Screening for Hepatitis C Virus in a Health Maintenance Organization

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Background: Chronic infection with hepatitis C virus (HCV) is a major public health problem and is associated with over 10,000 deaths a year in the United States. In its early stages, HCV tends to be asymptomatic and can be detected only through screening.

Objectives: To develop and validate a database risk algorithm for HCV infection using electronic data at HealthPartners, a health maintenance organization (HMO) in Minnesota. A secondary objective was to evaluate the benefit of screening health care workers for HCV.

Methods: A database risk algorithm was developed using diagnostic and procedure codes in the administrative database to identify at-risk enrollees. One thousand three hundred eighty enrollees (an at-risk sample and a control sample) and 502 health care workers participated in anonymous screening. Both descriptive statistics and logistic regression were used to examine the frequency of HCV infection, associations with risk factors, self-selection factors in participation, and concordance between the database risk algorithm and the risk profile questionnaire.

Results: Eleven enrollees tested positive for HCV, 9 from the at-risk sample and 2 from the control sample. All health care workers tested negative for HCV. Both lifestyle and medical risk factors were associated with positive test results for HCV. Enrollees with alcohol-drug diagnoses were less likely to participate in screening. A substantial proportion of enrollees with risk factors was identified either by the database risk algorithm or the risk profile questionnaire, but not by both.

Conclusions: While the frequency of HCV infection was lower than previous estimates for the US population, the strong correlation with risk factors suggests that using the database risk algorithm for screening is a useful approach. Managed care plans with suitable data on their enrollee populations are in a key position to serve an important public health role in detecting asymptomatic patients who are infected with HCV.

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The hepatitis C virus (HCV) has been described as “a worldwide health problem of immense proportions.” It is estimated that about 4 million Americans are infected. This blood-borne disease, which damages the liver, tends to have no obvious symptoms in its early stages, is the most common cause for liver transplants, and is associated with over 10,000 deaths a year in the United States. The HCV was identified in 1989. Currently, there is no vaccine.

This article reports the findings from an HCV screening project at HealthPartners, a health maintenance organization (HMO) in Minnesota. The primary goal of the screening program was to address the following question: Does an administrative database on HMO enrollees have sufficient specificity to identify persons with an elevated risk of hepatitis C? The availability of a database on HMO enrollees offered an unusual opportunity to develop and test an algorithm as a method for targeting limited resources to patients. A secondary purpose of this study was to assess the utility of screening health care workers for HCV in primary care clinics.

BACKGROUND

PREVALENCE

According to some current estimates, the prevalence of antibody to HCV in the general population of the United States is 1.8%, and the rate of newly acquired HCV infections is declining because of improved control over blood supplies and surgical procedures. However, rates of infection have varied widely—from 0.36% to...
SUBJECTS AND METHODS

The HCV-HMO screening project focused on 2 populations: enrollees who are at risk for HCV infection and health care workers. An algorithm was developed by identifying diagnoses and procedure codes associated with existing cases of HCV infection in the HMO database. The database risk algorithm was tested through anonymous screening of a sample of HMO enrollees. The study also assessed the prevalence of HCV infection among health care workers as a potential risk group.

SETTING

This project was conducted at HealthPartners, a staff-group model HMO in the Twin Cities metropolitan area of Minnesota. HealthPartners owns 19 primary care clinics that serve about 240,000 enrollees. The screenings of enrollees and health care workers were conducted in 4 of HealthPartners' largest clinics, which are dispersed geographically around the metropolitan region.

DEVELOPMENT OF A DATABASE RISK ALGORITHM

As our first task, we created a development sample by identifying adult HMO enrollees with an existing HCV diagnosis during the period 1996 through 1997. Because coding is often incomplete or inaccurate, especially with a newly recognized condition such as HCV, we grouped enrollees in the development sample into a hierarchy of 3 subsamples based on the likelihood that they had an actual HCV diagnosis:

- Patients with diagnosis codes for HCV (n = 459).
- Patients with diagnosis codes for hepatitis unspecified (n = 2296).
- Patients with diagnosis codes for liver disorders, HCV as a possible cause (n = 1645).

