

# PREVALENCE AND EPIDEMIOLOGY OF HEPATITIS B

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Links:

Chapter 5: Primary prevention of hepatitis B virus infection

Chapter 9: Hepatitis B virus-related hepatocellular carcinoma

## KEY POINTS

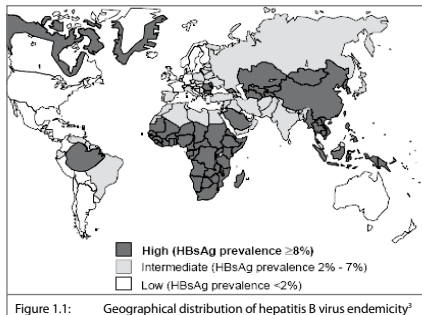
- There is an estimate of 90,000 to 160,000 people with HBV chronic infection in Australia.
- Immigrants from highly endemic countries, such as China, Vietnam and other countries in Asia and Pacific Islands, account for more than a half of chronic HBV infections.
- Higher rates of chronic HBV infection are also observed in Indigenous populations, injecting drug users and men who have sex with men.
- HBV vaccination uptake in at-risk populations and HBV treatment uptake among infected populations are both low.
- A National Hepatitis B Strategy encompassing public awareness campaigns, guidelines for HBV testing and counselling, and strategies to increase treatment uptake is required to develop an appropriate response to hepatitis B in Australia.

## Hepatitis B virus disease epidemiology worldwide

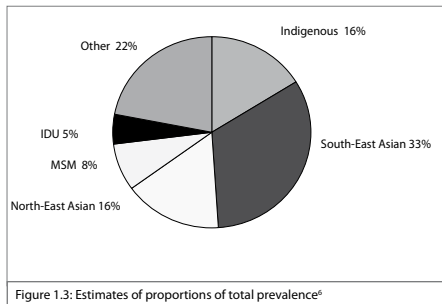
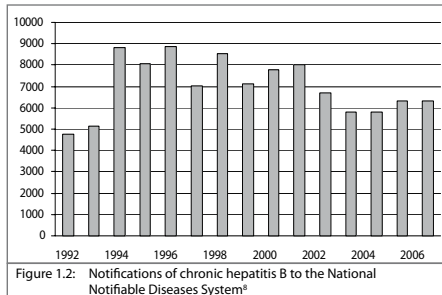
Hepatitis B virus (HBV) infection remains a major global public health problem, despite the availability of a highly effective vaccine and improvements in antiviral therapy. Globally, of the two billion people previously infected, more than 350 million people have developed chronic HBV infection, causing one million HBV-related deaths each year.<sup>1</sup> HBV infection varies according to geography, with chronic HBV prevalence ranging from 0.2% to 20%.<sup>2</sup> Approximately 45% of the world's population lives in highly endemic areas, such as Africa and the Asia-Pacific region (excluding Japan, Australia and New Zealand) (Figure 1.1).<sup>3</sup>

## HBV prevalence in Australia and the impact on its health system

The prevalence of chronic HBV infection in Australia has increased, predominantly related to the increase in immigration from highly endemic regions.<sup>4,5</sup> Based on a national laboratory-based serosurvey, the number of chronic HBV infection cases was estimated to be between 90,000 and 160,000, representing a 0.5–0.8% population prevalence.<sup>6</sup> A hospital-based study found

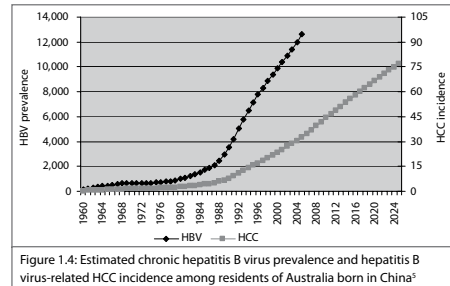


HBsAg prevalence of 2.1%, with 70% of patients with HBV infection born overseas.<sup>7</sup> Hepatitis B diagnosis requires mandatory notification in all Australian States and Territories. The annual number of hepatitis B cases reported to the National Notifiable Diseases Surveillance System varies from around 5000 in 1992 and 1993 to peaks of close to 9000 cases in 1994 and 1996, and around 6000 cases since 2003 (Figure 1.2).<sup>8</sup> The majority of people with chronic HBV infection come from four high-risk groups: immigrants from highly endemic countries (particularly North-East and South-East Asia); injecting drug users (IDUs); men who have sex with men (MSM); and Indigenous Australians (Figure 1.3).<sup>6</sup>



Chronic HBV infection in Australia is contributing to an increasing burden of advanced liver disease, including hepatocellular carcinoma (HCC).<sup>9-11</sup> HCC incidence and mortality rates have been increasing over the last three decades, particularly among overseas-born males.<sup>9,12,13</sup> Between 1978 and 1997, age-standardised HCC mortality rates increased from 2.4 to 4.4 per 100,000 for overseas-born males, and 0.6 to 1.4 per 100,000 for overseas-born females.<sup>12</sup>

In New South Wales, the incidence rate of liver cancer in males per 100,000 increased from 2.0 in 1972 to 7.4 in 2004, and in females from 0.5 in 1972 to 2.9 in 2004.<sup>14</sup> Despite the availability and efficacy of the HBV vaccine, the prevalence of chronic HBV infection and HBV-related HCC among Australian residents born in the Asia-Pacific region has been projected to increase in the next two decades. This is owed primarily to the continued immigration from highly endemic countries and the long latency of HCC development (Figure 1.4).<sup>5</sup>



