

Hepatitis B vaccination in Africa: mission accomplished?

Guido François^a, Carine Dochez^b, M. Jeffrey Mphahlele^c,
Rosemary Burnett^d, Guido Van Hal^a, André Meheus^b

Introduction

Hepatitis B more than ever holds a prominent position among the most notorious infectious diseases on a global scale and remains an actual threat to the world population. However, not all countries or continents are equally affected. Sub-Saharan Africa for example is a high-endemic region, with carrier rates of hepatitis B surface antigen (HBsAg) 8% among certain population groups, representing a significant burden to the health and development of a number of societies.

In sub-Saharan Africa, horizontal hepatitis B virus (HBV) transmission during early childhood (under 5 years of age) is considered a predominant route of infection.¹ Perinatal transmission also occurs, but its impact is less important. This is in contrast with the situation in low-endemic countries such as western Europe - with HBsAg levels <2% - where sexual transmission and high-risk behaviour represent major factors.

HBV infection during childhood endangers the health in later years of life, because it frequently leads to progression to a chronic carrier state and this in turn implies a higher chance of developing liver cirrhosis or hepatocellular carcinoma (HCC) during adulthood. It goes without saying that prevention is the best strategy to deal with HBV infection. Vaccination is therefore a powerful tool to combat hepatitis B, preventing acute symptomatic HBV infection, chronic HBV infection, liver cirrhosis, HCC, and death from these complications.²

Vaccination programmes

Initiating, preparing, implying, and maintaining a vaccination programme is a very complex task and requires considerable means. Factors contributing to this complexity are situated at organisational (guaranteed delivery, eg. is often a problem, sometimes even in western countries), administrative, technical, scientific, medical, logistic (eg. transport, cold chain, stock management), educative (eg. social mobilisation), financial, and political levels. Even before the whole process has started, the political will to proceed and future financing possibilities need to be ensured.

The Expanded Programme on Immunization (EPI)³ remains, since its launch in 1974, the foundation of vaccination programmes for children below 12 months of age all over the world. EPI programmes were originally created against measles, poliomyelitis, tuberculosis, diphtheria, tetanus, and pertussis. Most countries belonging to the African World Health Organization Region (WHO/AFRO)⁴ adopted and implemented this system in the 1980s. Many of them later on included tetanus vaccination for women, and yellow fever vaccination where the disease was endemic.

In a next stage, more vaccines - some new, some underused - were added to the package, depending on epidemiological needs and national possibilities. Besides the yellow fever vaccine, the other two most important underused vaccines are directed against HBV and *Haemophilus influenzae* type b (Hib) infection, respectively. Although a safe and effective HBsAg-based hepatitis B vaccine (HepB) has been available for over 25 years and since long in use in more developed parts of the world, it has taken many more years before it also came within the reach of many developing countries. The latter achievement is thanks mainly to the efforts and support of the GAVI Alliance.

The GAVI Alliance

The GAVI Alliance (formerly known as the Global Alliance for Vaccines and Immunization/GAVI) provides financial and other types of support to the countries most in need. GAVI was launched in 2000 as a partnership between public and private institutions and aimed at ensuring access for all children of the world to vaccines against diseases that threaten their health and future. The GAVI Alliance is now a historical association between national governments, UNICEF, WHO, the Bill and Melinda Gates Foundation, the World Bank, vaccine manufacturers, non-governmental organisations (NGOs), and research institutes. The necessary financial means to meet the objectives are provided through the GAVI Fund (formerly the Vaccine Fund).

The GAVI Fund, as one of the partners of the GAVI Alliance, raises the funds and efficiently transfers them to countries in need of help. More concretely, these resources are put to use to strengthen routine vaccination systems and, more generally, health systems services. The Fund does not pay for the traditional six vaccines, except for combined vaccines that include diphtheria-tetanus-pertussis (DTP). It does pay, however, for the hepatitis B, Hib, and yellow fever vaccines, and supports safe injection initiatives, such as the introduction of auto-disable (AD) syringes. The GAVI Fund also gives priority to an accelerated development and introduction of vaccines against rotavirus and pneumococcal infections suitable for use in developing countries.

GAVI Fund support is of course only available for the poorest countries, with the current eligibility criterion being a

^a G François, G Van Hal, Department of Epidemiology and Social Medicine, University of Antwerpen, Antwerpen, Belgium.