In addition, we selected a control group that included a random sample of adult enrollees without any of the above diagnoses (n = 4400).

The second step was to select known HCV risk factors that were available as diagnosis (International Classification of Diseases, Ninth Revision [ICD-9]) and procedure (Current Procedural Terminology 4 [CPT-4]) codes in the administrative database during the previous 5 years. These codes were grouped by category into the following 10 risk variables: liver disorders, hepatitis A or B, human immunodeficiency virus (HIV), alcohol problems, gastritis, dialysis, cocaine use, other drug-use problems, coagulation disorders, and miscellaneous symptoms.

Our third task was to evaluate the risk variables for possible inclusion in the database risk algorithm. We used the following 2 methods: contingency analyses and a classification tree analysis. The contingency analyses indicated significant associations between the sample groups and all the risk variables. For example, 13% of those in group 1 had diagnosis codes associated with alcohol problems compared with 2% in the random sample. A contingency analysis, however, did not control for the effects of other variables. We then used a classification tree approach to rank the importance of variables. After developing an initial tree that included all 10 variables, we used a pruning technique to reduce the complexity of the tree while maintaining goodness of fit. The classification tree indicated that the following 3 variables were significant predictors of HCV diagnosis: hepatitis A or B, liver disorders, and alcohol problems. For example, enrollees with hepatitis A or B in the development sample were about 11 times more likely to have an HCV diagnosis than those without hepatitis A or B (43% vs 3.8%).

Our final step in the development process was to select variables for inclusion in the database risk algorithm. In creating the algorithm, we opted to use inclusive rather than exclusive criteria. That is, based on findings from the development sample as well as other research, we selected an extensive set of variables that have been shown to be HCV risk factors and corresponded to diagnosis and procedure codes in the database. We selected the following 9 variables for the database risk algorithm: (1) alcohol problems, (2) coagulation disorders, (3) cocaine use, (4) dialysis, (5) drug problems (other than cocaine), (6) hepatitis A or B, (7) HIV, (8) liver disorders, and (9) blood transfusion before 1992.

ENROLLEE SCREENING SAMPLE

Two groups of enrollees were invited to participate in anonymous HCV screening: (1) enrollees who were identified through the database risk algorithm and (2) a control sample, designated as a random sample of enrollees who had "miscellaneous symptoms" but no specific risk factors. Persons with a diagnosis of HCV infection in the HMO database during the previous 5 years were excluded.

The control group included enrollees with symptom codes for miscellaneous conditions, such as fatigue, headaches, nausea, and digestive problems. We used these symptoms as criteria for selecting the control group because patients with such codes in their records constitute a population of enrollees who use health care services. Thus, the control sample should be more comparable with the group at risk (those selected based on diagnoses) than a random sample of all enrollees, which would include many healthy enrollees who do not use HMO services.

A total of 12,903 enrollees, including members of the database risk algorithm group and the control group, were sent letters inviting them to participate in anonymous screening. The letters were sent in batches, and the screening was completed in June and July 1998. Each person received a letter of invitation and a reminder postcard. The enrollees were offered 4 dates for screening, 1 at each clinic site; 1380 persons participated in the screening, a response rate of 10.7% (Table 1).

ENROLLEES SCREENING PROTOCOL

The recruitment letters included a coupon coded with a letter and a color. The letter-color codes were associated with key variables or combinations of variables. For example, one letter-color code referred to patients who had transfusions before 1992, another to patients with a diagnosis of alcohol problems, and so forth. The letter-color codes also referred to the number of miscellaneous symptoms. Altogether there were 24 code categories. The coded coupons preserved the anonymity of participants, while allowing analyses to be performed based on risk factors. At least 50 individuals were invited for each letter-color code. The coupon letter code was transcribed onto the risk profile questionnaire (described below). To ensure the anonymity of the participants, the phlebotomists and other staff members who administered the
screening did not know the translation of any of the codes. (The programmer-analyst on the research team was the “keeper of the codes.”)

