12]. The prevalence in other risk groups, such as certain travellers and recipients of blood products, differs depending on the circumstances of the exposure but is generally lower than in IDUs and high-risk immigrants.

In 1997 the Dutch Health Council stated that a campaign was necessary in order to increase public awareness of HCV [10]. In 2007, three pilot campaigns were constructed to prepare for and to optimize the effectiveness of a future national campaign:

- (1) the ‘general campaign’ – to reach the general population;
- (2) the ‘support campaign’ – to reach the general population, extended with a support programme for primary care;
- (3) the ‘drug users campaign’ – specifically aimed at present or former hard-drug users (HDUs).

The incremental cost-effectiveness ratio (ICER) can be used to support the decision whether or not to implement newly developed healthcare interventions. The ICER is the ratio of the additional effects (e.g. life-years gained) of an intervention to its additional costs [13]. This number can for instance be used as an objective measure to compare cost-effectiveness of different strategies for case-finding. The aim of this study is to estimate the ICERs of implementing each of the three campaigns nationwide in The Netherlands compared to ‘current practice’. Current practice was defined as usual care and attention as deemed appropriate by the GP consulted, regarding any consultations concerning HCV.

METHODS

Description of the pilot campaigns

The general campaign and the support campaign were implemented from October 2007 to January 2008, in two similar regions in the centre of The Netherlands (the Gelre-IJssel region and the Eemland region). These regions have a population structure that is representative of The Netherlands regarding age and the

presence of individuals and groups with an increased risk of HCV infection (immigrants and known HDUs) [14].

General campaign

The general campaign consisted of local broadcasting of radio advertisements, publishing advertisements in newspapers and the distribution of specially designed posters and brochures in public areas where risk groups were expected to congregate. In the Gelre-IJssel region, this campaign was implemented without any support for primary care.

Support campaign

A support programme especially designed for primary care was implemented in the Eemland region, complementary to a general campaign identical to the campaign implemented in the Gelre-IJssel region. This support programme consisted of (voluntary) plenary courses for GPs and the employment of two practice facilitators who visited the GP practices on appointment to provide information regarding HCV and the campaign.

Drug users campaign

The drug users campaign was implemented from May 2007 to September 2008 and was aimed at increasing the knowledge of HCV in HDUs, in particular IDUs, and increasing the willingness of these individuals to cooperate in HCV testing. This campaign was implemented in Rotterdam, which is the second largest city in the country with about 600 000 inhabitants. Based on data from the National Drug Monitor, it can be accurately estimated that Rotterdam has 5000 HDUs, which is 15% of all HDUs in The Netherlands [15].

In Rotterdam, 26 addiction care professionals were trained to provide HCV counselling, which was systematically and actively offered to HDUs at their meeting venues. In addition, three informative meetings were organized which were attended by 180 HDUs. At the counselling sessions and meetings, information was provided about HCV infection and HDUs were motivated and facilitated to be tested for HCV infection [16].

Costs and effects of nationwide campaigns

The total number of anti-HCV tests performed and the proportion of HCV-positive test results were measured in all laboratories in the pilot regions of the

general and support campaigns. These data were compared to a similar period of 4 months in previous years (October 2007 to January 2008 *vs.* October to January in the two previous years).

For the drug users campaign, data regarding the number of hepatitis C tests were registered by the addiction care centres which provided counselling and testing facilities in Rotterdam and the Municipal Health Service (GGD) Rotterdam – Rijnmond [14, 16].

Pre-intervention assessments showed that HCV testing in addiction care took place exclusively when specifically requested by HDUs. Data assessment by the Infectious Disease Control Department of the Municipal Health Service Organization of Rotterdam showed that this had happened sporadically and was inadequately registered. The number of tests in previous years was therefore considered negligible [16].

Cost estimates of implementing the campaigns nationwide were based on extrapolation of the costs of the pilot projects. The organizations involved in the three different pilot campaigns provided a detailed, standardized overview containing information regarding time investment by specified professionals for organization, training and other activities and direct costs of materials, design and other expenses. These organizations were The Netherlands Institute for Health Promotion and Disease Prevention (NIGZ) (general campaign), the Julius Center for Health Sciences and Primary Care (support campaign), the Trimbos institute, Netherlands Institute of Mental Health and Addiction and the Mainline Foundation (drug users campaign). The results of the pilot campaigns, in terms of additional number of tests performed and HCV carriers identified, were used to compute the number of additional HCV carriers that would be expected to be found if the campaigns were implemented nationwide. For the general campaign and the support campaign, we used the number of inhabitants in the regions where the campaigns were performed relative to the total number of inhabitants of The Netherlands (data provided by Statistics Netherlands). For the drug users campaign, we used the estimated numbers of HDUs in Rotterdam relative to overall hard-drug use in The Netherlands [15].

