such as contact with an individual with hepatitis or jaundice. Overall, the 1017 deferrals for tattoo and piercing in Group 1 and the 723 deferrals in Group 2 represent 35.5 and 28.4 percent of total donor deferrals based on the DHAQ before and after change in the deferral duration, respectively ($p < 0.0001$). This does not include deferrals due to donor hemoglobin (Hb), malaria risk travel, or vital signs assessment. The number of donors deferred for tattoo decreased by 21 percent while the number of donors deferred for piercing decreased by 32 percent after the change in deferral duration; the number of other temporary donor deferrals based on the self-administered portion of the questionnaire decreased by 3 percent, which was not significant ($p = 0.80$). In Group 1, risk activities were not evenly distributed in the 6 to 12 months versus less than 6 months before the donation attempt ($p < 0.0001$). For tattoo and piercing, respectively, 61 and 65 percent of reported risk activities occurred less than 6 months before donation. Since many of the other temporary deferrals in the comparison group were of very short duration, one would expect the majority of these to occur less than 6 months before the donation attempt, as seen in Table 2.

DISCUSSION

Our results demonstrate that there was no increase in TD rates after a shortening of the deferral period for tattoo or ear and body piercing. Furthermore, engaging in these activities, at least in the past 10 years, was not a risk factor for HCV and HBV positivity, the only two markers with enough positive donors to permit analysis. Piercings and tattoos, occurring in the past 6 months, were not infrequent in people who had recently successfully donated and had negative TD testing results. Shortening of the deferral period had a positive effect on our inventory, although less than one would have expected.

Body adornment by tattoo and body piercing are increasingly common, with prevalence rates of 8 to 25 percent for tattoos and 14 to 51 percent for body piercing reported in recent surveys conducted in various population groups.[4-7] It is therefore not surprising that tattoo and piercing are relatively common reasons for temporary donor deferral, both for CBS and for other blood suppliers.[10,11] Deferral rates are particularly high in younger donors, who are early in their donation career and may potentially have a negative impact on donor return rates.[8,10] Tattoo and piercing result in temporary deferral periods of 6 to 12 months in various jurisdictions; in some cases, shorter deferrals are permitted if additional testing is performed for HBV or HCV or if the donor states that single use needles were used.[12-14] In the United States, after the FDA granted licence amendments to several blood suppliers, AABB Standards were amended to permit donations if tattoos have been applied in a state-regulated entity with sterile needles and ink that has not been reused; however, this is only possible in states that regulate tattoo establishments.[15,16]

Deferrals for tattoos and piercing were implemented in Canada and other jurisdictions in the 1980s, when TD testing, quality standards, and deferral for other higher risk behaviors did not provide the same level of safety that we have achieved today.[17] The current contribution of these criteria to blood safety has not been extensively evaluated. In our study there was no change in the TD marker rate after shortening of the deferral period, in spite of acceptance of donors who would otherwise have been deferred. If these behaviors were important risk factors, one would expect an increase in TD rates immediately after implementation of the change. Zou and coworkers[18] from the ARC found that returning donors who had been temporarily deferred for potential infectious disease risk did not have a higher prevalence of positive TD markers, compared to other donors.

There are conflicting studies on the importance of tattoo and piercing as risk factors for HBV and HCV in the general population.[3,19,20] However, causal associations are generally difficult to establish and interpretation is limited by the different populations studied and by potential confounding effects of other established risk factors such as incarceration and IVDU, particularly since these carry much stigma and may be less readily acknowledged by study participants than piercings and tattoos. In any event, neither ear or body piercing or tattoos (in the past 10 years) were predictors of HCV or HBV positivity in our study, in spite of their high prevalence in donors, and shortening the length of deferral had no effect on this. Although we could not assess the association between piercings or tattoos and HIV or HTLV due to their low prevalence in donors and in the general population, it may be expected that if these were independent predictors of blood-borne pathogen transmission, they would be identified as such for HCV and/or HBV since these are more prevalent infections in the Canadian population and in the donor population. Furthermore, failure to report these risk factors appears to be fairly common, with an estimated 5265 donors having engaged in one of these behaviors in the last 6 months in 2006, and yet TD rates are very low in Canada, underscoring the nonspecificity of these behaviors as identifiers of risk.

Studies on TD marker rates in the blood donor population have consistently demonstrated much higher rates for first-time versus repeat donors, indicating that almost all infections in the donor population are related to remote rather than recent infections and risk factors.[21-24] There have been several studies examining risk factors in TD-positive donors.[8,23-26] In a large, case-control study performed by the REDS group in 1994 to 1995, ear or body piercing was a weak risk factor for HCV positivity, while tattoo was a risk factor on univariate analysis alone.[25]

Similar results were obtained on an earlier US study.[26] Results of earlier studies may not reflect risks associated with more recent piercings or tattoos, since these activities are currently much more common in the general population and less likely to have occurred in nonprofessional settings, such as jails. More recent studies from Holland and Australia are difficult to interpret because of the lack of a control group or analysis to remove confounding effects of IVDU and incarceration, which may be particularly important for HCV transmission.[23,24]

In Canada, a decrease in the deferral period from 12 to 6 months did result in decreased donor deferral rates for tattoo and piercing. However, a 50 percent decrease in the deferral interval only led to a decrease of 21 percent in deferrals related to tattoos and 32 percent in deferrals related to piercing. Analysis of the interval between donation attempt and reporting of risk behavior in Group 1 demonstrates an uneven distribution of reported risk throughout the 12-month deferral period, with increased reporting of more recent risk. Our donor survey data also indicate that many donors who have donated recently have engaged in one of these behaviors within the previous 6 months. Since there were likely a few weeks between the time when the donor made her or his last donation and completed their survey questionnaire, it is possible that a minority of donors engaged in the behavior after donating, however, most likely failed to report deferrable risk. Donors may judge that more temporally remote risk behaviors that did not result in infection do not actually require reporting and may also have decreased recall of more remote behaviors.[17] In spite of the less-than-expected donation gain, a decrease in deferral period was still advantageous, as it will result in approximately 2000 additional donations annually, without any adverse effect on safety. Additionally, the data generated provide reassurance that a further reduction of the length of deferral would not be expected to have any impact on safety. Interestingly, preliminary results from a study in Spain demonstrated that a reduction in donor deferral period from 12 to 4 months for a variety of risk activities, including tattoos and piercing, did not result in any increase in TD marker rates, but led to a less-than-expected decrease in deferral rates of 17 percent.[27]