^b C Dochez, A Meheus, Network for Education and Support in Immunisation (NESI), University of Antwerpen, Antwerpen, Belgium.

^c MJ Mphahlele, HIV and Hepatitis Research Unit, Department of Virology, University of Limpopo, Medunsa Campus, Pretoria, Gauteng, South Africa.

^d R Burnett, Department of Epidemiology, National School of Public Health, University of Limpopo, Medunsa Campus, Pretoria, Gauteng, South Africa. Correspondence to: G. François, Department of Epidemiology and Social Medicine, University of Antwerpen, Campus Drie Eiken, Universiteitsplein 1, B-2610 Antwerpen, Belgium. E-mail: guido.francois@ua.ac.be

maximum gross national income (GNI) of 1,000 US dollars per capita per year. On a global scale, this means that 72 countries are now eligible to apply - in the period 2000-2005 this number was 75. In December 2006, 73 countries were successful in obtaining at least one type of support. Received resources were used to 1) strengthen immunisation and healthcare delivery systems; 2) boost coverage with established vaccines; 3) introduce underused vaccines where needed; 4) ensure vaccination safety; and 5) accelerate development of and access to new vaccines.

Worldwide, only 12 countries meeting the GAVI criteria had introduced hepatitis B vaccine in 1999. This proportion rapidly increased and by the end of 2004, 52 GAVI-eligible countries had the vaccine in their universal infant immunisation programme and it is expected that 71 of them will have introduced the vaccine by the end of 2008.⁵

The current global situation

The Global Advisory Group of the Expanded Programme on Immunization recommended in 1991 that hepatitis B vaccine be integrated into national immunisation programmes: those with a HBsAg prevalence of 8% or greater by 1995, and all countries of the world by 1997. This advice was endorsed by the World Health Assembly (WHA) (1992) and WHO (1994).^{3,6} The aim was not achieved, but the plans gained considerable momentum after GAVI was founded.

In 2004, hepatitis B vaccine had been introduced into the routine infant immunisation programme in 153 (79.7%) of the 192 WHO Member States. By the end of 2005, this proportion had increased to 158/192 (82.3%) (193 Member States in September 2006).⁷

Also in 2005, more than half of the worldwide target population had received a third dose of hepatitis B vaccine (HepB3) in the first year of their life. Two aspects of this achievement are noteworthy. Firstly, this coverage has steadily and rapidly been growing through the years, from only 1% in 1990 to 33% in 2000, 35% in 2001, 40% in 2002, 46% in 2003, 51% in 2004, and 55% in 2005.⁸ Secondly, these numbers are global averages and the itemised numbers, calculated per country or by region, differ significantly for various reasons.

Of all children that remained unvaccinated in 2005 in GAVI-eligible countries all over the world, 42% lived in India, 9% in the People's Republic of China, 9% in Nigeria, 6% in Bangladesh, 5% in Ethiopia, 5% in the Democratic Republic of the Congo (DRC), and 25% in other countries. About 20% of all unvaccinated children lived in sub-Saharan Africa.⁵

Hepatitis B vaccination in sub-Saharan Africa

The WHO/AFRO Region comprises 46 Member States, i.e. all African countries except Djibouti, Egypt, Eritrea, Libya, Morocco, Somalia, Sudan, Tunisia, and the Western Sahara. The latter nine fall under the competence of the WHO Eastern Mediterranean Regional Office (EMRO).⁹

At present, WHO/AFRO takes up a clear and unambiguous position regarding hepatitis B vaccination: since the prevalence of HBV infection in Africa is among the highest in the world, it hopes to ensure, in close collaboration with the GAVI Alliance, that all countries introduce and effectively

use current HBV vaccines.¹⁰

The evolution of HepB3 coverage in the whole of the African Region looks as follows: 0% in 1990, 6% in 2000, 6% in 2001, 23% in 2002, 29% in 2003, 34% in 2004, and 39% in 2005.⁸ Also within the AFRO Region the numbers vary widely. For example, the estimated South African HepB3 coverage is towering high above that of the Region: 74% in 1997, 79% in 1998, 83% in 1999, 88% in 2000, 80% in 2001, 83% in 2002, 94% in 2003, 92% in 2004, and 94% in 2005.¹¹

Hepatitis B vaccination in the subregions

As from September 2006, the WHO African Region has been subdivided into three subregions, managed by Inter-Country Support Teams (ICSTs): ICST West, Central, and South/East, with their headquarters in Ouagadougou (Burkina Faso), Libreville (Gabon), and Harare (Zimbabwe), respectively.