The health economic model

After calculating the expected number of additional HCV carriers identified through a campaign, the costs and effects of finding one carrier were estimated. The

effect of a healthcare intervention was measured in quality-adjusted life-years (QALYs) gained. QALYs are calculated as the product of life-years experienced after an intervention (here HCV case-finding) and the quality of life of the patient during those years, expressed as a figure between 0 (death) and 1 (normal quality of life). To compute the expected savings in costs and gain in QALYs as a result of detecting one HCV carrier, we use a modified version of a previously published Markov model [17]. This model was adapted to fit the current Dutch situation. It describes the history of a chronic HCV infection considering the dependence on age at time of testing. It consists of nine health states for each of which mortality rates, healthcare costs and quality of life are estimated. Transition probabilities indicate the annual probability of moving from one state to another. A HCV carrier that is tested positively has a treatment probability that depends on the person's health state. Survival rates of the general Dutch population were obtained from Statistics Netherlands [18]. HDUs are assumed to have a 15-year shorter life expectancy [19]. A lifelong time horizon was used. The costs of each of the nine different health states were estimated in the original model, and converted to 2007 Euros using consumer price indices as provided by OECD [20]. The analysis was performed from a healthcare perspective, which means that only direct medical costs are included. Costs of consultations, tests and treatment are shown in Table 1. Treatment costs were corrected for discontinuation of treatment as observed in the paper by Veldt *et al.* and were updated for the current standard of treatment (peg-interferon *vs.* interferon) [22]. In accordance with Dutch pharmaco-economic guidelines, future (avoided) healthcare costs were discounted at 4% and health outcomes (QALYs) were discounted at 1.5% [23].

For each campaign type, two versions of the Markov model were employed simultaneously to compare the situation with and without the campaign. The two Markov models were run for each age group of 1 year, for ages 0–102 years. The total QALYs gained and treatment costs are the sum of these outcomes for each age, weighted according to the age distribution of the carriers.

Presumed clinical course of HCV identification and treatment

Based on Dutch HCV prevalence and infectious diseases monitoring data of the National Institute

Table 1. *Costs of diagnostic and therapeutic process*

	Costs (€)
Diagnostic tests and consultations before treatment	
First GP consultation to determine need for anti-HCV testing*	9.00
First hard-drug user (HDU) counselling to determine need for anti-HCV testing [21]	21.17
Immunoassay (EIA) screening tests + fee†	25.30
Polymerase chain reaction + fee†	120.10
Second GP consultation in case of positive test*	9.00
Second GP consultation (telephone) in case of negative test*	3.95
Second HDU counselling positive test [21]	28.23
Second HDU counselling negative test [21]	7.06
Total cost of medication and diagnostic procedures during treatment per patient after correcting for early discontinuation of treatment [22, 26]‡	
Genotypes 1 and 4 (48 weeks)	15772
Genotypes 2 and 3 (24 weeks)	9582

* Julius Center for Health Sciences and Primary Care.

† Laboratory MMC Amersfoort.

‡ Costs are adjusted for the current standard treatment (peg-interferon- α and ribavirin) and include diagnostic monitoring, occurrence of side-effects and early discontinuation of treatment.