The economic burden related to chronic HBV infection is substantial. The average annual direct cost per patient for managing HBV-related liver disease has been estimated at \$1778 for active hepatitis, \$1394 for compensated cirrhosis and \$11,753 for HCC (year 2001, A\$).<sup>15</sup>

## HBV prevalence in specific populations

### Culturally and linguistically diverse (CALD) communities

According to the 2001 census, 30% of the Australian population was born overseas, 24% of which was born in Asia, where HBV infection is highly endemic.<sup>16</sup> Although limited data are available on HBV infection patterns within CALD communities in Australia, it is likely that the HBV prevalence among immigrants reflects infection patterns in their countries of origin. Studies conducted in several countries have found that HBsAg prevalence among Asian immigrants and refugees is very similar to the HBsAg prevalence in their countries of origin.<sup>17-29</sup> For example, HBsAg prevalence among Vietnamese immigrants and refugees in several studies is 10.0–16.6%,<sup>17-22</sup> which reflects

the prevalence in population-based studies in Vietnam (10.0–19.5%).<sup>30–39</sup>

Immigration from highly endemic countries has been the major contributor to the increasing prevalence of chronic HBV infection in Australia. The five largest overseas-born population groups include people from highly HBV endemic countries, such as China and Vietnam.<sup>16</sup> An estimated 50–65% of chronic HBV infection cases in Australia occur in people born in Asia, particularly immigrants from China and Vietnam.<sup>6,40</sup> Overseas-born residents, particularly from Asia, are also more likely to develop HCC compared to those born in Australia.<sup>41</sup> A recent linkage study found that 70% of HBV-related HCC cases were in Asian-born residents, whose risk of developing HCC was estimated to be six times higher than those born in Australia.<sup>13</sup> Another study found that HCC incidence (per 100,000) for NSW male migrants who were born in mainland China, Taiwan, Hong Kong and Vietnam were 13.5 to 30.9, compared to 1.2 for Australian-born males.<sup>42</sup> Increased relative risks for HCC have also been found among Asian immigrants in other Western countries.<sup>43,44</sup> Likewise, Asian-born residents have a higher risk of dying from HCC than Australian-born residents.<sup>45</sup>

Immigrants from the Middle-East, the Mediterranean region and Africa also have a higher rate of HBV infection than the general Australian population. People from the Mediterranean region, the Middle East, the Pacific Islands and Africa constituted 18% of patients with chronic HBV infection in a liver clinic in Melbourne.<sup>6</sup> In another hospital-based study, the adjusted odds ratio of HBV infection was found to be six times higher in immigrants from North Africa, the Middle East and the Mediterranean region as compared to Australian-born residents.<sup>7</sup>

Meagre HBV knowledge, poor English literacy, and differences in health beliefs and practices are obstacles to health service access for CALD communities. Studies in the USA show that Vietnamese immigrants have poor HBV knowledge and low testing levels.<sup>46–48</sup> Low levels of HBV screening and vaccination and

poor knowledge have also been documented among Chinese ethnic populations in the USA and Canada.<sup>49,50</sup> Thus, an improved understanding of hepatitis B, particularly among immigrants from Asia-Pacific countries, together with an increased awareness of the need for HBV testing of high-risk groups among general practitioners and other primary health care practitioners is required.

## Aboriginal and Torres Strait Islander peoples

While Aboriginal and Torres Strait Islander peoples account for only 2.4% of the Australian population (2001 census), they account for 16% of chronic HBV infections.<sup>16,6</sup> The prevalence of HBsAg in the Aboriginal and Torres Strait Islander population ranges from 3.6% to 26.0%, according to place of residence and age group (Table 1.1).<sup>51–61</sup> HBsAg prevalence increases with age and is highest in people living in remote areas.<sup>52</sup> Despite the availability of the HBV vaccine and the implementation of 'catch-up' vaccine programs, a significant proportion of Aboriginal and Torres Strait Islander children are still at risk. A study in North Queensland in 2000 found that only 44% of Aboriginal and Torres Strait Islander teenagers had completed HBV vaccination.<sup>58</sup> More than 90% of the incompletely vaccinated teenagers had markers of HBV infection (anti-HBc positive), with 26% having active HBV infection (HBsAg positive). In addition, levels of HBV immunity, even among Aboriginal and Torres Strait Islander children fully vaccinated in infancy, have been shown to be sub-optimal.<sup>62,63</sup> Thus, poor vaccine coverage and low immune responses among Aboriginal and Torres Strait Islander children should be considered for the implementation of HBV control measures.

A higher risk of liver cancer among the Aboriginal and Torres Strait Islander population indicates a higher burden of chronic liver disease, including HBV.<sup>64</sup> The population-based incidence of HCC is five to ten times higher than in the non-Indigenous population.<sup>65</sup> The rate ratios of age-standardised liver cancer incidence between Indigenous and non-Indigenous Australians were 9.8 for males and

7.4 for females in the Northern Territory, and 5.7 for males and 10.0 for females in South Australia.<sup>66</sup> In one study, more than 60% of Aboriginal and Torres Strait Islander HCC cases were HBsAg positive, indicating that HBV is the major cause of HCC among Aboriginal and Torres Strait Islander people.<sup>65</sup>

Aboriginal and Torres Strait Islander people are not only at high risk of HBV infection, but also have difficulties in accessing health services. The major factors affecting Indigenous access are remote residence, lack of transport and shortage of health professionals. More than

a quarter of the Aboriginal and Torres Strait Islander population live in remote areas and 78% of remote Aboriginal and Torres Strait Islander communities are located more than 50km from the nearest hospital.<sup>67</sup> The number of medical practitioners, particularly specialist clinicians in remote areas is very low (29 per 100,000) compared to major cities (114 per 100,000).<sup>67</sup> Other factors, including cultural perceptions, low levels of education and limited private health insurance, are also barriers to accessing health services in Aboriginal and Torres Strait Islander communities.

