INTRODUCTION

Hepatitis B virus (HBV) and hepatitis C virus (HCV) are major public health problems worldwide, including in Thailand. Infected patients may progress to chronic liver disease, liver cirrhosis and hepatocellular carcinoma. HBV and HCV are found in blood and secretions, and are transmitted vertically and horizontally, such as by sexual contact, blood transfusion or organ transplantation (Burra, 2009; Liang, 2009; Liaw, 2009; Marcellin, 2009; Myrmel et al, 2009; Thomson, 2009). HBV and HCV are common transfusion-transmitted infections (TTI) in Thailand and thus, screening of blood donors plays an important part in the prevention of TTI (Liu et al, 2006; Dodd et al, 2009). The Ministry of Public Health has recommended universal HBV vaccination of newborns as part of the expanded program on immunization (EPI) since 1992 (Poovorawan et al, 2000). There is no vaccine for HCV (Burra, 2009; Myrmel et al, 2009; Thomson, 2009). This report describes HBV and HCV prevalence among Thai new blood donors who participated in the screening program conducted at the National Blood Center.
Blood donor screening program comprises donor self selection, general examination by health care providers, blood screening test and record collection. The donor ages range from 17 to 70 years old (NBC, 1989; Kunanusoon, 1991; NBC, 2009). Since 1985, all blood donations have been obtained from volunteers. Prisoners were excluded in 1986. Donor self selection is based on a screening questionnaire aimed at excluding donors at high risk for TTI: promiscuity without taking precautions, sex workers, homosexual men, prisoners, tattooing, and recipients of blood transfusion from donors (NBC, 1989; Kunanusoon, 1991; NBC, 2009). Until recently, serological techniques were applied for routine blood screening by the National Blood Center, Thai Red Cross Society. The HBV marker was HBsAg whereas the HCV marker was anti-HCV. Evolution of the screening test is shown in Fig 1. The reliability of these tests is limited since they do not detect viruses during the window.

Fig 1–Evolution of blood screening test at the National Blood Center, Thai Red Cross Society.

Serology test: RPHA, reverse passive hemagglutination; ELISA, enzyme-linked immunosorbent assay; EIA, enzyme immunoassay; CLIA, chemiluminescent immunoassay; NAT, nucleic acid amplification technology.

(NBC), Thai Red Cross Society, Bangkok, Thailand from 1988 to 2009.

BLOOD DONOR SCREENING PROGRAM

The blood donor screening program comprises donor self selection, general examination by health care providers, blood screening test and record collection. The donor ages range from 17 to 70 years old (NBC, 1989; Kunanusoon, 1991; NBC, 2009). Since 1985, all blood donations have been obtained from volunteers. Prisoners were excluded in 1986. Donor self selection is based on a screening questionnaire aimed at excluding donors at high risk for TTI: promiscuity without taking precautions, sex workers, homosexual men, prisoners, tattooing, and recipients of blood transfusion from donors (NBC, 1989; Kunanusoon, 1991; NBC, 2009). Until recently, serological techniques were applied for routine blood screening by the National Blood Center, Thai Red Cross Society. The HBV marker was HBsAg whereas the HCV marker was anti-HCV. Evolution of the screening test is shown in Fig 1. The reliability of these tests is limited since they do not detect viruses during the window.
Period nor occult hepatitis. The window period of HBV and HCV infections constitutes the acute phase of infection during which serological markers cannot be detected. Occult hepatitis has been described with both HBV and HCV. During the occult HBV stage, infected patients test negative for HBsAg irrespective of the presence or absence of HBV antibodies (anti-HBc and/or anti-HBs). Nevertheless, HBV DNA is present in the liver. A negative test result for HBsAg may be due to a low HBsAg titer, escape mutants of the surface gene region or, insufficient sensitivity of the screening tests (Allain, 2004; Liang, 2009; Ozaslan and Purnak, 2009). Anti-HBc is detected in many occult HBV patients but is not used for routine blood screening because Thailand is an area endemic for HBV and adults born prior to HB vaccine integration into the EPI display a high prevalence of anti-HBc. Occult HCV infection is characterized by a diseased liver and HCV RNA in peripheral blood mononuclear cells irrespective of the detection of HCV RNA in the serum, anti-HCV detection and/or abnormal liver enzyme levels (Carreño et al, 2009; De Marco et al, 2009; Pham et al, 2010). Virus detection in serology negative/NAT positive blood samples is depicted in Table 1. The window period and occult hepatitis cannot be discriminated from each other by this screening program. Further investigation is required to confirm the diagnosis by establishing a complete serologic profile and blood donor follow-up. The Chiron Procleix Ultrio test (Gen-Probe, San Diego, CA) on the TIGRIS platform (Chiron, Emeryville, CA) was used as the routine NAT in 2006. Subsequently, the Roche cobas TaqScreen Multiplex (MPX) test (Roche Molecular Systems, Branchburg, NJ) on the cobas s201 platform (Roche Instrument Center, Rotkreuz, Switzerland) was introduced to the National Blood Center, Thai Red Cross Society. Evaluation of both tests was performed in 2007. The result of one study showed both these tests are acceptable as routine screening tests for TTI (Phikulsod et al, 2009) (Table 2). Upon analyzing cost-effectiveness, the routine NAT was abandoned in favor of the Roche cobas TaqScreen Multiplex (MPX) test (Roche Molecular Systems, Branchburg, NJ) on the cobas s201 platform (Roche Instrument Center, Rotkreuz, Switzerland) in 2008.