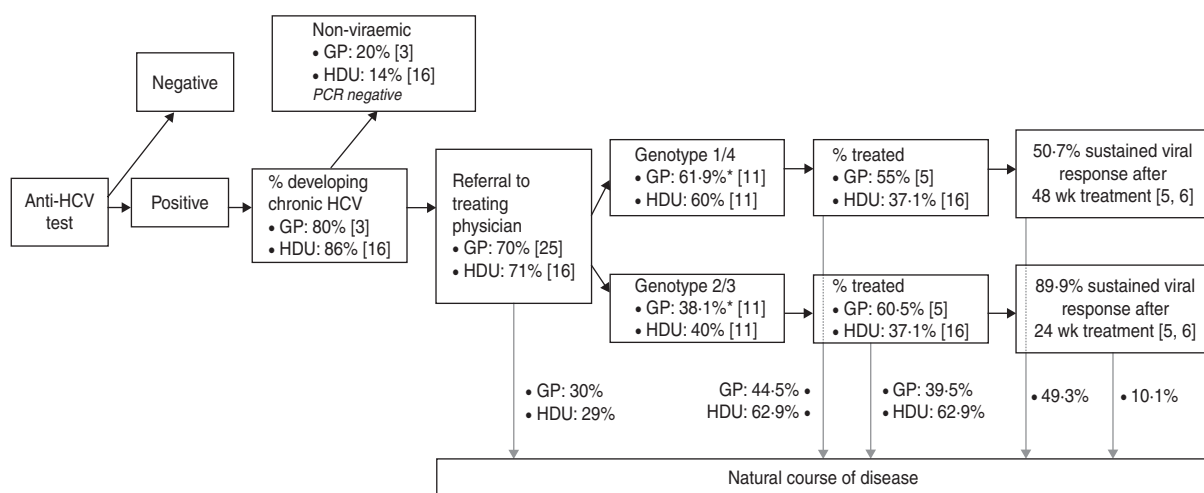


Fig. 1. Course of events after the first anti-HCV test and progression to possible outcomes [3, 5, 6, 11, 16, 25]. * There is a very low percentage of genotype 6 in The Netherlands (1.7%). Due to a lack of information on treatment and natural course, our analysis is based on the assumption that only genotypes 1, 2, 3 and 4 are present in the Dutch population.

for Public Health and the Environment, we estimated the annual probability of identification of a chronic HCV carrier without intervention to be 1.2% [7, 8, 24].

The course after identification specified for members of the general population and for HDUs is depicted in Figure 1. The diagnostic process in The Netherlands starts with a HCV-antibody test based on the use of enzyme immunoassays (EIAs). A positive anti-HCV test indicates that the patient has been infected in the past. Of the anti-HCV positive patients, an estimated 80–86% fails to clear the

virus and are considered chronic carriers [3, 16]. To determine if the patient has become a chronic HCV carrier, a polymerase chain reaction (PCR) is performed. If the PCR is positive the patient should be referred to a specialist.

A recent study on referral of HCV-positive patients showed that referral by untrained GPs occurs in 50% of HCV-positive cases [25]. Since the GP support programme encourages GPs to refer HCV-positive patients, an increase in referrals can be expected in the intervention region. Based on a study on referral and the underlying reasons for non-referral by de Jong

Table 2. *Clinical characteristics*

Parameter	Value
General population	
Natural course – probability of chronic HCV infection [3]	80%
Percentage infections of genotypes 1 or 4 [11]	61·9%
Percentage infections of genotypes 2 or 3 [11]	38·1%
Referral rate [25]	70%
Percentage eligible and accepting treatment, genotypes 1 or 4 [5]	55%
Percentage eligible and accepting treatment, genotypes 2 or 3 [5]	60·5%
Percentage of eligible patients starting treatment in first year*	78%
Percentage of eligible patients starting treatment in second year*	20%
Hard-drug users (HDUs)	
Probability of spontaneous clearance of virus [16]	14%
Percentage infections of genotypes 1 or 4 [11]	60·0%
Percentage infections of genotypes 2 or 3 [11]	40·0%
Referral rate [16]	71·43%
Percentage eligible and accepting treatment [16]	37·14%
Equal for general population and HDUs	
Annual probability of identification in case of no campaign†	1·2%
Average age at testing, for drug users and the general population [11]	44·3
Probability of successful treatment, genotypes 1 or 4, mild or moderate hepatitis [5]	54%
Probability of successful treatment, genotypes 1 or 4, cirrhosis [5]	24%
Probability of successful treatment, genotypes 2 or 3, mild or moderate hepatitis [5]	94%
Probability of successful treatment, genotypes 2 or 3, cirrhosis [5]	48%
Percentage of HCV carriers with mild hepatitis at time of testing [6]	46%
Percentage of HCV carriers with moderate hepatitis at time of testing [6]	43%
Percentage of HCV carriers with cirrhosis at time of testing [6]	11%

* Derived from the database of infectious diseases, University Medical Center Utrecht.