In summary, tattoos and piercing are frequent in donors, reflecting their increasing popularity in the general population. Our data suggest that deferral of donors for recent tattoo or piercing has a very limited contribution to blood safety in Canada, since decrease in the deferral period did not change the TD marker rate. Additionally, undisclosed risk is common, the TD marker rate is extremely low, and recent tattoo or piercing are not independent risk factors for HBV or HCV infections in donors. Given that window periods for HCV and HBV are estimated at less than 10 and less than 45 days, respectively, for HCV minipool NAT and HBsAg tests currently performed in Canada, a decrease in the duration of deferral to 4 months, which is the current EU standard, would not be expected to have any negative impact on safety.[21] The value of other temporary deferrals should similarly be reassessed.

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研究報告の概要

○B型肝炎の再燃

B型肝炎の再燃とは、非活動性B型肝炎またはB型肝炎が治癒した患者で、B型肝炎ウイルス（HBV）が急増することである。再燃は自然に起こる場合もあるが、一般的には癌、自己免疫疾患または臓器移植の免疫抑制療法によって引き起こされることが多い。再燃は、一過性で非顕在性となる場合もあるが、疾患増悪を引き起こし、重症化して急性肝不全に至ることもある。ほとんどの再燃例は自然治癒するが、免疫抑制が続く場合慢性肝炎を発症し、進行性肝障害や肝硬変に至る場合がある。もっともよく報告されている再燃例は、リンパ腫または白血病の癌化学療法治療を受けている非活動性またはほとんど活動性のないB型肝炎を有するB型肝炎表面抗原（HBsAg）キャリアに起きている。通常は化学療法時に血清HBV DNA値が上昇し、化学療法中止後に免疫再構築による疾患増悪およびHBV DNAのクリアランスが起こる。特殊なパターンとしては、臓器および骨髄移植後に再燃が起こり慢性感染を生じる。複数の無作為化プラセボ対照試験で、抗ウイルス剤の予防投与により再燃が予防できることが示された。以上により、癌化学療法または移植を受けるHBsAg陽性者に対してルーチンの予防が推奨されるが、重大な疑問が残る。どのような患者にHBsAgのスクリーニングを行うべきか、全員に治療を行うべきか？どの抗ウイルス剤を、どのくらいの期間使うべきか？ B型肝炎が治癒したHBsAg陰性患者に予防を行うべきか？今後の研究では、異なる患者集団を対象として、再燃の分子学的発症機序、および診断、治療、予防の最適な方法について、取り組む必要がある。

使用上の注意記載状況・その他参考事項等

新鮮凍結血漿「日赤」
新鮮凍結血漿-LR「日赤」
新鮮凍結血漿-LR「日赤」成分採血

血液を介するウイルス、細菌、原虫等の感染
vCJD等の伝播のリスク

報告企業の意見	今後の対応
癌、自己免疫疾患または臓器移植の免疫抑制療法によってB型肝炎再燃が誘発されることが多く、癌化学療法または移植を受けるHBsAg陽性者に対してルーチンの予防が推奨されるとの報告である。輸血後HBV感染の調査には、化学療法後のB型肝炎再燃の可能性を考慮する必要がある。日本肝臓学会から示された「免疫抑制・化学療法により発症するB型肝炎対策ガイドライン」の中で再燃時の対応が提示されている。	日本赤十字社では、薬事法及び関連法令に従い輸血副作用・感染症情報を収集し、医薬品医療機器総合機構を通じて国に報告している。HBV感染に関する新たな知見等について今後も情報の収集に努める。

③

Reactivation of Hepatitis B

Jay H. Hoofnagle

Reactivation of hepatitis B refers to the abrupt increase in hepatitis B virus (HBV) replication in a patient with inactive or resolved hepatitis B. Reactivation can occur spontaneously, but more typically is triggered by immunosuppressive therapy of cancer, autoimmune disease, or organ transplantation. Reactivation can be transient and clinically silent, but often causes a flare of disease that can be severe resulting in acute hepatic failure. Most instances of reactivation resolve spontaneously, but if immune suppression is continued, re-establishment of chronic hepatitis occurs which can lead to progressive liver injury and cirrhosis. The best-described instances of reactivation occur in hepatitis B surface antigen (HBsAg) carriers with inactive or minimally active disease who are given cancer chemotherapy for lymphoma or leukemia. Typically, serum HBV DNA rises during chemotherapy, followed by a disease flare and HBV DNA clearance with immune reconstitution after chemotherapy is stopped. Special forms of reactivation occur after solid organ and bone marrow transplantation in which chronic infection often results. Several randomized, placebo-controlled trials have shown that reactivation can be prevented by antiviral prophylaxis. Routine prophylaxis is therefore recommended for persons with HBsAg undergoing cancer chemotherapy or transplantation, but major questions remain. Which patients should be screened for HBsAg and should all be treated? Which antiviral should be used and for how long? Should persons with resolved hepatitis B without HBsAg receive prophylaxis? Future research should address the underlying molecular mechanisms of reactivation as well as its optimal means of diagnosis, treatment, and prevention in different patient populations. (HEPATOLOGY 2009; 49:S156-S165.)

Introduction

Reactivation of hepatitis B is a well-characterized syndrome marked by the abrupt reappearance or rise of hepatitis B virus (HBV) DNA in the serum of a patient with previously inactive or resolved HBV infection. Reactivation is also often, but not always, accompanied by reappearance of disease activity or a flare of hepatitis in previously minimal or inactive disease. Reactivation can be spontaneous, but is most commonly triggered by cancer chemotherapy, immune suppression, or alteration in immune function. Reactivation can lead to clinically apparent acute hepatitis, which can be severe and result in acute liver failure and death. Nevertheless, a large number of cases of reactivation are subclinical and resolve spontaneously, or result in persistent infection which may go undetected until advanced liver disease is present or the disease has been transmitted to sexual or family contacts.