At the screening, each participant was given a personal identification number. The identification number was recorded in the following 4 places: the vial with the blood specimen, the requisition form sent to the laboratory, the information pamphlet that included instructions about how to obtain test results, and the risk profile questionnaire. In all instructions, participants were told that the testing was anonymous and that they could not obtain their results without their confidential number, which was known only to them. Participants were given an 800 telephone number at an independent telephone center located in another state that they could call for test results.

The blood specimens were tested in batches of 250 or more specimens, using the polymerase chain reaction (PCR) test performed by National Genetics Institute (Los Angeles, Calif). The PCR test provides a direct measurement of viral load and has high sensitivity and specificity (the PCR test is able to detect as few as 100 copies of HCV RNA per milliliter of serum).

Risk Profile Questionnaire

Before the blood screen, participants were asked to complete a risk profile questionnaire. This 1-page instrument, formatted as a small brochure, covered the following 4 categories of variables:

1. Work history (eg, health care worker, contact with blood or blood products, work in an institution or prison, and/or military service).
2. Medical history (eg, transfusions before 1992, dialysis, history of surgery, cesarean section, diagnosis of hepatitis, and/or family member with hepatitis).
3. Lifestyle activities (eg, tattoo, alcohol problem, unprotected sex, and/or drug use).
4. Background (eg, age, sex, and country of origin).

Health Care Workers

Four clinics that are owned by the HMO served as pilot sites for a program of HCV education and anonymous screening for all employees. The educational-screening programs were widely publicized by sending multiple mailings to all 872 staff members in the 4 clinics, placing posters in the clinics, and providing opportunities to sign up for “lunch-and-learn” sessions. The programs were widely attended; 597 staff members participated in the educational sessions (68.3% of clinic staff). 43

Health Care Workers Screening Sample

The clinic staff members participating in the screening included a spectrum of health care workers in community clinics (ie, physicians, nurses, dentists, optometrists, phlebotomists, pharmacists, and receptionists). Five hundred two staff members participated in the anonymous screening (57.6% of clinic staff).

Health Care Workers Screening Protocol

The screening protocol for health care workers was comparable with the process used for screening enrollees. Participants were asked to complete the same risk profile questionnaire. A confidential identification number was placed on the vial with the blood specimen, the laboratory requisition form, the information pamphlet with instructions for obtaining test results, and the risk profile questionnaire. After completion of the educational sessions, a letter was sent to all staff members in the pilot clinics. The letter informed them that test results were available if they had participated in the anonymous screening and gave them the 800 telephone number to call (at an independent telephone center, that had no connection to their employer, HealthPartners).

Analyses

We examined the following 4 outcomes: (1) prevalence, (2) risk factors, (3) screening response, and (4) concordance between the database risk algorithm and the risk profile questionnaire. The enrollee sample was included in all of the analyses; the health care worker sample was included only in the prevalence analysis and some of the risk-factor analyses. To determine prevalence we calculated the number and percentage of participants with positive test results for both enrollees and health care workers.

Risk Factors

With data from the risk profile questionnaire and the risk algorithm, we assessed possible associations between risk factors and positive test results for HCV with both descriptive statistics and logistic regression. We examined simple associations among variables (P values were calculated using the Fisher exact test). We also used logistic regression to test relationships between risk factors and positive test results for HCV. In these equations, the dependent variable was positive test results for HCV. We had 2 separate sets of logistic regression equations with the same dependent variable but with somewhat different predictor variables: database risk algorithm variables and database risk algorithm plus risk profile questionnaire variables. The first set of equations included risk variables from the database risk algorithm, based on diagnosis and procedure codes in the administrative database. The second set of variables combined data from the database risk algorithm with self-report data from the risk profile questionnaire, and included age and sex as well as risk variables. Potential interaction effects were investigated, and nonsignificant variables were removed. P<.05 was considered statistically significant.