† Estimation based on Dutch prevalence and monitoring data [7, 8, 24].

et al., it can be assumed that referral during a campaign including a support programme for primary care will improve up to about 70% [25]. Follow-up of the pilot campaign aimed at HDUs demonstrated that the referral rate in HDUs is 71% after instruction of healthcare professionals [16].

After referral, the genotype of the HCV is determined by a HCV genotype assay (LiPa). In the general public, 55% of carriers of genotypes 1 or 4 are treated for 48 weeks with a combination therapy consisting of a weekly dose of an average of 180- μ g peg-interferon- α and 1000–1200 mg ribavirin each day [5, 22, 26]. Of the patients infected with HCV genotypes 2 or 3, 60·5% are treated with the same therapy for 24 weeks [5].

Among HDUs, 37% of PCR-positive patients are treated (no distinction between genotypes available) [16]. Prognosis depends on the health state of the patient at time of testing, patient age and response to treatment [5, 17]. Model parameters are shown in Table 2. Those testing positive but not referred to treating physicians and those not treated after

identification as a chronic carrier follow the natural history of HCV infection (see Fig. 1).

Sensitivity and scenario analyses

Multivariate sensitivity analyses were performed to discover which input parameters are most influential on the uncertainty in the ICERs. In a multivariate sensitivity analysis, next to uncertainty in the outcome due to individual model parameters, the impact of potential interactions between model parameters was also accounted for. Various values for model parameters were sampled in accordance with their likelihood of occurring. Details on the distribution functions used in the simulation can be found in the Supplementary material (available online). The multivariate parameter sensitivity is expressed in terms of standardized regression coefficients (SRCs). Furthermore, parameter uncertainty was dealt with by probabilistic sensitivity analysis (PSA). Monte Carlo simulations were run until convergence of the results

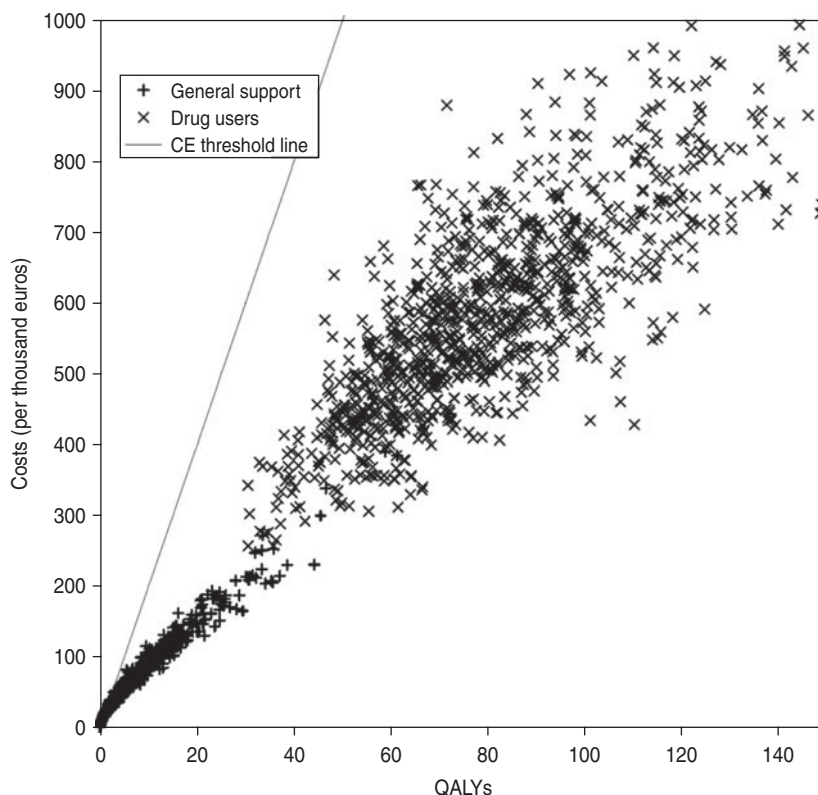


Fig. 2. Cost-effectiveness plane.

was obtained. This was achieved after 1500 iterations for the support campaign and 1000 iterations for the drug users campaign. For all input variables with uncertain values, a random value was drawn from the distribution given in the tables in the Supplementary material. Simulated net costs are plotted against the effects (QALYs) (Fig. 2). In addition, a cost-effectiveness acceptability curve was constructed, which shows the likelihood that hepatitis C campaigns are cost-effective for a range of cost-effectiveness thresholds (Fig. 3).