The importance of reactivation of hepatitis B rests on its potential severity and the ease of its prevention with prophylactic oral antiviral therapy. In addition, reactivation reveals fundamental features of HBV and its ability to persist in a latent replicative form for prolonged periods despite other evidence of viral clearance. Importantly, the lack of recognition of reactivation and its complex virological and biological features often cause confusion and delayed recognition until it has already occurred and caused clinical consequences. Furthermore, reactivation can be misdiagnosed as superimposition of another form

Abbreviations: AASLD, American Association for the Study of Liver Diseases; anti-HBc, antibody to hepatitis B core antigen; anti-HBs, antibody to hepatitis B surface antigen; anti-HBe, antibody to hepatitis B e antigen; HBeAg, hepatitis B e antigen; HBsAg, hepatitis B surface antigen; HBV, hepatitis B virus; HIV, human immunodeficiency virus; TNF, tumor necrosis factor.

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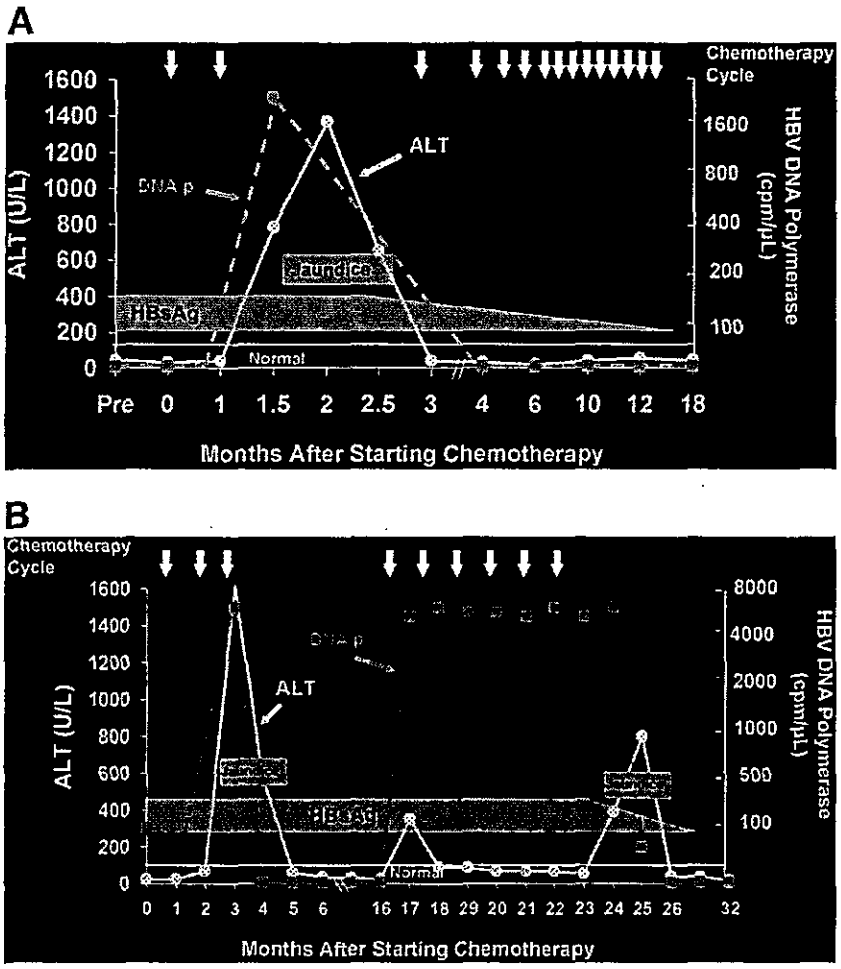

Fig. 1. (A) Reactivation of hepatitis B in an HBsAg carrier with testicular cancer undergoing cyclic chemotherapy. After the second course of chemotherapy, he presented with jaundice and marked elevations in ALT and HBV DNA polymerase activity in serum. Testing of stored serum demonstrated HBsAg without HBeAg or detectable HBV DNA before chemotherapy. The acute hepatitis eventually resolved and he tolerated further courses of chemotherapy without recurrent reactivation. In follow-up 18 months later, he was HBsAg-negative and anti-HBs positive. (B) Reactivation of hepatitis B in an HBsAg carrier with non-Hodgkin's lymphoma undergoing cyclic chemotherapy. After the third course of chemotherapy, she presented with jaundice and marked elevations in ALT and HBV DNA polymerase activity. Testing of stored serum demonstrated HBsAg without HBeAg and low levels of HBV DNA polymerase in serum before chemotherapy. The acute hepatitis eventually resolved, but she developed HBV reactivation again when chemotherapy was restarted. Prospective monitoring demonstrated the rise in HBV DNA with the first course of treatment, but only mild ALT elevations and no clinical symptoms until chemotherapy was stopped, at which point she suffered a severe bout of icteric hepatitis. Approximately 6 months later, she was found to have cleared HBsAg and tested positive for anti-HBs. Modified with permission from Hoofnagle et al.[3]

of liver disease (drug-induced liver disease, alcoholic liver disease) occurring in a previously stable, inactive HBV carrier. There is a need for a wider awareness about reactivation of hepatitis B, when and where it occurs and how it should be prevented or managed.

Virological and Clinical Features of HBV Reactivation

HBV reactivation occurs in many situations in which a person with mild or inactive hepatitis B is exposed to immunosuppressive agents or suffers from immune deficiency. Reactivation has been shown to occur with chemotherapy for solid cancers and leukemia[1-5] particularly when using rituximab;[6] with immune modulation using prednisone or infliximab for autoimmune conditions;[7,8] with progression of human immunodeficiency virus (HIV) infection;[9] after solid organ transplantation (heart, lung, kidney);[10,11] and, most commonly and dramatically, after bone marrow[12,13] and liver transplantation.[14]

The typical course of reactivation is shown in Fig. 1, which shows the course of two hepatitis B surface antigen (HBsAg)-positive patients who received cancer chemotherapy in the early 1980s before the availability of antiviral therapy which might alter the course and outcome.[3] HBV reactivation can be separated into three phases: (1) increase in HBV replication; (2) appearance of hepatic injury; and (3) recovery (Table 1).