Screening Response

For this component of the analysis, we looked at predictors of participation in the enrollee screening. Using descriptive statistics and data from the database risk algorithm, we compared the sample of enrollees invited to be screened with the subsample who actually participated in the screening.

Concordance

An important issue in creating an algorithm using HMO administrative data is the sensitivity of this database for identifying enrollees with risk factors. Therefore, we looked at the concordance between the database risk algorithm and risk profile questionnaire variables for specific categories of risk factors. For example, we compared the database risk algorithm identification of drug use and the risk profile questionnaire responses concerning use of drugs.
effective screening of blood donors. Some studies virtually eliminated in the United States and many other missions of HCV through blood transfusion has been virulent: Individuals who had blood transfusions prior to 1992, hemophiliacs, patients undergoing hemodialysis, organ transplant recipients, needle stick victims, prison employees, intravenous drug users, and persons with a large number of sex partners. Since 1992, the transmission of HCV through blood transfusion has been virtually eliminated in the United States and many other countries that have implemented programs for the effective screening of blood donors. Some studies have found that rates of HCV infection among health care personnel are comparable with those of general populations. However, there appear to be higher rates in certain settings, such as inner-city emergency departments.

RISK FACTORS

The following groups may be at increased risk for HCV infection: individuals who had blood transfusions prior to 1992, hemophiliacs, patients undergoing hemodialysis, organ transplant recipients, needle stick victims, prison employees, intravenous drug users, and persons with a large number of sex partners. Since 1992, the transmission of HCV through blood transfusion has been virtually eliminated in the United States and many other countries that have implemented programs for the effective screening of blood donors. Some studies have found that rates of HCV infection among health care personnel are comparable with those of general populations. However, there appear to be higher rates in certain settings, such as inner-city emergency departments.

COURSE OF THE DISEASE

Most of those infected with HCV remain asymptomatic for many years, and it is difficult to predict which patients who are infected are at risk for the development of life-threatening consequences. Fatigue is the most common symptom. It is estimated that about 20% of patients with HCV will progress to cirrhosis of the liver and/or liver cancer. A recent article reported a substantial increase in the incidence of hepatocellular carcinoma in the United States, with HCV and hepatitis B virus (HBV) as the major risk factors. Hepatitis C virus also affects other organs besides the liver, including the pancreas, salivary glands, kidney, blood vessels, bone marrow, blood cells, and lymph nodes.

TREATMENT

The currently accepted treatment for HCV infection is a combination of interferon and ribavirin. The minimum duration of treatment is 6 months, with an overall permanent response rate of about 40%. The cost of treatment is $9000 to $18000. The combination treatment is substantially more effective than interferon alone, which until recently was the only approved treatment for HCV.

RATIONALE FOR SCREENING

Screening for HCV is important for public health. Screening can reduce the transmission of HCV and encourage patients who are infected with HCV to take appropriate precautions, such as avoiding alcohol and other drugs and being vaccinated for other forms of hepatitis. Another reason to screen for HCV is to uphold the ethical principle of a patient’s right to know.

Several recent reports on HCV screening efforts have concluded that selective screening is reasonably efficient and comparable with screening for other diseases. A high percentage of HCV infection is associated with specific risk factors, such as drug use. Thus, developing an algorithm and method for risk-based screening should be appropriate and cost-effective.

PREVALENCE

As Table 1 shows, among the sample of 1380 enrollees who were screened, 11 individuals tested positive for HCV, a prevalence of 0.8%. The cases identified by the database risk algorithm were 10 times more likely to test positive than the control sample, selected on the basis of miscellaneous symptoms (2.0% vs 0.2%). All of the 502 health care workers tested negative for HCV.