EXPANDED PROGRAM ON IMMUNIZATION OF HBV VACCINE

The HBV vaccine was approved by the US Food and Drug Administration in 1982 (CDC, 1982). Plasma derived hepatitis B and recombinant yeast derived vaccines have been used in Thailand for more than 25 years. Both vaccines have proven highly effective in preventing HBV infection, including in high risk neonates born to carrier...
mothers. The plasma derived vaccine has become obsolete. Many reports show HBV vaccination reduces the HBV carrier rate in the general population (Zanetti et al, 2008; Liang et al, 2009a, b; Ni and Chen, 2010; Park et al, 2010). The most effective way to reduce the carrier rate in the population is with mass vaccination of newborns with HBV vaccine at birth. In 1988, the universal HBV vaccination program for newborns in Thailand was started. A pilot project was performed in 2 provinces: Chiang Mai and Chon Buri. The program was expanded to include 10 additional provinces in 1990 and was expanded to nationwide vaccination in 1992 (Chunsuttiwat et al, 1997; Poovorawan et al, 2000; Jutavijittum et al, 2005). The HBV vaccine is recommended to be administered to all newborns at 0, 1-2, and 6 months. Hepatitis B immunoglobulin (HBIG) was added for newborns of HBV carrier mothers. The combined HBV and DTP vaccine (DTP-HB) was included in the EPI in 2007. The alternative dose administration recommended for newborns is at 0, 2, 4 and 6 months (Bureau of General Communicable Disease, 2004, 2005, 2007, 2008; Tharmaphornpilas et al, 2009). To reduce HBV carrier status in high risk newborns an additional monovalent HB vaccine was added at one month for newborns with HBsAg positive mothers (Tharmaphornpilas et al, 2009). National vaccine coverage of HBV increased from 77.4% in 1994 to 98.3% in 2005 (Table 3) (Bureau of General Communicable disease, 2004, 2005, 2007, 2008; Tharmaphornpilas et al, 2009). The prevalence of HBsAg in the general population had declined to 4% in 2004. In comparison with children born prior to the EPI, those born after the EPI have a lower HBV carrier rate (Chongsrisawat et al,

### Table 2
Comparison of nucleic acid amplification technologies (NAT).

<table>
<thead>
<tr>
<th>Test</th>
<th>Technique</th>
<th>Lower limit of detection a (IU/ml)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiron TIGRIS/Procleix Ulitio</td>
<td>Individual sample</td>
<td>HBV 10  HCV 3</td>
<td>&gt;95</td>
<td>99.9</td>
</tr>
<tr>
<td>Roche Cobas s 201/Cobas</td>
<td>Pooled sample (1:6)</td>
<td>HBV 3  HCV 10</td>
<td>&gt;95</td>
<td>99.9</td>
</tr>
</tbody>
</table>

\*Lower limit of detection, sensitivity and specificity were evaluated by the National Blood Center, Thai Red Cross Society; the serology test served as the gold standard.