Reactivation starts with the abrupt increase in viral replication that typically occurs soon after initiating immune suppression or chemotherapy. The degree of increase in viral replication is measured by the rise in HBV DNA in serum (the examples show HBV DNA polymer-

Table 1. Three Phases of HBV Reactivation

Phase	Feature	Diagnostic Markers	Comments
1	Increase in Viral Replication	HBV DNA HBeAg HBsAg	Rise of > 1 $\log_{10}$ IU/mL In HBeAg negative Reverse seroconversion
2	Appearance of Disease Activity	ALT Symptoms Jaundice	Rise of > 3 times baseline Indicative of more severe injury
3	Recovery	HBV DNA ALT HBsAg	Fall to baseline values Fall to baseline values May be cleared late

ase activity, an insensitive, early quantitative measure of viral replication). In patients without hepatitis B e antigen (HBeAg), this marker may reappear in the serum. The second phase of reactivation starts when immunosuppression is withdrawn or decreased and hepatocellular injury or hepatitis arises, as shown by rises in serum aminotransferase levels and, in more severe instances, symptoms and jaundice. During this phase, HBV DNA levels may start to fall. The third phase of reactivation is recovery, as the evidence of liver injury resolves and HBV markers return to baseline levels.

Not all patients with reactivation have all three phases. In some patients, HBV DNA reappears and rises to high levels, but there is no immune reconstitution and no liver injury arises. These patients also typically do not recover completely, a pattern that is common in patients who remain immunosuppressed, such as solid organ and bone marrow transplant recipients.[10-13] In other patients, the hepatitis phase is severe and can be fatal so that recovery does not occur.[1,4] In other instances, the hepatitis phase persists and a chronic hepatitis is established, of varying severity. Finally, recovery may be marked by a return to the previous inactive state of hepatitis B or may actually result in more complete recovery. In the examples shown in Fig. 1, both patients ultimately became HBsAg-negative and developed antibody to HBsAg (anti-HBs). The examples also show that restarting chemotherapy and immune suppression does not necessarily cause recurrence of reactivation (Fig. 1A), but in some instances can (Fig. 1B).

The Frequency of HBV Reactivation

The frequency of reactivation is not well defined. In a landmark study from the 1980s, investigators from Hong Kong carefully followed 100 patients with lymphoma while undergoing cancer chemotherapy for virological, serological, and biochemical evidence of reactivation.[4] Almost half of the 27 HBsAg-positive patients (48%) developed reactivation during or shortly after chemotherapy, compared to 0 of 22 patients with no serological markers for ongoing or previous hepatitis B. Importantly, two of 51 patients (4%) with serological evidence of resolved hepatitis B (without HBsAg, but with antibody to hepatitis B core antigen [anti-HBc] in serum) developed reactivation with reappearance of HBsAg in serum. This latter pattern is commonly referred to as "reverse seroconversion" and represents an extreme form of HBV reactivation. In this initial prospective study, half of patients who developed reactivation became jaundiced, and 20% of patients with jaundice died. While the incidence of reactivation has varied in different case series, the fatality rate of HBV reactivation has been consistently greater than 10%, far higher than the fatality rate of typical acute hepatitis B and similar to fatality rates of hepatocellular drug-induced liver injury.

A recent meta-analysis of the role of prophylaxis with lamivudine in preventing reactivation of hepatitis B has provided support for these early results on the frequency of its occurrence.[15] Among 13 studies enrolling 424 patients who did not receive prophylaxis, the combined rate of HBV reactivation was 50%, ranging in individual studies from 24%-88%. Subsequent studies have assessed risk factors for developing reactivation; the likelihood of HBV reactivation is higher in patients with HBeAg or HBV DNA before chemotherapy[16] and with the use of corticosteroids in the chemotherapy regimen.[17] Actually, the most important factor—the aggressiveness of the cancer chemotherapy or rigor and duration of immune suppression—could not be analyzed in these studies because of the homogenous populations enrolled.

The role of degree of immunosuppression in the frequency and severity of HBV reactivation is highlighted by reports of severe reactivation following more aggressive forms of chemotherapy or immune suppression such as with the use of rituximab[8] or fludarabine[18] in the therapy of lymphoma. Rituximab is a monoclonal antibody against CD20, a major cell surface marker on B cells, which effectively reduces B cell numbers and antibody levels. The rate of HBV reactivation with rituximab therapy has not been defined but appears to be high. Thus, in the 12 individual case reports of HBV reactivation associated with rituximab therapy in the literature, the mortality rate was 83%, and five cases occurred in patients who were HBsAg-negative before therapy (reverse seroconversion).[8,18-28] In cases of reverse seroconversion, the reappearance of HBsAg and HBV DNA typically occurs late, after several cycles of chemotherapy with rituximab, and generally at a time when anti-HBs and anti-HBc have fallen to low or undetectable levels (Fig. 2).[26]

HBV Reactivation After Immune Suppression for Nonmalignant Disease

Reactivation is not limited to patients with cancer undergoing chemotherapy (Table 2). Simple immune suppression as is given to patients with autoimmune or allergic diseases who have either HBsAg or anti-HBc in serum can also induce reappearance of HBV replication and disease activation, although at a lower rate than occurs with cancer chemotherapy.[7] Thus, reactivation of hepatitis B is uncommon with immune suppression using azathioprine and low doses of corticosteroids, but has been reported (rarely) with long-term use of methotrexate.[29-31] Although rare reports of reactivation have been described in patients receiving corticosteroids alone, more