RISK FACTORS

Table 2 uses data from the risk profile questionnaire to compare the following 3 screened groups: enrollees who tested positive for HCV, enrollees who tested negative for HCV, and health care workers (who tested negative for HCV). As this table indicates, enrollees who tested positive for HCV were much more likely to report risk factors, especially those associated with certain medical conditions and lifestyle risk activities. They were more likely to self-report having had a previous hepatitis diagnosis, a liver enzyme test (alanine aminotransferase [ALT] test) with elevated results, or a blood transfusion before 1992. They were also significantly more likely to have a diagnosis for another form of hepatitis (A or B). Only 10 persons with a record of a blood transfusion before 1992 were included in the screening sample—all of them tested negative for HCV.
engaging in lifestyle risk activities (ie, had a tattoo, transfusion before 1992, an alcohol or drug problem, and a previous hepatitis-related diagnosis, self-report of a blood found to increase the chance of testing positive for HCV: profile questionnaire. The following 4 variables were bining data from the database risk algorithm and the risk pared with enrollees without this kind of a diagnosis. or 13 times more likely to test positive for HCV com-
ing positive for HCV. In this equation, using only the limited set of database risk algorithm variables, it appears that enrol-
ors increase the odds of testing positive for HCV. These analyses, which control for other factors, show that certain risk fac-
tors increase the likelihood of testing positive for HCV. Table 4 and Table 5 report findings from logistic regression analyses. Both equations were based on the sample of enrollees, and the dependent variable was test-
ing positive for HCV. These analyses, which control for the effects of other variables, show that certain risk fac-
tors increase the odds of testing positive for HCV. An odds ratio can be interpreted as a multiplying effect. The data in Table 4, using variables based on the database risk alg-
orriment variable was positive test results for HCV. CI indicates confidence interval.

Table 4. Logistic Regression Analysis Showing Variables That Predict Positive Test Results for Hepatitis C Virus (HCV) (n = 1382)*

<table>
<thead>
<tr>
<th>Significant Predictor Variables</th>
<th>Odds Ratio (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis-related diagnoses†</td>
<td>13.9 (2.7-72.1)</td>
<td>.002</td>
</tr>
<tr>
<td>Alcohol and/or drug problem</td>
<td>12.5 (2.3-89.0)</td>
<td>.004</td>
</tr>
</tbody>
</table>

*Variables from the database risk algorithm were used. The dependent variable was positive test results for HCV. CI indicates confidence interval.
†Includes diagnosis of hepatitis A, hepatitis B, and/or human immunodeficiency virus and/or elevated liver enzyme level.

Table 5. Logistic Regression Analysis Showing Variables That Predict Positive Test Results for Hepatitis C Virus (HCV) (n = 1382)*

<table>
<thead>
<tr>
<th>Significant Predictor Variables</th>
<th>Odds Ratio (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis-related diagnoses†</td>
<td>5.4 (1.3-19.6)</td>
<td>.02</td>
</tr>
<tr>
<td>Blood transfusion before 1992‡</td>
<td>4.4 (1.3-14.9)</td>
<td>.02</td>
</tr>
<tr>
<td>Alcohol and/or drug problem</td>
<td>3.9 (1.1-13.9)</td>
<td>.04</td>
</tr>
<tr>
<td>Lifestyle risk activities§</td>
<td>5.2 (1.4-19.0)</td>
<td>.01</td>
</tr>
</tbody>
</table>

*Variables from the database risk algorithm combined with variables from the risk profile questionnaire were used. Blood transfusion before 1992 (from data base algorithm), sex, and age were excluded from the final equations because they were not significant. The dependent variable was positive test results for HCV. CI indicates confidence interval.
†Includes diagnosis of hepatitis A, hepatitis B, and/or human immunodeficiency virus; elevated liver enzyme level; family member with hepatitis diagnosis; and/or vaccinated for hepatitis A or B.
‡Based on self-report (from risk profile questionnaire).
§Includes having tattoos, frequent sex partners, and/or unprotected sex.

changed sex partners frequently, or had unprotected sex outside of a monogamous relationship). For example, while controlling for other factors, enrollees with lifestyle risk activities appear to be 5 times more likely to test positive for HCV than enrollees who did not engage in lifestyle risk activities.