Table 1.1: Prevalence of HBsAg in the Indigenous population in Australia<sup>51-61</sup>

References	Study population (N)	Study setting	Prevalence of HBsAg+ (%)
Burrell CJ et al. 1983 <sup>59</sup>	Aboriginal (327)	South Australia	26.0
Barrett EJ, 1972 <sup>60</sup>	Aboriginal adults (160) Aboriginal children (731) Torres Strait Islander adults (79)	Queensland	8.1 3.4 13.9
Barrett EJ, 1976 <sup>61</sup>	Aboriginal (2193)	Queensland and Northern Territory	6.1
Moore et al. 1987 <sup>51</sup>	Aboriginal women (816)	Non-metropolitan Western Australia	3.6
Holman et al. 1987 <sup>52</sup>	Aboriginal population aged 12 or older (1150)	Western Australia	7.0 (3.0-22.0)
Campbell et al. 1989 <sup>54</sup>	Aboriginal (375)	North-Western New South Wales	19.2
Gill et al. 1990 <sup>56</sup>	Aboriginal children (277)	Kimberley Western Australia	6.1
Campbell et al. 1991 <sup>53</sup>	Aboriginal children aged 0-16 years (408)	Western New South Wales	14.0
Gardner et al. 1992 <sup>57</sup>	Aboriginal children (439)	Northern Territory	8.2
Patterson et al. 1993 <sup>55</sup>	Aboriginal (98)	Condobolin New South Wales (urban)	16.9 (1983-1984) 6.0 (1987-1988)
Malcolm et al. 2000 <sup>58</sup>	Indigenous teenagers (132 incomplete vaccination)	North Queensland	26.0

## Injecting drug users

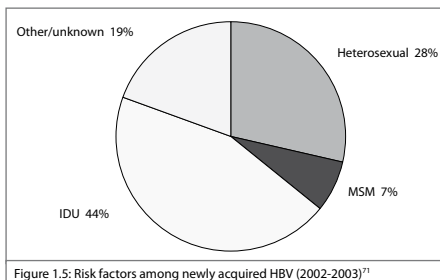
People who inject drugs are at high risk of HBV infection. An estimated 200,000 people inject drugs in Australia<sup>6</sup> and half of regular injecting drug users (IDUs) have markers of HBV infection (Table 1.2).<sup>68-70</sup> IDUs also contribute significantly to the number of newly acquired HBV cases in Australia (Figure 1.5).<sup>71</sup> The prevalence of HBsAg is considerably lower than that of anti-HBc (2% versus 40–50%),<sup>68,72</sup> due to high rates of spontaneous HBsAg clearance among adolescents and young adults, and explains the considerably lower proportion of IDU cases among the population with chronic HBV infection, compared to the population with newly acquired HBV infection in Australia (5% versus 44%). An estimated 4000 IDUs have chronic HBV infection.<sup>6</sup> A

similar pattern of HBV infection was found in prisoners, 44%–46% of whom are IDUs.<sup>70,73</sup> A third of prisoners have markers of HBV infection and around 3.0% are HBsAg positive (Table 1.2).<sup>68-70,72-76</sup> Notably, only 5% of prisoners reported having been immunised against HBV.<sup>73</sup> Long-term injecting, having been to prison, and injecting in prison are independently associated with HBV infection.<sup>70,76</sup>

Limited data are available on the prevalence of HBV-HCV coinfection in IDUs. One study of 360 IDUs found that 20% had markers of infection for both HBV and HCV (anti-HBc and anti-HCV antibody positive), while rates of chronic HBV-chronic HCV co-infection are considerably lower, at around 1–2%.<sup>76</sup>

Table 1.2: Prevalence and incidence of hepatitis B virus infection in injecting drug users and prisoners<sup>68-70, 72-76</sup>

References	Study population	Prevalence of anti-HBc (%)	Prevalence of HBsAg+ (%)	HBV infection incidence (per 100 person years)
Crofts N et al. 1994 <sup>68</sup>	IDUs	47.0	1.8	
Crofts N et al. 1997 <sup>69</sup>	IDUs	52.4		1.8
Cook PA et al. 2001 <sup>76</sup>	IDUs	26.6		
Maher L et al. 2004 <sup>72</sup>	IDUs	28.0	2.7	
Crofts N et al. 1995 <sup>73</sup>	Prisoners	32.5	2.6	12.6
Butler TG et al. 1997 <sup>74</sup>	Prisoners	31.0	3.2	
Butler TG et al. 1999 <sup>70</sup>	Prisoners	35.0		
Butler TG et al. 2005 <sup>75</sup>	Prisoners	31.0	3.0	



Poor knowledge of HBV infection, poor HBV vaccine uptake, and high-risk behaviours in IDUs all contribute to high levels of HBV exposure. At the time of a recent study, around a third (30–36%) of IDUs had reused injecting equipment in recent months.<sup>69,77</sup> HBV vaccination uptake and completion rates are low.<sup>78</sup> A recent national survey found that only a third of drug and alcohol agencies in Australia routinely provide HBV testing and vaccination onsite, and a quarter of the agencies did not offer this service at all.<sup>79</sup> In addition, the high stigma relating to injecting drug use often precludes

IDUs from accessing health services. Education about hepatitis B risk factors, increased access to HBV testing, and vaccination for IDUs are required to reduce the prevalence of HBV infection in this group.