To illuminate the influence of the prevalence of HCV on the cost-effectiveness of the campaigns, a scenario analysis was performed. The HCV prevalence in urban regions was estimated to be approximately twice as high as in the rural campaign regions. The prevalence in the least densely populated regions of The Netherlands was estimated to be half the prevalence compared to the campaign region. This is based on estimations of the presence of risk groups, made by Statistics Netherlands and the National Drug Monitor [15, 27]. Therefore the ICER of the support campaign and the drug users campaign was calculated for a region with double and half the

prevalence. This implies that twice or half the number of HCV carriers will be identified.

RESULTS

Effects and costs of the general campaign

The results of the campaigns are summarized in Table 3. During the 4 months of the general campaign, the number of anti-HCV tests performed increased by 32, compared to the same period in the previous year (from 86 to 118 tests). None of these tests identified a HCV carrier, so there was no positive effect on case-finding and no measurable effect of this campaign [14]. If implemented nationwide, the general campaign would cost about €490000, plus €120000 for the resulting consultations and anti-HCV tests.

Effects and costs of the support campaign

During the 4 months of the support campaign the number of anti-HCV tests performed increased by 115 (from 57 to 172 tests), resulting in the identification of

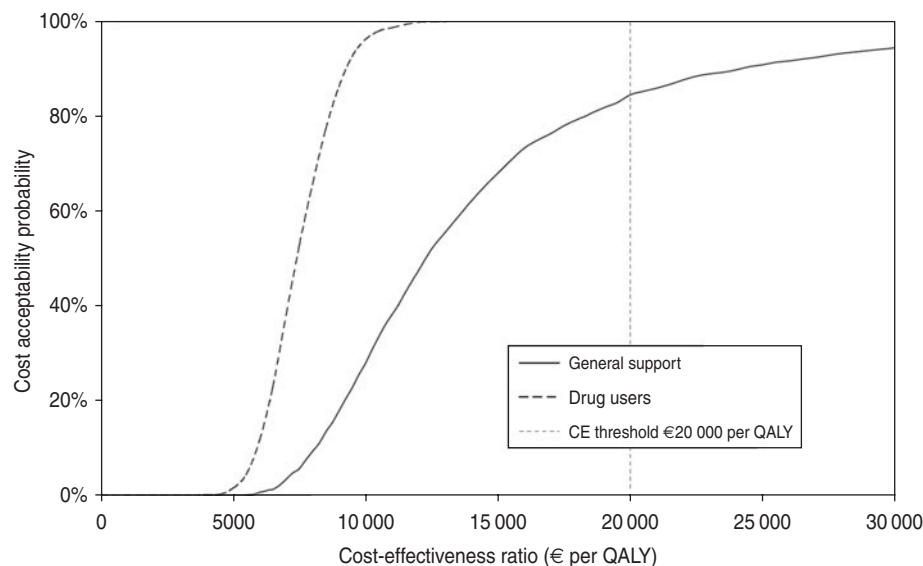


Fig. 3. Acceptability curve.

three anti-HCV-positive patients (from 0 to 3 positive patients) [14]. Since 80% of the infections are expected to lead to chronic disease, the expected number of patients with a positive PCR test is $0.8 \times 3 = 2.4$. Extrapolation of these results to a nationwide campaign leads to an estimated increase in the number of anti-HCV tests performed of 6990 tests, leading to the identification of an additional 146 chronic HCV carriers. The costs for the nationwide support campaign are about €490000 for the general campaign (as described above), €770000 for the GP support programme and €1.2 million for the nationwide additional GPs consultations, the requested tests and additional HCV treatments. This leads to a total cost of about €2.5 million (95% CI €1715139–3820432). Combining these numbers yields that the costs of the support campaign, including the additional testing and treatment, amount to €17000 (95% CI €10655–57364) for each additionally identified chronic HCV carrier (Table 4).