ICST West

A number of data regarding hepatitis B vaccination programmes in the ICST West zone are summarised in Table 1. The subregion comprises 17 countries (total population 295,978,507) and all but two (Algeria and Cape Verde) are eligible for GAVI support based on the national income criterion. The latter two countries both introduced hepatitis B vaccination into their EPI in 2002.

Among the 15 GAVI-eligible countries, 12 - Benin, Burkina Faso, Côte d'Ivoire, The Gambia, Ghana, Guinea, Liberia, Mali, Mauritania, Senegal, Sierra Leone, and Togo - are receiving specific GAVI funding for their hepatitis B vaccination programmes. The Gambia was the first country among them to introduce the vaccine - in 1990, long before the GAVI era - and the list was provisionally completed with Burkina Faso, Guinea, Guinea-Bissau, Sierra Leone, and Togo in 2007. Liberia and Niger receive support and are planning HepB introduction in 2008. Monovalent (HepB), tetravalent (diphtheria, tetanus, pertussis, HepB), as well as pentavalent (diphtheria, tetanus, pertussis, Hib, HepB) vaccines are in use. Niger plans to introduce a hexavalent vaccine containing diphtheria, tetanus, pertussis, IPV (inactivated polio vaccine), Hib, and HepB antigens in 2008.

ICST Central

Some characteristics of the hepatitis B vaccination programmes in the ICST Central zone (11 countries; total population 125,568,661) are displayed in Table 2. Again, all but two countries (Equatorial Guinea and Gabon) are GAVI-eligible, based on general grounds. Gabon introduced HepB in its EPI in 2004, while Equatorial Guinea has not made the move yet. Among the nine GAVI-eligible countries, seven - Angola, Burundi, Cameroon, Congo, the DRC, Rwanda, and São Tomé and Príncipe - are currently receiving specific support for hepatitis B vaccination. Both the Central African Republic and Chad have yet to apply. Mono-, tetra-, and pentavalent vaccines are administered.

ICST South/East

The WHO ICST South/East zone comprises 18 countries (total population 314,493,879). A number of aspects of their hepatitis B vaccination programmes are represented in Table 3. Six countries belonging to this subregion are not GAVI-

Table 1: Universal infant hepatitis B vaccination programmes in the WHO African Region ICST West^a

Country	Population (x 1000) ^b	HepB in EPI ^c	GAVI-eligible country ^d	GAVI funding for HepB ^d	Current vaccine ^e	Current schedule ^e	HepB3 coverage ^e	
							2002 (%)	2005 (%)
Algeria	32,854	2002	no	n.a.	mono	birth; 1,5 m	-	83
Benin	8,439	2002	yes	yes	penta	6,10,14 w	15	92
Burkina Faso	13,228	2007	yes	yes	tetra/penta	2,3,4 m	-	-
Cape Verde	0,507	2002	no	n.a.	mono	birth; 6,14 w	40	69
Côte d'Ivoire	18,154	2001	yes	yes	tetra	6,10,14 w	48	56
Gambia	1,517	1990	yes	yes	mono	birth; 2,4 m	90	88
Ghana	22,113	2001	yes	yes	penta	6,10,14 w	80	84
Guinea	9,402	2007	yes	yes	mono	6,10,14 w	-	-
Guinea-Bissau	1,586	2007	yes	yes	penta	6,10,14 w	-	-
Liberia	3,283	2008	yes	yes ^e	penta	-	-	-
Mali	13,518	2002	yes	yes	mono/penta	6,10,14 w	-	85
Mauritania	3,069	2005	yes	yes	mono	6,10,14 w	-	42
Niger	13,957	2008	yes	yes	hexa	6,10,14 w	-	-
Nigeria	131,530	2004	yes	eligible but uses own funding ^e	mono	birth; 10,14 w	-	27
Senegal	11,658	2004	yes	yes	penta	6,10,14 w	-	84
Sierra Leone	5,525	2007	yes	yes	penta	6,10,14 w	-	-
Togo	6,145	2007	yes	yes	penta	6,10,14 w	-	-

^a Inter-Country Support Team West, based in Ouagadougou, Burkina Faso, as of September 2006

^b Source: World Population Prospects: The 2004 Revision, New York, United Nations, 2005.