### Men who have sex with men

The prevalence of HBV infection in MSM is higher than in the general population. During the 1980s, the prevalence of HBV infection among MSM ranged from 34.0% to 81.7%, while HBsAg prevalence was 3.0% to 8.7%.<sup>80-87</sup> In the USA, an estimated 15–20% of all new HBV infections are in MSM.<sup>88</sup>

Although an HBV vaccine has been available for two decades, coverage rates in MSM populations are low. Studies have demonstrated coverage rates of 9% in the United Kingdom, 25–26% in the USA, and 53% in Australia (Sydney).<sup>89-92</sup> A high prevalence of HBV infection is found among unvaccinated MSM: around 38.0% have markers of HBV infection and 4.2% are HBsAg positive.<sup>89,93</sup>

Factors associated with poor HBV vaccination coverage in MSM include a lack of knowledge of HBV infection and HBV vaccination, the high cost of vaccine, a low level of education and injecting drug use.<sup>94-96</sup>

Unsafe behaviours, such as reusing injecting equipment and unprotected sex, continue to be risk factors for HBV infection among MSM. The duration of sexual activity, the number of partners, oro-anal and genito-anal sexual contacts, the lifetime number of sexually transmissible infections, and injecting drug use are associated with HBV infection.<sup>89,92,97</sup>

The MSM population in Australia is estimated at 300,000 (including men who identify as gay or homosexual and men who identify as heterosexual but have some history of sexual contact with other men).<sup>98</sup> Due to the availability of a HBV vaccine and the increased adoption of safer sex practices, the prevalence of HBV infection among MSM decreased from 61% in 1982 to 38% in 1991.<sup>93</sup> However, ongoing high-risk behaviour<sup>99,100</sup> and low

rates of HBV vaccination as outlined in recent studies<sup>91</sup> suggest that MSM remain a high-risk population. Appropriate HBV vaccination strategies and education about the risk factors for HBV transmission are required in order to prevent infection among MSM.

### Increasing the burden of HBV-related liver disease

Since the 1970s, increased immigration from highly endemic HBV countries, particularly from the Asia-Pacific region, has produced an increasing prevalence of chronic HBV infection in Australia. Although population-level HBV vaccination programs in highly endemic HBV countries will eventually reduce the HBV prevalence among immigrants to Australia, the late introduction of these programs in many countries (e.g. in Vietnam and China in 2000) means the burden of chronic HBV infection is likely to continue to rise. This increasing burden of chronic HBV infection will produce an increasing incidence of advanced liver disease (including HCC) over the coming two decades. For example, among Australians of Chinese origin, the number of HBV-related HCC cases is projected to more than double over the period 2005 to 2025 (see Figure 1.4).<sup>5</sup> Similar trends are expected for other high-risk groups such as Vietnamese-born Australians. However, the improved uptake of HBV therapy has the potential to limit these trends.

### Public health response to hepatitis B

While effective national strategies for HIV and hepatitis C have been adopted, the public health response to HBV is very limited and relies predominantly on universal infant hepatitis B vaccination. The number of people with hepatitis B is projected to increase due to continuing immigration from high endemic countries and sub-optimal vaccine coverage among high-risk populations (IDUs, MSM, Aboriginal and Torres Strait Islander peoples). To reduce the impact of hepatitis B infection, a national strategy should be developed focusing on enhanced HBV prevention, education and improvement of diagnosis, treatment and care.

The implementation of hepatitis B prevention and education is crucial to increase public awareness of hepatitis B including the risk factors for transmission, measures for prevention, and the availability of therapy. These programs should be designed specifically for at-risk populations, such as CALD communities, the Aboriginal and Torres Strait Islander populations, IDUs, MSM, and prisoners.

The increasing number of people with chronic HBV infection and the improved availability of HBV therapy mandate an enhanced response to treatment and care. This response should include national guidelines for HBV diagnosis and monitoring. The establishment of community hepatitis clinics and the enhancement of GP shared-care models in areas with large Asian and Aboriginal and Torres Strait Islander populations is also a priority.

Finally, barriers to health care service access among IDUs, MSM, CALD and Aboriginal and Torres Strait Islander communities include stigma and discrimination related to high-risk behaviours, the lack of English proficiency, and cultural differences. Therefore, besides providing training and essential information related to hepatitis B for primary care practitioners, improving their understanding of health beliefs, language difficulties, and the cultural attitudes of affected populations is also crucial to facilitating access to health services for at-risk groups.