Effects and costs of the drug users campaign

During the drug users campaign 213 counselling sessions took place. This led to 186 additional anti-HCV tests, resulting in the identification of 57 anti-HCV-positive patients of whom 49 had a positive PCR test (and can therefore be considered chronic HCV patients) [16]. Evaluation by the Infectious Disease Control Department of the Municipal Health Service of Rotterdam showed that hepatitis C testing in a regular addiction-care setting only occurred

sporadically over the past years [16]. Therefore, this cost-effectiveness analysis is based on the assumption that all the anti-HCV tests performed on HDUs during the four campaign months were a direct consequence of the campaign. Extrapolating these data, it was estimated that nationwide implementation of the drug users campaign would result in the counselling of 1427 additional persons, leading to 1246 additional anti-HCV tests and the identification of 328 chronic carriers of HCV (PCR confirmed). The additional costs of this implementation are about €156000 for the campaign and €2 million for the resulting consultations, tests and treatments. This leads to a total cost of about €2.2 million (Table 4; 95% CI €1599613–2880541). Combining these numbers yields that the costs of the drug users campaign, including the resulting testing and treatment, amount to €6700 (95% CI €5422–8170) for each chronic HCV carrier additionally identified.

Model outcomes on cost-effectiveness

For the support campaign the discounted incremental cost per tested person is €353 (95% CI €245–547) with an associated gain of 0.031 QALYs (~11 days, 95% CI 0.006–0.077). The resulting ICER is €11297 (95% CI €6804–38685) per QALY. For the drug users campaign the discounted incremental cost per tested person is €1773 (95% CI €1284–2311) with an associated gain of 0.242 QALYs (~88 days, 95% CI 0.152–0.353). The resulting ICER is €7321 per QALY (95% CI €5214–10436).

Table 3. *Extrapolation of regional results to national campaigns*

	Regional campaign	Nationwide extrapolation
Campaigns aimed at the general public		
Inhabitants of the Eemland region (support campaign)*	269 125	
Inhabitants of the Gelre IJssel region (general campaign)†	166 315	
Inhabitants of The Netherlands – 2007‡	16 357 992	
<hr/>		
Additional number of persons tested for HCV [14]	32	3147
General campaign	(from 86 to 118)	
Additional number of identified HCV carriers [14]	0	0
General campaign		
Additional number of persons tested for HCV [14]	115	6990
Support campaign	(from 57 to 172)	
Additional number of identified HCV carriers [14]	2·4	146
Support campaign	(from 0 to 2·4)	
<hr/>		
Campaign aimed at hard-drug users (HDUs)		
HDUs in Rotterdam [15]	5000	
HDUs in The Netherlands [15]	33 500	
<hr/>		
Additional number of HDUs tested for anti-HCV [16]	186	1246
Additional number of identified HCV carriers (PCR confirmed) [16]	49	328

* Official website of the Eemland region.

† Official website of the Gelre IJssel region.

‡ Statistics Netherlands (CBS).

Sensitivity and scenario analysis

In the multivariate analysis, SRCs were determined. The SRCs indicate that the uncertainty of the ICER for the support campaign is primarily determined by uncertainty with regard to the number of cases found in the campaign (SRC = -0·64) and the referral rate (SRC = -0·15). Due to the nonlinearity of the ICER for the support campaign, the variance explained (R^2) by the linear regression model is only 0·42. When rank regression was performed instead, the same significant parameters were found (with an R^2 of 0·98) with SRCs of -0·94 and -0·21, respectively.

The sensitivity of the ICER for the drug users campaign was primarily determined by the age at testing (SRC = 0·64). Furthermore, various costs and disease progression parameters play a role. There are about 10 such parameters with SRCs between 0·10 to 0·30. The variance explained (R^2) by the linear regression model that was fitted for this sensitivity analysis was 0·96. Details on the 10 most influential parameters for each campaign can be found in the Supplementary material (Table 4).

The uncertainty analysis indicates that the probability that the ICER for the support campaign remains below a threshold of €30000 per QALY is over 95%. A threshold of €20000 is often used in The Netherlands. The probability of an ICER below this threshold is 84%. For the drug users campaign the likelihood that the Dutch threshold value for an ICER will be exceeded is negligible. This is illustrated in the cost-effectiveness plane (Fig. 2) and, more specific, in the cost-effectiveness acceptability curve (Fig. 3).

The scenario analysis for double prevalence rates leads to an ICER of €7099 in the support campaign and €6676 in the drug users campaign. The scenario for half the prevalence rates yields ICERs of €15760 and €7056, respectively.