SCREENING RESPONSE

Because only a small percentage of enrollees who were invited to be screened actually participated in the screening, there was likely to be self-selection in response to
the opportunity to be screened. The data presented in Table 6 suggest that enrollees with alcohol-drug diagnoses may be underrepresented in the screened sample compared with those who were recruited. Because this variable is associated with the risk of HCV infection, the prevalence in the screened sample may underestimate the rate of infection in the population that was identified through the database risk algorithm.

CONCORDANCE

In this final set of analyses, we examined the concordance between the database risk algorithm and the risk profile questionnaire. The issue here is not the ability to predict positive test results for HCV, but rather the sensitivity of the algorithm, which was created from an HMO electronic database to identify enrollees with specific risk factors. The denominator for these analyses was defined as the total number of enrollees who would be identified with each risk factor if we considered information from a diagnosis or procedure code in the HMO database (the database risk algorithm) and/or self-report (the risk profile questionnaire). For the sake of this analysis, we assumed that a code in the database and a self-report response were equally true but that there was missing information in each data source.

Table 7, shows that if our information was based on the database risk algorithm alone, we would fail to detect a substantial proportion of enrollees with specific risk factors. For example, the algorithm identified only half of the screened sample with evidence of a drug abuse problem.

Unfortunately, there is no criterion standard in this analysis. The database risk algorithm was limited because certain conditions are notoriously underdiagnosed, especially stigmatized conditions, such as alcoholism and drug abuse. The risk profile questionnaire items were also problematic because individuals may not be completely honest on a questionnaire, even an anonymous questionnaire. Furthermore, the variables are not exactly equivalent. The items on the risk profile questionnaire were by necessity brief (to fit into a small brochure that could be completed in a few minutes) and are not validated items for these conditions.

The variable for blood transfusion before 1992 was problematic in different ways in the database risk algorithm and the risk profile questionnaire. The algorithm variable was an underestimate because participating individuals could have had blood transfusions before they enrolled in the HMO or if they had them performed outside the HMO. Moreover, the historical data in the HMO database are much less complete than data in current data files. Conversely, this variable was highly inflated in the risk profile questionnaire because respondents often misunderstood the question. This became evident in 2 ways. First, during the screening process many of the enrollees were uncertain about this item and made comments to the effect that “If I had some kind of surgery, I must have had a transfusion, right?” Second, the health care workers were far less likely to report having had blood transfusions. Presumably, health care professionals would understand the term transfusion (Table 2).

Table 6. Predictors of Participation in Hepatitis C Virus (HCV) Screening Among Health Maintenance Organization (HMO) Enrollees

<table>
<thead>
<tr>
<th>Database Risk Algorithm Variables</th>
<th>Recruitment Sample Invited to Be Screened (n = 12,903)</th>
<th>Screened Sample Participating in Screening (n = 1380)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis-related diagnosis*</td>
<td>1964 (15.2)</td>
<td>189 (13.7)</td>
</tr>
<tr>
<td>Alcohol and/or drug diagnosis</td>
<td>3066 (23.8)</td>
<td>167 (12.1)</td>
</tr>
<tr>
<td>Blood transfusion before 1992</td>
<td>83 (0.6)</td>
<td>10 (0.7)</td>
</tr>
<tr>
<td>Any risk factor from database risk algorithm</td>
<td>5764 (44.7)</td>
<td>454 (32.9)</td>
</tr>
<tr>
<td>No risk factor</td>
<td>7139 (55.3)</td>
<td>926 (67.1)</td>
</tr>
</tbody>
</table>

* Includes diagnosis of hepatitis A, hepatitis B, and/or human immunodeficiency virus and/or elevated liver enzyme level.