## References

- World Health Organization. Hepatitis B Fact sheet No 204. 2000 [Last accessed September 2006]; Available from: <http://www.who.int/mediacentre/factsheets/fs204/en/print.html>
- World Health Organization, Department of Communicable Diseases Surveillance and Response. Hepatitis B; 2002. Report No.: WHO/CDS/CSR/LYO/2002.2.
- World Health Organization. Introduction of hepatitis B vaccine into childhood immunisation services. Report No.: WHO/V&B/01.31.Geneva; 2001.
- Crawford DH, Fawcett J. Hepatocellular carcinoma in Australia: largely preventable. *Med J Aust* 2000; 173: 396-7.
- Nguyen VTT, Razali K, Amin J, Law MG, Dore GJ. Estimates and projections of hepatitis B-related hepatocellular carcinoma in Australia among people born in Asia-Pacific countries. *J Gastroenterol Hepatol* 2007. doi:10.1111/j.1440-1746.2007.05065.x
- O'Sullivan BG, Gidding HF, Law M, Kaldor JM, Gilbert GL, Dore GJ. Estimates of chronic hepatitis B virus infection in Australia, 2000. *Aust NZ J Public Health* 2004;28:212-6.
- Tawk HM, Vickery K, Bisset L, Lo SK, Selby W, Cossart YE. The current pattern of hepatitis B virus infection in Australia. *J Viral Hepat* 2006;13:206-15.
- National Notifiable Diseases Surveillance System (NNDSS). Number of notification of hepatitis B (unspecified). 2007 [Last accessed 22 May 2007]; Available from: [http://www9.health.gov.au/cda/Source/Rpt\\_4\\_sel.cfm](http://www9.health.gov.au/cda/Source/Rpt_4_sel.cfm)
- Roberts SK, Kemp W. Hepatocellular carcinoma in an Australian tertiary referral hospital 1975-2002: Change in epidemiology and clinical presentation. *J Gastroenterol Hepatol* 2007;22:191-6.
- McCaughan GW, Parsons C, Gallagher ND. An Australian experience of hepatitis B infection, cirrhosis and hepatocellular carcinoma. *Ann Acad Med Singapore* 1980;9:199-200.
- Bortolotti F, Jara P, Crivellaro C, Hierro L, Cadrobbi P, Frauca E, et al. Outcome of chronic hepatitis B in Caucasian children during a 20-year observation period. *J Hepatol* 1998;29:184-90.
- Law MG, Roberts SK, Dore GJ, Kaldor JM. Primary hepatocellular carcinoma in Australia, 1978-1997: increasing incidence and mortality. *Med J Aust* 2000;173:403-5.
- Amin, J., O'Connell, D., Bartlett, M., Tracey, E., Kaldor, J., Law, M. & Dore, G. (2007) Liver cancer and hepatitis B and C in New South Wales, 1990-2002: a linkage study. *Australian and New Zealand Journal of Public Health*, 31,475-482.
- NSW Central Cancer Registry. Liver cancer: age standardised incidence rates NSW. In. Sydney: NSW Central Cancer Registry, 2007.

15. Butler JRG, Pianko S, Korda RJ, Nguyen S, Gow PJ, Roberts SK, et al. The direct cost of managing patients with chronic hepatitis B infection in Australia. *J Clin Gastroenterol* 2004; 38 (suppl 3): S187-S192.
16. Australian Government. Department of Immigration and Multicultural and Indigenous Affairs (DIMIA). Population flows: Immigration aspects. 2004-05 edition. Canberra: Commonwealth of Australia, 2005.
17. Katsumata T, Kohno S, Yamashita K, Takeno Y, Matsunaga K, Oka R, et al. Health problems among Vietnamese refugees resettled in Japan. *Southeast Asian J Trop Med Public Health* 1993;24:647-53.
18. Skinhoj P, Aldershvile J, Black F, Kjersem H, Kryger P, Mathiesen L. Viral hepatitis in Southeast Asian refugees. *J Med Virol* 1981; 7:149-55.
19. Skinhoj P, Aldershvile J, Kjersem M, Black F. Hepatitis B infection in Vietnamese families. *J Med Virol* 1983;11:125-9.
20. Patel PA, Voigt MD. Prevalence and interaction of hepatitis B and latent tuberculosis in Vietnamese immigrants to the United States. *Am J Gastroenterol* 2002;97:1198-203.
21. Catanzaro A, Moser RJ. Health status of refugees from Vietnam, Laos, and Cambodia. *J Am Med Assoc* 1982;247:1303-8.
22. Banffer JR. Markers of hepatitis B in a group of Vietnamese boat-refugees in the Netherlands. *Trop Geogr Med* 1982;34:251-5.
23. Song E, Kew MC, Hwang LY, Beasley RP. Epidemiology of hepatitis B virus infection in South African Chinese. *Am J Epidemiol* 1988;128:828-38.
24. Goldenring JM, Castle GF. Prevalence of disease in Southeast Asian teenagers. Results of screening medical examination at a residential vocational training facility. *J Adolesc. Health Care* 1983;4:266-9.
25. Chaudhary RK, Nicholls ES, Kennedy DA. Prevalence of hepatitis B markers in Indochinese refugees. *Can Med Assoc J* 1981;125:1243-6.
26. Chadwick RG, Hall AJ, Davidson I, Bull FG, Wright R. Hepatitis B among Indochinese refugees in Great Britain. *Postgrad Med J* 1982;58:676-9.
27. Roussos A, Goritsas C, Pappas T, Spanaki M, Papadaki P, Ferti A. Prevalence of hepatitis B and C markers among refugees in Athens. *World J Gastroenterol* 2003;9:993-5.
28. Banffer JRJ, Brunings EA, Gielis-Proper FK, Schmitz PIM. The epidemiology of hepatitis B infections in a poly-ethnic population. *Am J Epidemiol* 1977;106:507-11.
29. Sutherland JE, Avant RF, Franz WB, Monzon CM, Stark NM. Indochinese refugee health assessment and treatment. *J Fam Pract* 1983;16:61-7.
30. Chau HH. An epidemiological survey on viral hepatitis infection in a general population of Tan Chau district, An Giang province [PhD dissertation, in Vietnamese]. Hanoi: Institute of Military Medicine, 1995.
31. Tran HT-T, Ushijima H, Quang VX, Phuong N, Li T-C, Hayashi S, et al. Prevalence of hepatitis virus types B through E and genotypic distribution of HBV and HCV in Ho Chi Minh City, Vietnam. *Hepatol Res* 2003;26:275-80.
32. Hoang B, Simonneau M, Le Xuan P, Audat F, Guichoux P, Jaulmes B. Prevalence of hepatitis B viral markers in Vietnamese blood donors. *Rev Fr Transfus Immunohematol* 1985;28:227-36.
33. Hipgrave DB, Van NT, Huong VM, Long HT, Dat DT, Trung TN, et al. Hepatitis B infection in rural Vietnam and the implications for a national program of infant immunisation. *Am Trop Med Hyg* 2003;69:288-94.
34. Katelaris PH, Robertson G, Bradbury R, Tippett G, Hoa DQ, Ngu MC. Seroprevalence of hepatitis viruses in children in rural Viet Nam. *Trans R Soc Trop Me. Hyg* 1995;89:487.
35. La TN. Hepatitis B and C infection in different population groups in Southern Vietnam and implication for seeking blood donors [PhD dissertation, in Vietnamese]. Hanoi: Hanoi Medical University, 1995.
36. Vien CC. Investigation on hepatitis B infection in some cities of Central Vietnam and effects of hepatitis B vaccination [PhD dissertation]. Hanoi: National Institute of Hygiene and Epidemiology, 1997.
37. Vu HC, Nguyen TV. Hepatitis B infection in different population groups in Thanh Hoa city. *J Hyg Prevent Med* 1996;6:44-7.
38. Le VA. Preliminary assessment of HBV infection and chronic HBV infection status among Hanoi population [PhD dissertation, in Vietnamese]. Hanoi: Hanoi Medical University; 1995.
39. Nguyen VT-T, McLaws M-L, Dore G. Highly endemic hepatitis B infection in rural Vietnam. *J Gastroenterol Hepatol* 2006. doi:10.1111/j.1440-1746.2007.05010.x