DISCUSSION

Summary of findings

The cost-effectiveness of three different hepatitis C identification strategies was evaluated in order to optimize a future national hepatitis C campaign. Two

Table 4. *Costs of nationwide campaigns*

Campaign	Costs (€)
General campaign*	
Campaign organization and execution	110000
Campaign materials (radio advertisements, newspaper advertisements, posters, brochures, website, mailing costs)	380000
Additional GP consultations and testing (3147 tested persons of which 0 were chronic HCV carriers)	120373
Total costs of a 4-month national campaign	610373
Campaign including support programme	
Campaign costs (organization, execution and materials)	490000
Plenary courses (30 min) provided for GPs (41 per meeting)†	160508
Courses (45 min) for GPs in small settings (7 per meeting)†	469557
Educational brochure for GPs and associates‡	31000
Support for general practice associates/assistants§	100000
Other costs (mailings, personal communication)†	10405
Additional GP consultations, testing and treatment resulting from campaign (6990 tested persons of which 146 were chronic HCV carriers)	1206545
Total costs of a 4-month national campaign. Including support for primary-care practice and the resulting additional consultation, testing and treatment	2468015 (1715139–3820432)
Drug users campaign¶	
Training and research	83600
Project organisation	5600
Project execution	45000
Expenses (materials/travelling)	22243
Additional consultations, testing and treatment (1246 tested persons of which 328 were chronic HCV carriers)	2053234
Total costs of a national campaign, including consultations, testing and treatment	2209677 (1599613–2880541)

* The Netherlands Institute for Health Promotion and Disease Prevention (NIGZ).

† Julius Center for Health Sciences and Primary Care.

‡ Dutch College of General Practitioners (NHG).

§ Raedelijn.

¶ The National Institute of Mental Health and Addiction in The Netherlands (Trimbos Institute) and the Mainline Foundation.

|| Values in parentheses are 95% confidence intervals.

similar campaigns (the general campaign and the support campaign) were aimed at risk groups in the general public, but only the support campaign implemented a complementary support programme for primary care. The third strategy entailed an active and 'on-the-spot' approach for HDUs, facilitating the entire process from counselling to referral.

The general campaign did not result in an increase in the identification of HCV carriers which means there was no gain in effects and therefore no ICER could be calculated. Consequently this strategy is not cost-effective. In The Netherlands, an informal threshold for cost-effectiveness often quoted is €20000 per QALY [28]. Considering this cut-off point, the ICERs of the support campaign and the drug users campaign indicate that both these

campaign strategies should be considered cost-effective.

The ICER for the drug users campaign is hardly influenced by prevalence, as was shown in the sensitivity analysis. The reason for this is that 87% of the costs for each additionally identified HCV carrier in this campaign consists of treatment costs. In the support campaign treatment costs are 38% of the total costs for each additionally identified HCV case. Here the cost-effectiveness outcome is clearly determined by HCV prevalence.

Strengths and limitations

One of the main strengths of our study is that it is based on actual experience in performing HCV

campaigns instead of hypothetical campaigns based on assumptions. Since the support campaign resulted in a low number of additionally identified HCV carriers, the generalizability of the ICER for this campaign is moderate at present and leaves room for research on a larger scale.

Even though the drug users campaign leads to a relatively large increase in the number of identified chronic HCV carriers, the resulting ICER is close to the ICER resulting from the support campaign. This can be explained by the lower effects in terms of QALYs gained, due to the reduced life expectancy of HDUs which is estimated to be 15 years fewer than that of the general population [19]. We were not able to explicitly take into account the relatively high prevalence of HIV in HDUs due to lack of information. The implementation of these effects in the model is expected to negatively influence the cost-effectiveness of the drug users campaign due to its negative effects on the prognosis and treatment of HCV.

The estimated discontinuation rate is based on a treatment with ribavirin and interferon [22]. In the current standard treatment, interferon has been replaced by peg-interferon. Assuming that the current treatment is less burdensome, this might lead to an overestimation of treatment discontinuation and an underestimation of the success rate. Therefore the true cost-effectiveness may be more favourable than reflected in the estimated ICER.