Table 7. Concordance Between Risk Variables in the Database Risk Algorithm (Diagnosis and Procedure Codes) and the Risk Profile Questionnaire (Self-Report)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Identified by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hepatitis-related Condition</td>
</tr>
<tr>
<td>Database risk algorithm</td>
<td>326 (100)</td>
</tr>
<tr>
<td>and/or risk profile questionnaire</td>
<td></td>
</tr>
<tr>
<td>Database risk algorithm only</td>
<td>124 (38.0)</td>
</tr>
<tr>
<td>Risk profile questionnaire only</td>
<td>144 (44.2)</td>
</tr>
<tr>
<td>Database risk algorithm and risk profile questionnaire</td>
<td>58 (17.8)</td>
</tr>
</tbody>
</table>

**IS SCREENING FOR HCV IN AN HMO BASED ON A DATABASE RISK ALGORITHM WORTH THE EFFORT?**

Our consideration of this question hinges on 2 key findings. First, the percentage of participants who had positive test results for HCV was unexpectedly low. Second, risk factors were highly correlated with positive test results. It is possible to draw opposing conclusions from these 2 findings. On the one hand, a low “hit” rate means that the cost per case is relatively high. On the other hand, it is clear that targeted screening is far more cost-effective than general population screening.

After screening nearly 1900 individuals, we identified only 11 enrollees and no health care workers as being HCV positive. If our results had been similar to the national estimated rate of HCV-positive cases (1.8%), we should have detected 3 times as many—8 to 10 in the sample of health care workers (N = 502) and about 25 in
the sample of enrollees (n = 1380). In fact, because we purposely recruited an at-risk population, we should have found a substantially higher rate!

The lack of HCV-positive cases among health care workers suggests that they are not an especially high-risk population. Other recent studies have also found that health care workers in nonemergency settings do not appear to be especially at risk. Based on our findings, we have no reason to recommend the general screening of health care workers in community clinics for HCV. Of course, it still might be wise to test for HCV among health care staff members after needle stick injuries.

The low prevalence of HCV infection found in the sample of enrollees is somewhat surprising. There are a number of potential interpretations. First, the estimated national infection rate of 1.8% could be wrong. Specifically, some screening studies may have selectively recruited higher-risk populations, so that projections to general community rates could be exaggerated. As we noted at the beginning of this article, the rates of positive test results for HCV have varied widely across studies. A large-scale study of blood donors found a rate of only 0.36%. Second, there may be a low prevalence of HCV among our sample of enrollees because the prevalence in Minnesota may be lower than in other parts of the country. Third, it is also possible that our study underestimated the true rate of infection among the population identified for screening because the individuals who are at risk may have declined to participate.

Low prevalence means that it is relatively costly to detect a single case. If we include the entire population screened for this project (health care workers, database risk algorithm sample of enrollees, and control sample of enrollees), we screened almost 1900 individuals to detect 11 cases, or about 170 screenings per case. However, if we count only the database risk algorithm sample, then the yield was considerably higher: 50 screenings per case detected.

The strong correlation between risk factors and HCV infection suggests that risk-targeted screening is an appropriate approach. Our study indicates that medical history and lifestyle factors are associated with an increased risk of HCV infection. Specifically, those who tested positive for HCV were more likely to have other forms of hepatitis or liver conditions, to have problems with drug use or alcoholism, and to report other lifestyle risk behaviors, such as having tattoos and engaging in unprotected sex with multiple partners.

Even among patients with risk factors, we found only a modest number of cases with HCV (2%). If our findings could be projected to other managed care populations, this could be interpreted as good news, not only to individuals but also to society and to health plans, both public and private. In other words, if the number of infected cases among persons at risk for HCV is not of epidemic size, a screening initiative would not yield alarming numbers of patients requiring treatment.

Hepatitis C virus screening is a form of preventive health care, comparable with mammograms and other diagnostic procedures, which are intended to detect cases early in the course of a disease. Until recently, the value of screening for HCV has been a matter of controversy because the only available treatment (interferon) was effective in only a small percentage of patients, and it was not clear if the disease course of those patients would progress to a serious level. Moreover, the treatment was expensive, both in dollars and in discomfort to patients, and the benefit was uncertain. However, the improvement in treatment outcomes with a combination of interferon and ribavirin therapy substantially increases the benefits of HCV treatment.