40. Bell SJ, Lau A, Thompson A, Watson KJR, Demediuk B, Shaw G, et al. Chronic hepatitis B: recommendations for therapy based on the natural history of disease in Australian patients. *J Clin Virol* 2005;32:122-7.
41. Thompson SC, Lin A, Warren R, Giles G, Crofts N. Risk factors associated with hepatocellular carcinoma notified to the Anti-Cancer Council of Victoria in 1991-1992. *Aust NZ J Public Health* 1997;21:626-30.
42. Grulich AE, McCredie M, Coates M. Cancer incidence in Asian migrants to New South Wales, Australia. *Br J Cancer* 1995;71:400-8.
43. El-Serag HB, Mason AC. Rising incidence of hepatocellular carcinoma in the United States. *N Engl J Med* 1999;340:745-50.
44. Bouchardy C, Parkin DM, Khlal M. Cancer mortality among Chinese and South-East Asian migrants in France. *Int J Cancer* 1994;58:638-43.
45. McCredie M, Williams S, Coates M. Cancer mortality in East and Southeast Asian migrants to New South Wales, Australia, 1975-1995. *Br J Cancer* 1999;79:1277-82.
46. Taylor VM, Jackson JC, Pineda M, Pham P, Fischer M, Yasui Y. Hepatitis B knowledge among Vietnamese immigrants: implications for prevention of hepatocellular carcinoma. *J Cancer Educ* 2000;15:51-5.
47. Taylor VM, Yasui Y, Burke N, Nguyen T, Chen A, Acorda E, et al. Hepatitis B testing among Vietnamese American men. *Cancer Detect Prev.* 2004;28:170-7.
48. Wiecha JM. Differences in knowledge of hepatitis B among Vietnamese, African-American, Hispanic, and white adolescents in Worcester, Massachusetts. *Pediatrics* 1999;104:1212-16.
49. Cheung J, Lee T, Teh C, Wang C, Kwan W, Yoshida E. Cross-sectional study of hepatitis B awareness among Chinese and Southeast Asian Canadians in the Vancouver-Richmond community. *Can. Gastroenterol* 2005;19:245-9.
50. Thompson M, Taylor V, Jackson J, Yasui Y, Kuniyuki A, Tu SP, et al. Hepatitis B knowledge and practices among Chinese American women in Seattle, Washington. *J Cancer Educ* 2002;17:222-6.
51. Moore DJ, Bucens MR, Holman CD, Ott AK, Wells JL. Prenatal screening for markers of hepatitis B in Aboriginal mothers resident in non-metropolitan Western Australia. *Med J Aust* 1987;147: 557-8.
52. Holman CD, Quadros CF, Bucens MR, Reid PM. Occurrence and distribution of hepatitis B infection in the Aboriginal population of Western Australia. *Aust NZ J Med* 1987;17:518-25.
53. Campbell DH, Plant AJ, Sargent JW, Mock PA, Barrett ER, Archer KH. Hepatitis B infection of children in a mixed-race community in western New South Wales. *Med J Aust* 1991;154:253-6.
54. Campbell DH, Sargent JW, Plant AJ. The prevalence of markers of infection with hepatitis B virus in a mixed-race Australian community. *Med J Aust* 1989;150:489-92.
55. Patterson F, Bumak J, Batey R. Changing prevalence of hepatitis B virus in urbanized Australian Aborigines. *J Gastroenterol Hepatol* 1993;8:410-3.
56. Gill JS, Bucens M, Hatton M, Carey M, Quadros CF. Markers of hepatitis B virus infection in schoolchildren in the Kimberley, Western Australia. *Med J Aust* 1990;153:34-7.
57. Gardner ID, Wan X, Simms PA, Worswick DA, Burrell CJ, Mathews JD. Hepatitis B virus markers in children and staff in Northern Territory schools. *Med J Aust* 1992;156:638-41.
58. Malcolm RL, Ludwick L, Brookes DL, Hanna JN. The investigation of a 'cluster' of hepatitis B in teenagers from an Indigenous community in North Queensland. *Aust NZ J Public Health* 2000;24:353-5.
59. Burrell CJ, Cameron AS, Hart G, Melbourne J, Beal RW. Hepatitis B reservoirs and attack rates in an Australian community. A basis for vaccination and crossinfection policies. *Med J Aust* 1983;2:492-6.
60. Barrett EJ. Hepatitis-associated antigen in Aboriginal groups in Northern Australia. *Med J Aust* 1972;2:472-4.
61. Barrett EJ. Hepatitis B in Australian Aborigines and Torres Strait Islanders: geographical, age and familial distribution of antigen subtypes and antibody. *Aust NZ J Med* 1976;6 (2):106-11.
62. Hanna JN, Sexton WL, Faogali JL, Buda PJ, Kennett ML, Brussen KA. Immunity to hepatitis B, poliomyelitis and measles in fully vaccinated Aboriginal and Torres Strait Island children. *J Paediatr Child Health* 1995;31:345-9.
63. Hanna JN, Faogali JL, Buda PJ, Sheridan JW. Further observations on the immune response to recombinant hepatitis B vaccine after administration to Aboriginal and Torres Strait Island children. *J Paediatr Child Health* 1997;33:67-70.