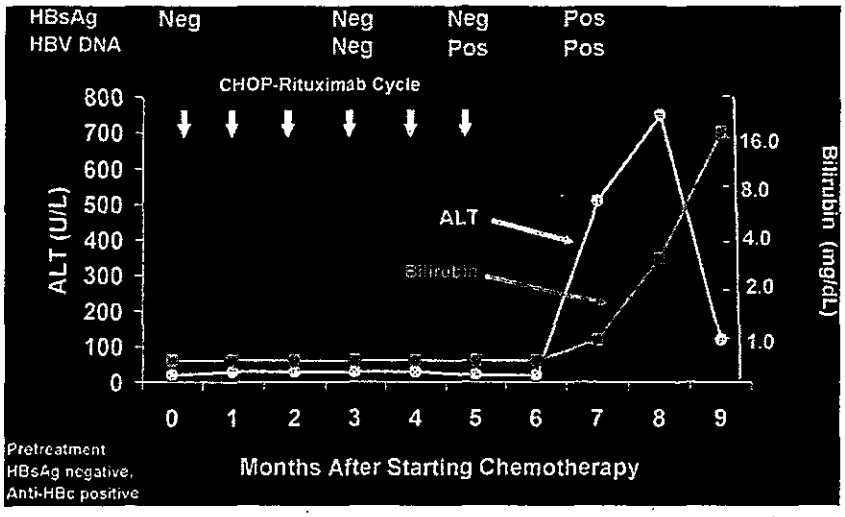

Fig. 2. Fatal reactivation of hepatitis B with reverse seroconversion in a patient with large B-cell lymphoma treated with rituximab-CHOP (cyclophosphamide, doxorubicin, vincristine, and dexamethasone). The patient was HBsAg-negative but anti-HBc-positive before therapy, becoming HBV DNA-positive during the last of six cycles of chemotherapy and subsequently developing HBsAg and rising levels of ALT and bilirubin leading to acute liver failure and death. Modified from Yamagata et al.[26]

striking examples occur after the use of potent immune suppression such as with anti–tumor necrosis factor-alpha therapies (infliximab).[8] Thus, there have been more than a dozen published reports of severe reactivation (three being fatal) after use of infliximab for Crohn's disease, rheumatoid arthritis, or ankylosing spondylitis which has resulted in a "black box" warning.[8,32-36] The rates of reactivation have been difficult to ascertain, because only rare patients receiving these therapies have pre-existing HBsAg or anti-HBc, and prophylaxis with nucleoside analog is now common. In a study from Spain,[8] patients who were both HBsAg-positive and who did not receive prophylaxis with lamivudine developed severe reactivation after treatment with infliximab, whereas no patient given lamivudine prophylaxis during infliximab therapy developed reactivation.

Organ Transplantation and HBV Reactivation

Solid organ transplantation usually requires long-term moderate-to-severe immune suppression to prevent rejection and, consequently; is a setting for occurrence of HBV reactivation in susceptible patients. Before the introduction of antiviral prophylaxis, the rates of HBV reactivation after renal transplantation ranged from 50%-94%.[10,37-39] Reactivation was frequently subclinical and resulted in chronic hepatitis rather than acute reactivation episodes. For this reason, the frequency and consequences of HBV reactivation were often overlooked. A similarly high rate of reactivation occurs after heart transplantation.[11] Rates of reverse seroconversion after kidney and heart transplantation have not been well defined, but may be rising in recent years with the use of more potent antirejection regimens.[10] Currently, patients evaluated for heart, lung, and kidney transplantation are routinely tested for HBsAg and anti-HBc and, if positive, considered for antiviral prophylaxis and long-term antiviral treatment.[40] At issue is the long-term benefit of this approach and whether antiviral therapy must be continued indefinitely.

Liver transplantation offers a special and somewhat confusing example of reactivation. Because the infected liver is removed at transplantation, the reappearance of HBsAg and HBV DNA afterwards in HBV-infected transplant recipients is considered reinfection rather than reactivation. Reinfection is almost universal after liver transplantation in patients who are HBsAg-positive, but can be reliably prevented by appropriate use of hepatitis B immune globulin and antiviral therapy.[40,41] Reinfection after liver transplantation for patients with anti-HBc without HBsAg appears to be uncommon, and such patients are usually not given immunoprophylaxis or long-term therapy.[41]

Reactivation in the setting of liver transplantation occurs when the organ donor rather than recipient is positive for HBsAg or, more frequently, for anti-HBc. Indeed, the most dramatic examples of reverse seroconversion occur with the transplantation of a liver from a donor with anti-HBc without HBsAg into a recipient without HBV infection.[14,42-46] Retrospective analyses indicate that approximately 70% of such transplants result in HBV infection in the recipient and almost always results in chronic infection which can be progressive and severe.[14]

Table 2. Different Causes and Forms of HBV Reactivation

Spontaneous
Progressive Immunodeficiency (HIV Infection)
Sudden Withdrawal of Antiviral Therapy
Cancer Chemotherapy
Immunosuppression for Autoimmune or Allergic Conditions
Solid Organ Transplantation (Kidney, Heart, Lung)
Liver Transplantation (Reactivation in Graft)
Bone Marrow Transplantation

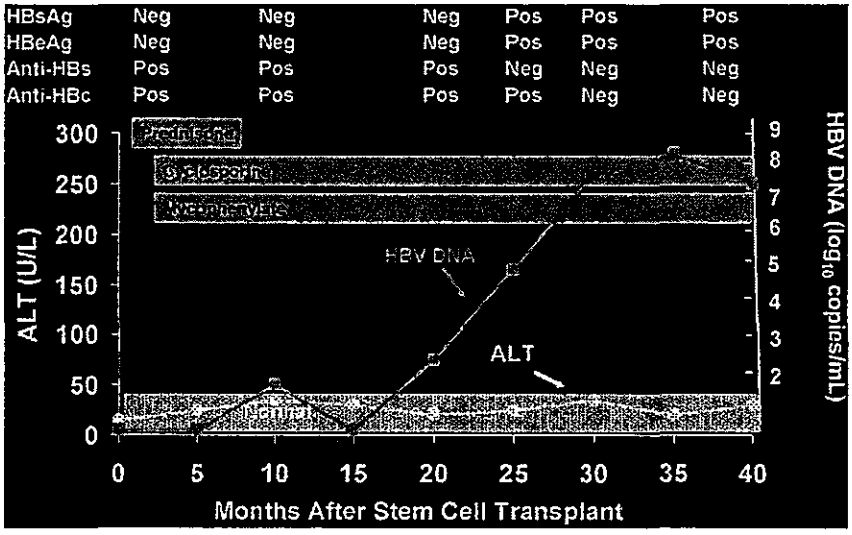

Fig. 3. Reverse seroconversion occurring 20 months after successful bone marrow transplantation for chronic myelogenous leukemia in a patient who was HBsAg-negative but anti-HBs-positive and anti-HBc-positive before transplant. Levels of anti-HBs and anti-HBc fell during 16 months after transplantation, and HBV DNA arose shortly thereafter. HBsAg was detected once HBV DNA levels rose above 1000 copies/mL. The patient required continued immunosuppression with prednisone, cyclosporine, and mycophenylate mofetil for graft-versus-host disease. Serum ALT levels remained normal. Modified from Knoll et al.[12]