From a population perspective, cost-benefit is a consideration in screening for HCV. That is, the cost of screening 50 individuals per case detected along with the “prevention” treatment cost would have to be compared with the cost of liver transplantation for a much smaller number of patients who subsequently develop serious liver damage.

More importantly, a commitment to preventive health care is never simply a matter of cost. Hepatitis C virus infection is a potentially fatal disease. To the extent that an HMO or other health plan provider is responsible for managing the health care of a population, it would seem reasonable to include this disease in initiatives for preventive health care. Specifically, risk-based screening for HCV should be an acceptable approach for identifying asymptomatic patients as candidates for treatment.

**IS IT FEASIBLE TO APPLY A RISK ALGORITHM?**

When we began the algorithm development process, it was not obvious that we would be able to identify a sufficient number of indicators in the HMO database. For the most part, we have demonstrated the feasibility of this initiative. That is, we have identified a series of indicators (diagnosis and procedure codes) that are routinely recorded and regularly available, at least in the database on HealthPartners’ enrollees. We created a database risk algorithm that is easy to apply and that performs effectively in identifying persons at elevated risk for HCV infection.

We conclude that the database on HMO enrollees is a reasonable source for current data on diagnoses and procedures. However, historical data on enrollees are much less available or reliable. Our ability to identify patients who underwent blood transfusions 7 or more years before we contacted them was very limited.

**IS A DATABASE RISK ALGORITHM SUFFICIENT?**

While the database risk algorithm appears to be useful, it is not sufficient. Only 8% of the sample identified through the database risk algorithm actually participated in the screening. Thus, our screening program missed the majority of enrollees who were at risk in the HMO. If all the enrollees in the database risk algorithm sample had participated in the screening, we could have found more than 100 additional cases of HCV infection. It is possible that many of the same factors that increase the risk of infection also decrease the likelihood of patients participating in a preventive health program.
We conjecture that the low participation rate in the enrollee screening for this project was exacerbated by the fact that the invitation for screening was completely separate from the patients' medical care. Although persons in the eligible sample were offered 4 separate dates, each at a different clinic, most patients would have had only 1 date at a clinic in a convenient location. Moreover, all of the times for HCV screening were on weekdays and during daytime hours.

Alternatively, HCV screening could be offered to patients who are at risk as part of their routine medical care. This would eliminate at least some problems of inconvenience or self-selection; virtually any appropriate patient who is at risk and comes to the clinic would have an opportunity to be screened. In the HealthPartners care system, it would be possible to identify candidates for screening through a "flag" in the database or by including a form in the patient's chart. Either way, the HCV test could be included along with other laboratory procedures.

Another, related issue is that the risk algorithm, developed from diagnosis and procedure codes in the database, is incomplete. If risk-targeted screening were included as part of preventive health care, there would also be an opportunity to screen patients whose risk factors are discovered during the clinic interview.

In sum, the database risk algorithm appears to be a useful tool, especially when a screening protocol is integrated into a comprehensive system of preventive health care. New treatments for HCV are being developed, tested, and implemented. Thus, the inclusion of HCV screening as part of routine health care for patients who are at risk will become increasingly appropriate and acceptable. Managed care plans that have suitable data on their enrollee populations are in a key position to serve an important public health role in detecting asymptomatic patients who are infected with HCV.

LIMITATIONS

This project was not designed as an epidemiological study. The enrollee sample was selected based on a database risk algorithm and does not represent a population. Furthermore, there was self-selection bias because only about 11% of enrollees invited to participate actually did participate. With only 11 positive test outcomes for HCV, we did not have the power to distinguish the separate effects of all the risk variables. Furthermore, both administrative (the database risk algorithm) and self-report (the risk profile questionnaire) data are not entirely reliable because of inaccuracies and deficiencies in information.

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