### Table 3
National HBV vaccine coverage in Thailand.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>77.4</td>
<td>88</td>
<td>93.4</td>
<td>95.4</td>
<td>96</td>
<td>98.3</td>
</tr>
</tbody>
</table>
Prevalence of HBV and HCV in Thai new blood donors during 2000-2009, n (%) 

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>66,340</td>
<td>70,139</td>
<td>73,017</td>
<td>82,818</td>
<td>96,720</td>
<td>84,875</td>
<td>92,460</td>
<td>96,773</td>
<td>84,216</td>
<td>89,311</td>
<td></td>
</tr>
</tbody>
</table>

Type of coinfection

<table>
<thead>
<tr>
<th>Coinfection</th>
<th>2000 (n)</th>
<th>2001 (n)</th>
<th>2002 (n)</th>
<th>2003 (n)</th>
<th>2004 (n)</th>
<th>2005 (n)</th>
<th>2006 (n)</th>
<th>2007 (n)</th>
<th>2008 (n)</th>
<th>2009 (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBV/HCV</td>
<td>31 (0.047)</td>
<td>33 (0.047)</td>
<td>38 (0.052)</td>
<td>33 (0.040)</td>
<td>42 (0.043)</td>
<td>26 (0.031)</td>
<td>30 (0.032)</td>
<td>19 (0.020)</td>
<td>15 (0.018)</td>
<td>21 (0.024)</td>
</tr>
<tr>
<td>HBV/HIV</td>
<td>25 (0.038)</td>
<td>10 (0.014)</td>
<td>11 (0.015)</td>
<td>23 (0.028)</td>
<td>22 (0.023)</td>
<td>21 (0.025)</td>
<td>19 (0.021)</td>
<td>22 (0.023)</td>
<td>20 (0.024)</td>
<td>13 (0.015)</td>
</tr>
<tr>
<td>HCV/HIV</td>
<td>32 (0.048)</td>
<td>41 (0.059)</td>
<td>28 (0.038)</td>
<td>31 (0.037)</td>
<td>46 (0.048)</td>
<td>20 (0.024)</td>
<td>19 (0.021)</td>
<td>19 (0.020)</td>
<td>6 (0.007)</td>
<td>11 (0.012)</td>
</tr>
<tr>
<td>HBV/HCV/HIV</td>
<td>1 (0.002)</td>
<td>2 (0.003)</td>
<td>6 (0.008)</td>
<td>3 (0.004)</td>
<td>1 (0.001)</td>
<td>1 (0.001)</td>
<td>1 (0.001)</td>
<td>0 (0)</td>
<td>1 (0.001)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
donors, such as HBV/HCV, HBV/HIV, HCV/HIV and HBV/HCV/HIV (Table 4). Various factors explain the reduction in HBV prevalence. First, Thailand has an effective HBV immunization program and nearly all newborns have received HBV vaccine since 1992; thus, HBV prevalence in the community has drastically declined. Second, several techniques of blood donor screening have been applied to detect infected donors. Finally, all blood donors of the National Blood Center, Thai Red Cross Society have been safe volunteer blood donors since 1987. Blood donor recruitment and screening for HCV is similar to HBV, but HCV prevalence has reduced at a slower rate due to the higher risk of chronic infection and lack of a HCV vaccine. Over the past two decades, blood screening programs and prevention of blood-borne infections in the general population have improved, which eventually may lead to reduced HCV prevalence in new blood donors.

CONCLUSION

Thailand is an area endemic for HBV and HCV. Infected blood donors cause TTI in recipients which may lead to serious complications, such as acute hepatitis, chronic hepatitis, liver cirrhosis and hepatocellular carcinoma. An effective screening program for blood donors is essential to decrease TTI. In order to decrease HBV and HCV prevalence in new blood donors HBV and HCV prevalences have to be reduced in the community.

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REFERENCES

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