64. Fisher DA, Huffam SE. Management of chronic hepatitis B virus infection in remote-dwelling Aboriginals and Torres Strait Islanders: an update for primary healthcare providers. *Barrett EJ* 2003;178:82-5.
65. Wan X, Mathews JD. Primary hepatocellular carcinoma in Aboriginal Australians. *Aust J Public Health* 1994;18:286-90.
66. Condon JR, Armstrong BK, Barnes A, Cunningham J. Cancer in Indigenous Australians: a review. *Cancer Causes Control* 2003;14:109-21.
67. Australian Institute of Health and Welfare. Access to health services. [Online] 2006 [Last accessed 28 May 2007]; Available from: <http://www.aihw.gov.au/indigenous/health/access.cfm>
68. Crofts N, Hopper JL, Milner R, Breschkin AM, Bowden DS, Locarnini SA. Blood-borne virus infections among Australian injecting drug users: Implications for spread of HIV. *Eur J Epidemiol* 1994;10: 687-94.
69. Crofts N, Aitken CK. Incidence of bloodborne virus infection and risk behaviours in a cohort of injecting drug users in Victoria, 1990-1995. *Med J Aust* 1997;167:17-20.
70. Butler T, Spencer J, Cui J, Vickery K, Zou J, Kaldor J. Seroprevalence of markers for hepatitis B, C and G in male and female prisoners, NSW, 1996. *Aust NZ J Public Health* 1999;23:377-84.
71. National Centre in HIV Epidemiology and Clinical Research. HIV/AIDS, viral hepatitis and sexually transmissible infections. Annual Surveillance Report 2004.
72. Maher L, Chant K, Jalaludin BIN, Sargent P. Risk behaviors and antibody hepatitis B and C prevalence among injecting drug users in south-western Sydney, Australia. *J Gastroenterol Hepatol* 2004;19:1114-20.
73. Crofts N, Stewart T, Hearne P, Ping XY, Breschkin AM, Locarnini SA. Spread of bloodborne viruses among Australian prison entrants. *Br Med J* 1995;310:285.
74. Butler TG, Dolan KA, Ferson MJ, McGuinness LM, Brown PR, Robertson PW. Hepatitis B and C in New South Wales prisons: prevalence and risk factors. *Med. J. Aust.* 1997; 166: 127-30.
75. Butler T, Boonwaat L, Hailstone S. National prison entrants' bloodborne virus survey report, 2004. Centre for Health Research in Criminal Justice, National Centre in HIV Epidemiology and Clinical Research, University of New South Wales, 2005. Report No.: CHRCJ Research Report No. 1.
76. Cook PA, McVeigh J, Syed Q, Mutton K, Bellis MA. Predictors of hepatitis B and C infection in injecting drug users both in and out of drug treatment. *Addiction* 2001;96:1787-97.
77. Maher L, Sargent P, Higgs P, Crofts N, Kelsall J, Le TT. Risk behaviours of young Indo-Chinese injecting drug users in Sydney and Melbourne. *Aust NZ J Public Health* 2001;25:50-4.
78. Macdonald V, Dore GJ, Amin J, van Beek I. Predictors of completion of a hepatitis B vaccination schedule in attendees at a primary health care centre. *Sexual Health* 2007;4:27-30.
79. Winstock AR, Anderson CM, Sheridan J. National survey of HIV and hepatitis testing and vaccination services provided by drug and alcohol agencies in Australia. *Med J Aust* 2006;184:560-2.
80. Dietzman DE, Harnisch JP, Ray CG, Alexander ER, Holmes KK. Hepatitis B surface antigen (HBsAg) and antibody to HBsAg. Prevalence in homosexual and heterosexual men. *J Am Med Assoc* 1977;238 2625-6.
81. Bleeker A, Coutinho RA, Bakker-Kok J, Tio D, de Koning GA. Prevalence of syphilis and hepatitis B among homosexual men in two saunas in Amsterdam. *Br J Vener Dis* 1981;57:196-9.
82. Coutinho RA, Schut BJ, Albrecht-Van Lent NA, Reerink-Brongers EE, Jesdijk LS. Hepatitis B among homosexual men in The Netherlands. *Sex Transm Dis* 1981;8:333-5.
83. Schreeder MT, Thompson SE, Hadler SC, Berquist KR, Zaidi A, Maynard JE, et al. Hepatitis B in homosexual men: prevalence of infection and factors related to transmission. *J Infect Di.* 1982;146:7-15.
84. Coester CH, Bienzle U, Hoffmann HG, Koehn E, Guggenmoos-Holzmann I. Syphilis, hepatitis A and hepatitis B seromarkers in homosexual men. *Klin. Wochenschr.* 1984; 62: 810-3.
85. Coester CH, Avonts D, Colaert J, Desmyter J, Piot P. Syphilis, hepatitis A, hepatitis B, and cytomegalovirus infection in homosexual men in Antwerp. *Br J Vener Dis* 1984;60:48-51.