The reappearance of hepatitis B in the recipient of a liver donor with serological evidence of recovery from hepatitis B (anti-HBc with or without anti-HBs in the absence of HBsAg) indicates that HBV can become latent and that virus with replicative capabilities remains in the liver in patients who have recovered from hepatitis B. Indeed, blood from such donors can be infectious for hepatitis B,[47] and persons who have recovered from acute or chronic hepatitis B have been shown to harbor HBV DNA in liver despite absence of active liver disease or presence of HBsAg or HBV DNA in serum.[48-50]

For these reasons, donors with anti-HBc (even without HBsAg) are not used in liver transplantation, unless they are given to patients undergoing transplantation for hepatitis B (and thus who will receive antiviral prophylaxis) or are given with informed consent to a patient who receives long-term prophylaxis with an antiviral agent.[40,41] Reactivation can be prevented by prophylactic antiviral therapy in this situation, but the long-term efficacy and safety of this latter approach have yet to be fully documented.[51-55]

Bone Marrow Transplantation and HBV Reactivation

Perhaps the most dramatic examples of HBV reactivation have been described in patients undergoing bone marrow transplantation. In typical allogeneic bone marrow transplantation, the recipient bone marrow is ablated using high doses of chemotherapy and then replaced by the infusion of donor marrow from someone who may or may not have immunity to hepatitis B. Thus, bone marrow transplantation represents the most extreme form of immune suppression/ablation. Reactivation of hepatitis B is almost universal among patients with HBsAg undergoing bone marrow transplantation.[56,57] In addition, reverse seroconversion is common, although it is often not detected or is misdiagnosed.[12,13,58-60] In retrospective analyses using sensitive serological and virological markers, a high proportion of persons with anti-HBc without HBsAg in serum redeveloped HBV DNA and HBsAg after bone marrow transplantation, occurring in three of six patients (50%) in a study from Germany[12] and in seven of 14 patients (50%) in a study from Japan.[13] Serial testing demonstrated that the bone marrow recipients gradually lost anti-HBs reactivity, with levels of antibody falling to undetectable between 1 and 3 years after transplantation. With loss of anti-HBs (and anti-HBc), HBV DNA appeared and levels increased; once HBV DNA levels rose above ~1000 copies/mL (~200 IU/mL), HBsAg typically appeared in the serum (Fig. 3). In the case series, most patients did not develop clinically apparent hepatitis, but among those with clinically apparent disease, fatalities are not infrequent. Importantly, reactivation and particularly reverse seroconversion usually occurred late, between 1 and 3 years after the bone marrow transplantation, and further follow-up may show that a higher proportion of patients would eventually become infected. Because of multiple publications of fatal instances of reverse seroconversion after bone marrow transplantation, current recommendations are for all potential marrow recipients to be tested for HBsAg, anti-HBs, and anti-HBc and patients with HBV markers should receive antiviral prophylaxis. Although this approach appears to be effective, the late development of reactivation after bone marrow transplantation suggests that long-term, if not lifelong, antiviral prophylaxis may be necessary.[61-66]

Spontaneous Reactivation

Chronic hepatitis B is a dynamic condition, and patients with inactive infection (the inactive HBsAg carrier state) can revert spontaneously to the immune-active

phase with reappearance of high levels of HBV DNA and disease activity.[67-69] Indeed, a not uncommon pattern of disease in patients with HBeAg-negative chronic hepatitis B is a relapsing course with periods of normal alanine aminotransferase (ALT) levels and no or low levels of HBV DNA followed by acute episodes of marked ALT elevations and HBV DNA detectability.[70] This pattern represents recurrent HBV reactivation and can present in a fashion resembling acute viral hepatitis[71,72] and appears to have a high likelihood of resulting in cirrhosis.[69,70] Spontaneous reactivation of chronic hepatitis B is often misdiagnosed,[73] yet this pattern of disease activity has been found to be quite responsive to antiviral therapy with nucleoside analogs which block the episodic flares of disease.[70]

Reactivation of Hepatitis B in HIV-Infected Patients

The progressive immunodeficiency that accompanies chronic infection with HIV can lead to reactivation in patients with chronic HBV infection and reverse seroconversion in patients with anti-HBc without HBsAg in serum. Testing of stored serum specimens from patients with HIV infection followed in clinical research cohorts has identified several instances in which anti-HBs reactivity is gradually lost and HBsAg with HBV DNA and ALT elevations appears.[74-76] Many of the antiretroviral agents used to treat HIV infection also have activity against HBV, and in several instances, patients have had sudden exacerbation of chronic hepatitis B when HIV medications are adjusted and drugs with activity against HBV (lamivudine, tenofovir, emtricitabine) are discontinued.[77] A similar severe flare in hepatitis that is potentially fatal can occur in HIV-uninfected individuals who abruptly stop lamivudine therapy.[78] For these reasons, patients with HIV infection should be tested for HBV markers and patients with HBsAg and/or anti-HBc should not be switched away from agents with anti-HBV activity.

Prevention of Reactivation

Controlled clinical trials[79,80] and several subsequent meta-analyses[15,81,82] have shown that prophylaxis with nucleoside analogs (most commonly lamivudine) decreases the incidence of HBV reactivation and the frequency of clinical hepatitis and death from HBV-associated liver injury in patients undergoing cancer chemotherapy. Initiating therapy once reactivation has occurred is typically done for control subjects in these trials and appears to be ineffective.