An evaluation of a sustained effect after the campaign was not included in our calculations because these data were unavailable. Including these data could lead to a less favourable ICER if the increase in HCV-related tests and consultations persisted without increasing the number of HCV identifications. However, considering the results of the pilot campaigns, it is more likely that the increased awareness of GPs induced by the HCV campaign would lead to a higher number of identified HCV carriers at relatively low costs and consequently to a more favourable ICER.

This is the first paper on the cost-effectiveness of HCV campaigns in The Netherlands. Literature from other European countries is scarce, but it generally concludes that HCV campaigns are a moderately cost-effective means of identifying HCV carriers if aimed at high-risk groups in the general population. Thompson Coon *et al.* [5] estimated the ICER at €20000–24000 per QALY, for both a non-targeted case-finding strategy and for a targeted strategy (aimed at former IDUs) in primary care within the UK. Castelnovo

et al. [29] and Stein *et al.* [30] estimated the ICER of case-finding in IDUs in the UK at €20000–23000 per QALY if peg-interferon is used as standard therapy.

Our data show a somewhat more favourable estimation of cost-effectiveness than existing studies [31]. The more favourable ICER found in our study can be explained by the fact that we evaluated a relatively cheap campaign with relatively large gains in QALYs per patient identified. The latter may be related to the fact that our analyses are based on treatment with peg-interferon and ribavirin which is less burdensome and more effective than less advanced forms of treatment used in other studies [31].

Sensitivity analysis shows that the number of cases found have substantial influence on the cost-effectiveness of a campaign aimed at the general public. The prevalence of HCV is strongly correlated with the presence of risk groups (mainly immigrants and HDUs), resulting in substantial regional differences. Consequently, in order to optimize cost-effectiveness, future HCV case-finding campaigns should be focused on regions where a high concentration and agglomeration of HCV risk groups are expected to be present, such as large cities [15, 32].

Considering the Wilson & Jungner criteria and the new insights regarding these criteria posed by the WHO in 2008 [33, 34], targeted hepatitis C screening campaigns meet all the required conditions for implementation of a screening programme. This underlines the importance of the implementation of hepatitis C campaigns and should stimulate implementation in all countries where these required conditions can be met.

When implementing a HCV campaign, it is worthwhile considering integrating screening for related diseases. Hepatitis B virus (HBV) and HIV are infectious diseases which have similar high-risk populations as HCV. Recent studies regarding HBV and HIV screening in high-risk populations indicate that screening programmes for HBV and HIV are likely to be cost-effective [35–37]. Considering the overlapping target populations, combining these diseases in one screening campaign could reduce total campaign costs and increase the effectiveness compared to the implementation of individual strategies.

Developments in treatment for HCV infection are rapidly evolving. Treatment will become more effective after shorter treatment duration, and improvements in the use of short-term indications of non-response will lead to shorter treatment of those who

do not reach sustained viral response [4]. In addition new medical treatments such as polymerase inhibitors and protease inhibitors are expected to dramatically improve cure rates [38, 39]. Even though these medications will initially come at a high cost, the shorter duration of treatment, higher success rates and increased quality of life during treatment, are expected to improve cost-effectiveness for HCV case-finding in the near future.

The constantly changing composition of the Dutch population might also influence the cost-effectiveness of future hepatitis C campaigns. Assuming that the largest increase in unidentified HCV carriers is due to the increasing immigrant population, the prevalence of HCV in The Netherlands is expected to increase [8, 40]. This will result in a lower ICER of case-finding strategies, assuming that the campaign in its current form will be as successful in reaching immigrants as it is in reaching other inhabitants.

CONCLUSION

The incremental cost-effectiveness ratio (ICER) of implementing a nationwide HCV campaign with complementary support for primary care is estimated at €11297 per QALY. The ICER of implementing a national campaign aimed at the identification of HCV carriers among HDUs is estimated at €7321 per QALY. Considering a Dutch cut-off point of €20000 as a favourable cost-effectiveness ratio, both campaigns can be considered as cost-effective strategies for improving case-finding and preventing future complications of HCV [28]. Since the pilot HCV campaign without primary-care practice support did not result in improved case-finding of HCV carriers, a support programme for primary-care practices is vital for achieving cost-effectiveness in a HCV campaign aimed at the general public.

NOTE

Supplementary material accompanies this paper on the Journal's website (<http://journals.cambridge.org/hyg>).

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DECLARATION OF INTEREST

None.

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