^c Source: WHO vaccine-preventable diseases: monitoring system. 2006 global summary. WHO, Immunization, Vaccines and Biologicals, 2006.

^d Source: GAVI Alliance. www.gavialliance.org

^e Source: Macauley R. Update on GAVI activities in the African Region. EPI managers' meeting, Harare, Zimbabwe, March 2007.

n.a.: not applicable

Table 2: Universal infant hepatitis B vaccination programmes in the WHO African Region ICST Central^a

Country	Population (x 1000) ^b	HepB in EPI ^c	GAVI-eligible country ^d	GAVI funding for HepB ^d	Current vaccine ^e	Current schedule ^e	HepB3 coverage ^e	
							2002 (%)	2005 (%)
Angola	15,941	2006 ^d	yes	yes	penta	2,4,6 m	-	-
Burundi	7,548	2004	yes	yes	penta	6,10,14 w	-	87
Cameroon	16,322	2005	yes	yes	tetra	6,10,14 w	-	79
Central African Republic	4,038	not yet	yes	yet to apply ^e	n.a.	n.a.	-	-
Chad	9,749	not yet	yes	yet to apply ^e	n.a.	n.a.	-	-
Congo	3,999	2007	yes	yes ^e	tetra	8,12,16 w	-	-
D.R. Congo	57,549	2007	yes	yes ^e	tetra	6,10,14 w	-	-
Equatorial Guinea	0,504	not yet	no	n.a.	n.a.	n.a.	-	-
Gabon	1,384	2004	no	n.a.	mono	6,10,14 w	-	55
Rwanda	9,038	2002	yes	yes	penta	6,10,14 w	88	95
São Tomé and Príncipe	0,157	2003	yes	yes	mono	6,10,14 w	-	96

^a Inter-Country Support Team Central, based in Libreville, Gabon, as of September 2006

^b Source: World Population Prospects: The 2004 Revision, New York, United Nations, 2005.

^c Source: WHO vaccine-preventable diseases: monitoring system. 2006 global summary. WHO, Immunization, Vaccines and Biologicals, 2006.

^d Source: GAVI Alliance. www.gavialliance.org

^e Source: Macauley R. Update on GAVI activities in the African Region. EPI managers' meeting, Harare, Zimbabwe, March 2007.

n.a.: not applicable

eligible: Botswana, Mauritius, Namibia, the Seychelles, South Africa, and Swaziland, and all but Namibia introduced hepatitis B vaccine between 1995 (Seychelles and South Africa) and 2000 (Botswana). All of the 12 GAVI-eligible countries - the Comoros, Eritrea, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Tanzania, Uganda, Zambia, and Zimbabwe - are receiving specific GAVI support for hepatitis B. Mono-, tetra-, and pentavalent vaccines are being used. The most recent introduction of hepatitis B vaccine was in 2007, in Ethiopia.

Zimbabwe has a special place in this list, having first attempted to introduce HepB in the national EPI in October 1994. The programme was suspended already in July 1995

because of inadequate funding. However, a renewed introduction in 1999 proved to be successful.¹²

Discussion

Currently, most of the countries in the WHO African Region have implemented hepatitis B vaccine in their national EPI by now (Tables 1-3). These include 15 out of the 17 countries in the ICST West subregion, 8/11 ICST Central countries, and 17/18 ICST South/East countries, constituting 40/46 (87.0%) countries in the whole WHO/AFRO Region. This is an impressive achievement and it is quite obvious that the establishment of GAVI and its subsequent activities dramatically accelerated the whole process. At present, 31

Table 3: Universal infant hepatitis B vaccination programmes in the WHO African Region ICST South/East^a