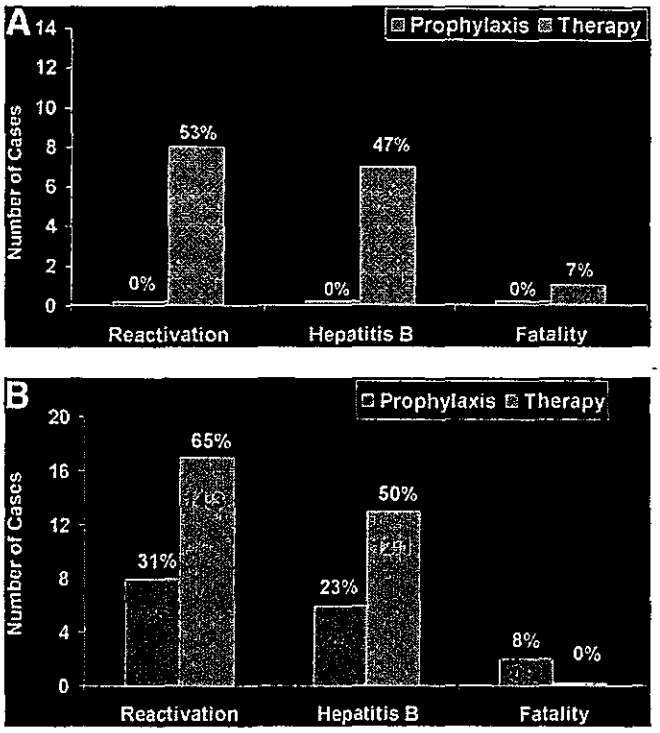

Fig. 4. Rates of HBV reactivation, hepatitis, and fatal hepatitis in two prospective, randomized controlled trials of prophylactic versus delayed (therapeutic) lamivudine in patients with malignant lymphoma undergoing cancer chemotherapy. (A) Study from Hong Kong in 30 patients.[79] (B) Study from Taiwan in 52 patients[80]: numbers in the horizontal bars represent number of cases that arose during the period of prophylaxis versus number of cases that arose afterward.

There have been two prospective, randomized controlled trials of lamivudine prophylaxis against HBV reactivation in patients with HBsAg who were undergoing chemotherapy for malignant lymphoma. Both studies were conducted in Asia, one from Hong Kong[79] and one from Taiwan.[80] Both studies enrolled HBsAg-positive patients only (not those with anti-HBc without HBsAg) who were scheduled to undergo chemotherapy for previously untreated lymphoma. In the study from Hong Kong,[72] 30 patients were enrolled and randomized to receive prophylactic lamivudine (100 mg daily starting 1 week before chemotherapy and stopping 6 weeks after completion of the last cycle of chemotherapy) or lamivudine treatment only if reactivation were documented to occur. Reactivation was defined by a 10-fold rise of serum HBV DNA levels and "hepatitis" was defined by a threefold increase in ALT levels in patients with HBV reactivation. Reactivation occurred in eight of 15 control subjects (53%) but 0 of 15 patients given lamivudine prophylactically ($P = 0.002$) (Fig. 4A). Seven of the eight instances of HBV reactivation were accompanied by hepatitis (88%), two were icteric (25%), and one was fatal (12%).

A second study was recently published from Taiwan[80] which employed a similar design, and, indeed, was discontinued early because of the results of the study from Hong Kong. In this multicenter trial, 52 HBsAg-positive patients with newly diagnosed non-Hodgkin's lymphoma were randomized to receive either prophylactic or therapeutic lamivudine. The prophylactic group received 100 mg daily starting 1 week before chemotherapy and continuing for 2 months after completion of chemotherapy. The therapeutic group received lamivudine if serum ALT levels rose during therapy. Definitions of HBV reactivation (1 $\log_{10}$ rise in HBV DNA levels) and hepatitis (three-fold rise in ALT levels) were similar in the two studies. Among 26 patients receiving lamivudine prophylactically, only three (12%) developed HBV reactivation while on therapy compared to 14 of the 25 control patients (56%) ($P = 0.002$). Most control patients with HBV reactivation also fulfilled criteria for hepatitis (82%), and five patients developed jaundice. In contrast, the cases of reactivation in the prophylactic group were mild and were not accompanied by jaundice. Two of the patients who developed reactivation despite lamivudine therapy were found to harbor lamivudine-resistant HBV which had not been detected before therapy. Most importantly, HBV reactivation and hepatitis were also common after therapy was stopped, occurring in similar proportions of the prophylactic (19%) and the therapeutic (14%) groups (Fig. 4B). In addition, cases of reactivation occurring after prophylactic therapy tended to be clinically apparent: three patients developed jaundice and two died of liver failure.

Thus, both studies clearly demonstrated that prophylactic lamivudine decreased the rate of HBV reactivation and hepatitis; however, the larger trial from Taiwan, which had a more rigorous design and follow-up, demonstrated that HBV reactivation is not completely eliminated by prophylactic lamivudine treatment, perhaps because of development of lamivudine resistance, and that continuation of therapy for 2 months after stopping chemotherapy was not adequate to prevent delayed reactivation.

Prospective trials of antiviral prophylaxis have not been performed in other situations with high risk for HBV reactivation (bone marrow transplantation, solid organ transplantation, HIV infection, immune modulation for autoimmune conditions), but small case series with historical controls indicate that reactivation appears to be decreased, if not eliminated, if prophylaxis is provided.[8,83-87] Given the safety and tolerability of current nucleoside analogs for hepatitis B and given that prophylaxis against reactivation of hepatitis B appears to be effective, it would seem appropriate to recommend its application widely. Indeed, clinical guidelines from expert groups in Asia, Australia, Europe, Canada, and the United States all recommend prophylaxis against reactivation of hepatitis B in high-risk situations.[88-91]

Conclusions and Recommendations

Reactivation of HBV is a common occurrence after immune suppression and can be clinically severe and result in death from acute liver failure or progressive liver disease and cirrhosis. HBV reactivation can be prevented in some instances by prophylactic use of antiviral agents. Nevertheless, it is difficult to make rigorous recommendations regarding the prevention and control of HBV reactivation. Issues include: which patients should be screened for evidence of hepatitis B before starting immune suppression or chemotherapy? Should screening tests include both HBsAg and anti-HBc? Which patients should be offered prophylaxis against reactivation? Which antiviral agent should be used? And for how long? Using what tests to monitor therapy for both efficacy and safety?