86. Shah N, Ostrow D, Altman N, Baker AL. Evolution of acute hepatitis B in homosexual men to chronic hepatitis B. Prospective study of placebo recipients in a hepatitis B vaccine trial. *Arch Intern Med* 1985;145:881-2.
87. Keeffe EB. Clinical approach to viral hepatitis in homosexual men. *Med Clin North Am* 1986;70:567-86.
88. US Department of Health and Human Services. Centers for Disease Control and Prevention. Hepatitis B prevention for men who have sex with men. 2006 [Last accessed June 2007]; Available from: [http://www.cdc.gov/Ncidod/diseases/hepatitis/msm/hbv\\_msm\\_fact.htm](http://www.cdc.gov/Ncidod/diseases/hepatitis/msm/hbv_msm_fact.htm)
89. Gilson RJ, de Ruiter A, Waite J, Ross E, Loveday C, Howell DR, et al. Hepatitis B virus infection in patients attending a genitourinary medicine clinic: risk factors and vaccine coverage. *Sex Transm Infect* 1998;74:110-5.
90. Mackellar DA, Valleroy LA, Secura GM, McFarland W, Shehan D, Ford W, et al. Two decades after vaccine license: hepatitis B immunization and infection among young men who have sex with men. *Am J Public Health* 2001;91:965-71.
91. Jin F, Prestage GP, Pell CM, Donovan B, Van de Ven PG, Kippax SC, et al. Hepatitis A and B infection and vaccination in a cohort of homosexual men in Sydney. *Sexual Health* 2004;1:227-37.
92. Diamond C, Thiede H, Perdue T, Secura GM, Valleroy L, Mackellar D, et al. Viral hepatitis among young men who have sex with men: prevalence of infection, risk behaviors, and vaccination. *Sex Transm Dis* 2003;30:425-32.
93. Anderson B, Bodsworth NJ, Rohrsheim RA, Donovan BJ. Hepatitis B virus infection and vaccination status of high risk people in Sydney: 1982 and 1991. *Med J Aust* 1994;161:368-71.
94. Yee LJ, Rhodes SD. Understanding correlates of hepatitis B virus vaccination in men who have sex with men: what have we learned? *Sex Transm Infect* 2002;78:374-7.
95. Rhodes SD, Hergenrather KC. Exploring hepatitis B vaccination acceptance among young men who have sex with men: facilitators and barriers. *Prev Med* 2002;35:128-34.
96. Rudy ET, Detels R, Douglas W, Greenland S. Factors affecting hepatitis vaccination refusal at a sexually transmitted disease clinic among men who have sex with men. *Sex Transm Dis* 2003;30:411-8.
97. Brook MG. Sexual transmission and prevention of the hepatitis viruses A-E and G. *Sex Transm Infect* 1998;74:395-8.
98. Pitts MK, Couch MA, Smith AMA. Men who have sex with men (MSM): how much to assume and what to ask? *Med J Aust* 2006;185:450-2.
99. Van de Ven P, Prestage G, French J, Knox S, Kippax S. Increase in unprotected anal intercourse with casual partners among Sydney gay men in 1996-98. *Aust NZ J Public Health* 1998;22:814-8.
100. Van de Ven P, Prestage G, Crawford J, Grulich A, Kippax S. Sexual risk behaviour increases and is associated with HIV optimism among HIV-negative and HIV-positive gay men in Sydney over the 4 year period to February 2000. *AIDS* 2000;14:2951-3.