Country	Population (x 1000) ^b	HepB in EPI ^c	GAVI-eligible country ^d	GAVI funding for HepB ^d	Current vaccine ^e	Current schedule ^e	HepB3 coverage ^e	
							2002 (%)	2005 (%)
Botswana	1,765	2000	no	n.a.	mono	birth; 2,9 m	85	85
Comoros	0,798	2002	yes	yes	mono/tetra	6,10,14 w	-	80
Eritrea	4,401	2002	yes	yes	tetra	6,10,14 w	83	83
Ethiopia	77,431	2007 ^f	yes	yes	penta ^{4e}	6,10,14 w ^d	-	-
Kenya	34,256	2001	yes	yes	penta	6,10,14 w	72	76
Lesotho	1,795	2003	yes	yes	mono	6,10,14 w	-	83
Madagascar	18,606	2001	yes	yes	tetra	6,10,14 w	62	61
Malawi	12,884	2001	yes	yes	penta	6,10,14 w	64	93
Mauritius	1,245	1997	no	n.a.	mono	3,4,5 m	88	97
Mozambique	19,792	2001	yes	yes	tetra	8,12,16 w	72	72
Namibia	2,031	not yet	no	n.a.	n.a.	n.a.	-	-
Seychelles	0,081	1995	no	n.a.	mono	3,4,9 m	98	99
South Africa	47,432	1995	no	n.a.	mono	6,10,14 w	83	94
Swaziland	1,032	1996	no	n.a.	tetra	6,10,14 w	78	71
Tanzania / Zanzibar	38,329	2002	yes	yes	tetra	4,8,12 w (T) 6,10,14 w (Z)	89	90
Uganda	28,816	2002	yes	yes	penta	6,10,14 w	42	84
Zambia	11,668	2005	yes	yes	penta	6,10,14 w	-	80
Zimbabwe	13,010	1994/1999	yes	yes	mono/penta 2008 ^g	3,4,5 m	75	90

^a Inter-Country Support Team South/East, based in Harare, Zimbabwe, as of September 2006

^b Source: World Population Prospects: The 2004 Revision, New York, United Nations, 2005.

^c Source: WHO vaccine-preventable diseases: monitoring system. 2006 global summary. WHO, Immunization, Vaccines and Biologicals, 2006.

^d Source: GAVI Alliance. www.gavialliance.org

^e Source: Macauley R. Update on GAVI activities in the African Region. EPI managers' meeting, Harare, Zimbabwe, March 2007.

n.a.: not applicable

countries in the sub-Saharan region are being supported for hepatitis B vaccination by the GAVI Alliance.

Liberia and Niger are planning to introduce the vaccine in 2008. This will eventually result in 42/46 WHO/AFRO countries, or 91.3% of all Member States, with HepB in their EPI - only the Central African Republic, Chad, Equatorial Guinea, and Namibia have not reached that stage yet.

Hepatitis B vaccination coverage varies significantly throughout the region - between 27% and 99% in 2005 - but among the countries for which relevant data are available, many (24/31) had reached rates over 70%, and 9/31 (Benin, Malawi, Mauritius, Rwanda, São Tomé and Príncipe, the Seychelles, South Africa, Tanzania, and Zimbabwe) had coverage rates of at least 90% in 2005. Overall, the highest rates were reached in Mauritius (97%) and the Seychelles (99%), which is not surprising because these small island states are easier to manage than the bigger countries. The lowest coverage rates are to be found in Mauritania (42%) and Nigeria (27%). In cases where figures for 2002 are available, the progression between 2002 and 2005 is often remarkable (eg. Benin: 15 vs 92%; Uganda: 42 vs 84%). In other cases, the rates seem to have reached a plateau at a high (eg. Tanzania: 89 vs 90%) or rather low (e.g., Madagascar: 62 vs 61%) level. The target immunisation coverage for all EPI vaccines is 90%.¹³

Although many countries worldwide complied with the original recommendation in recent years, the goal to achieve this by 1997 was ultimately not reached. This held a fortiori true for sub-Saharan Africa, where by December 1997 only The Gambia (1990), the Seychelles (1995), South Africa (1995), Swaziland (1996), and Mauritius (1997) were successful in this respect.

In 2002, WHO/AFRO stated that since the advent of GAVI, a new trend in hepatitis B vaccination acceptance could result in the majority of African countries introducing HepB in their EPI by 2005.⁶ Based on the information given in Tables 1-3, 31/46 or about 67%, indeed a pronounced majority, had done so by 2005. In 2007, the sub-Saharan region was very close to complying with the original recommendation: almost all countries had HepB in their national programme.