Recommendations regarding reactivation have been published by several academic societies[88-90] and by the Centers for Disease Control and Prevention,[91] but the recommendations differ and are frequently complex and require special expertise or knowledge about hepatitis B and its risk factors and serology. Based on the current literature about reactivation as well as the realization that chemotherapeutic and immunosuppressive regimens continue to evolve and have become more rigorous and aggressive with newer immunosuppressive agents and regimens, simple recommendations can be made, although not all are convincingly supported by medical evidence.

All patients who are to undergo cancer chemotherapy, marked immunosuppressive treatments or solid organ or bone marrow transplantation should be screened for evidence of ongoing or previous hepatitis B (for HBsAg and anti-HBc).

Persons found to be HBsAg-positive should be evaluated for indications for therapy of hepatitis B and, if found to warrant treatment, started on appropriate therapy before starting cancer chemotherapy or immune suppression. Such therapy should continue for the duration of chemotherapy and for as long as dictated by the chronic hepatitis B.

Persons found to have the inactive HBsAg carrier state or immune-tolerant chronic hepatitis B should receive antiviral prophylaxis before starting chemotherapy or immune suppression.

Persons found to have anti-HBc without HBsAg in serum should be considered for antiviral prophylaxis if they are scheduled for organ or bone marrow transplan-

tation or if aggressive or prolonged chemotherapy or immune suppression is planned.

Prophylaxis against HBV reactivation should continue for at least 6 months after stopping chemotherapy. In situations in which immune suppression is continued for the long term, long-term prophylaxis should be considered.

Although lamivudine or adefovir may be adequate for short-term prophylaxis, antiviral nucleoside analog with a higher barrier to resistance should be considered for patients in whom long-term prophylaxis is likely, particularly if high levels of HBV DNA are present before immune suppressive therapy.

Needs for Future Research

The complexity of reactivation of hepatitis B and the many issues surrounding its management call for prospective studies of its incidence, pathogenesis, treatment, and prevention. At present, recommendations have to be based on our understanding of reactivation, uncontrolled observations, and limited studies of its prevention. Because the oral nucleoside analogs active against hepatitis B are relatively potent and are well tolerated, prevention is easy to recommend. More difficult is to decide when to stop therapy and how to monitor patients before or during prophylaxis. Although future controlled studies of prophylaxis versus no prophylaxis are not warranted, controlled trials of different approaches to prophylaxis are reasonable and would provide valuable information. Thus, prospective clinical trials might compare the efficacy of lamivudine versus entecavir or tenofovir, or evaluate discontinuation of prophylaxis at 2 versus 12 months after stopping chemotherapy. Studies of nonliver organs from donors with anti-HBc without HBsAg might be developed that compared limited, short-term prophylaxis to continued antiviral therapy. These studies should include careful virological analyses and ancillary studies directed at elucidating the nature of HBV latency, factors that lead to an increase in HBV replication and liver cell injury, and features of the innate and adaptive immune system that lead to immune clearance of HBV after acute reactivation.

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医薬品 研究報告 調査報告書

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研究報告の概要

○日本のB型肝炎ウイルス(HBV)陽性供血者のHBV genotypeの年齢、性別特異的な分布

背景:日本の急性・慢性HBV感染患者において、B型肝炎ウイルス(HBV)genotype分布の報告が増加しているが、供血者のHBV genotypeについての報告はほとんどない。B型肝炎表面抗原(HBsAg)陽性供血者のHBV genotypeを感染患者と比較するために、すべてのHBsAg陽性供血者のgenotypeを決定した。

試験デザインおよび方法:2006年10月～2007年9月の日本の供血者のデータを、日本赤十字社のデータベースから入手した。利用可能な検体数は1979検体であり、1887検体でHBV genotypeを決定した。HBVの6つの主要genotype(A-F)を、酵素結合免疫吸着検定法を用いて調べた。HBsAg陽性ドナー全員について、抗HBVコア抗原IgM抗体の有無を酵素免疫測定法を用いて調べた。

結果:ドナーと患者の間のHBV genotype分布に関する有意差はC/B遺伝子型比率でみられた。比率は供血者(2.0～3.9)で低く、患者(5.3～18.2)で高かった。genotype Bの比率は、10代のドナーの13.8%から50歳台の42.4%まで増加するが、genotype C比率の差は、10代ドナーの83.1%から50代では55.1%に減少する。抗HBVコア抗原IgM抗体および核酸増幅検査陽性供血者において、genotype AとBは男性のドナーに限定された。

結論:日本の供血者において、HBV遺伝子型の年齢特異的な分布が、genotype C/Bの比で観察された。米国または西欧諸国を起源とするHBV genotype Aの性別特異的分布が、日本の男性ドナーに観察された。

使用上の注意記載状況・その他参考事項等

クロスエイトM250
クロスエイトM500
クロスエイトM1000
クロスエイトM静注用250単位
クロスエイトM静注用500単位
クロスエイトM静注用1000単位

血液を原料とすることに由来する感染症伝播等
vCJD等の伝播のリスク

報告企業の意見	今後の対応
日本のHBsAg陽性供血者においてHBV遺伝子型の分布を調べたところ、genotype Cは若年層で、Bは中高年層でより多く、genotype Aはほとんどが男性供血者であったとの報告である。これまで、本剤によるHBV感染の報告はない。また本剤の製造工程には、平成11年8月30日付医薬発第1047号に沿ったウイルス・プロセスバリデーションによって検証された2つの異なるウイルス除去・不活化工程が含まれている。さらに最終製品についてHBV-NAT陰性であることを確認しており、安全性は確保されていると考える。	特別な対応を必要としないが、HBV感染に関する新たな知見等について今後も情報の収集に努める。

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