In parallel, the introduction of polyvalent vaccines including hepatitis B antigen offers good prospects. Application of such combination vaccines leads to cost reduction (elimination of costs for separate vials, packaging, labeling, cold-chain storage expansion, and additional needles and syringes) and simplification of delivery logistics (vaccine delivery, central storage, administration, and simplified record-keeping and surveillance activities). Moreover, application of combination vaccines leads to better coverage due to increased family acceptance. In 2001, polyvalent vaccines were not yet in use in Africa, but a number of requests for GAVI support to introduce them were under consideration.¹⁴ In 2007, the situation was totally different, with the majority of countries using tetra- or pentavalent vaccines (Tables 1-3).

The long way that was covered in only a few years is illustrated by the following. In 2002, it was still reasonable to state that '... the major reason for the failure of the majority of sub-Saharan countries to introduce universal hepatitis B vaccination is financial constraints. Other reasons include ignorance of the seriousness of the threat posed by chronic HBV infection, lack of political will, local and regional wars, natural disasters, and the HIV epidemic, which rightfully absorbs much of the health resources.'¹² A number of typical constraints were also more specifically described as follows: 1) lack of awareness of the public health significance of

hepatitis B; 2) lack of awareness of the impact of prevention strategies; 3) insufficient knowledge to integrate hepatitis B into existing prevention and control programmes; 4) insufficient co-ordination and collaboration between partners at all levels; 5) competing public health priorities; and 6) economic conditions rendering procurement of vaccines more difficult.¹⁵ In 2007, at least part of these considerations are still valid, but a major breakthrough has been realised all the same. A limited number of countries have been able to introduce the vaccine using their own resources, others needed the assistance of the GAVI Alliance. All must remain committed to the programme however and also those that enjoy GAVI support should provide for sustainability and financing on a long-term basis.

The whole of sub-Saharan Africa can be proud of the achievements described in this paper. Sustained efforts must however be made to strengthen healthcare delivery systems including immunisation programmes in order to guarantee safe delivery of vaccines and to reach and sustain high coverages.¹⁶ And even when the goals are fully reached, these efforts will remain necessary. At the end of the period for which GAVI support is granted, viable mechanisms ensuring financial sustainability should be functioning properly, otherwise all the anticipated gain in terms of morbidity and mortality will be reversed.⁶ Debilitating diseases such as hepatitis B will indeed continue to threaten African and other countries as long as they are not eradicated globally.

References

1. Kew M. Hepatitis B virus infection: the burden of disease in South Africa. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 4-7
2. Mphahlele MJ, François G, Kew M, Hoosen A, Meheus A. Hepatitis B virus infection in eastern and southern Africa: epidemiology, clinical aspects and prevention. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 1-66
3. World Health Organization. Expanded Programme on Immunization. Global Advisory Group Part I. *Wkly Epidemiol Rec* 1992; **67**: 11-15
4. World Health Organization, Regional Office for Africa (WHO/AFRO). www.afro.who.int [Accessed February 2008]
5. GAVI Alliance. www.gavialliance.org [Accessed February 2008]
6. Manzila T, Okwo-Bele J-M. Hepatitis B vaccination in the WHO Africa Region and the Global Alliance for Vaccines and Immunization context. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 63-66
7. Global Immunization Coverage, 2006. www.who.int/immunization/newsroom/Global_imm_data_October_2006.pdf [Accessed February 2008]
8. WHO vaccine-preventable diseases: monitoring system. 2006 global summary. www.who.int/vaccines-documents/GlobalSummary/GlobalSummary.pdf [Accessed February 2008]
9. World Health Organization, Regional Office for the Eastern Mediterranean (WHO/EMRO). www.emro.who.int [Accessed February 2008]
10. Arevshatian L, Clements C, Lwanga S, *et al.* An evaluation of infant immunization in Africa: is a transformation in progress? *Bull Wld Hlth Org* 2007; **85**: 449-457
11. World Health Organization. www.who.int [Accessed February 2008]
12. Chihota V, Tswana SA. Hepatitis B prevention and vaccination in Zimbabwe. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 60-62
13. Dhlamini T. Hepatitis B prevention and vaccination in South Africa. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 55-56
14. Aspinall S, Mphahlele MJ. Update of hepatitis B vaccines and usage in Africa. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 45-47
15. Mphahlele MJ, François G. Hepatitis B in eastern and southern Africa at the onset of the third millennium. *South Afr J Epidemiol Infect* 2002; **17**(Suppl): 2-3
16. Lavanchy D. Hepatitis B virus epidemiology, disease burden, treatment, and current and emerging prevention and control measures. *J Viral Hepatitis* 2004; **11**: 97-107