

Asian-Pacific consensus statement on the management of chronic hepatitis B: a 2008 update

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Abstract Large amounts of new data on the natural history and treatment of chronic hepatitis B virus (HBV) infection have become available since 2005. These include long-term follow-up studies in large community-based cohorts or asymptomatic subjects with chronic HBV infection, further studies on the role of HBV genotype/naturally occurring HBV mutations, treatment of drug

resistance and new therapies. In addition, Pegylated interferon $\alpha 2a$, entecavir and telbivudine have been approved globally. To update HBV management guidelines, relevant new data were reviewed and assessed by experts from the region, and the significance of the reported findings were discussed and debated. The earlier “Asian-Pacific consensus statement on the management of chronic hepatitis B”

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was revised accordingly. The key terms used in the statement were also defined. The new guidelines include general management, special indications for liver biopsy in patients with persistently normal alanine aminotransferase, time to start or stop drug therapy, choice of drug to initiate therapy, when and how to monitor the patients during and after stopping drug therapy. Recommendations on the therapy of patients in special circumstances, including women in childbearing age, patients with antiviral drug resistance, concurrent viral infection, hepatic decompensation, patients receiving immune-suppressive medications or chemotherapy and patients in the setting of liver transplantation, are also included.

Keywords Chronic hepatitis B · Liver cirrhosis · Hepatocellular carcinoma · Hepatitis B virus (HBV) · Interferon- α · Pegylated interferon · Lamivudine · Adefovir · Entecavir · Telbivudine

Introduction

Since the third version of “Asian-Pacific consensus statement on the management of chronic hepatitis B” was published in June 2005 [1], pegylated interferon- α 2a (Peg-IFN- α 2a), entecavir, and telbivudine have been approved globally and several updated guidelines on chronic hepatitis B virus (HBV) infection have been published [2–4]. Large amount of new data on the natural history and treatment of chronic HBV infection has also become available. These include long-term follow-up studies in community-based cohorts and asymptomatic subjects with chronic HBV infection, further studies on the role of HBV genotypes and naturally occurring HBV mutations, and treatment of drug resistance. In addition, new issues such as the “roadmap” concept toward more effective management of the condition and pharmacoconomics of drug therapy are emerging. We have closely followed the progress in the field and invited experts from the Asian-Pacific region to review and assess relevant new data. The significance of the reported findings were discussed and debated during a 2-day expert meeting at Pattaya, Thailand, in November 2007. The 2005 update of the “Asian-Pacific consensus statement on the management of chronic hepatitis B” [1] was revised accordingly. The key terms used in the statement were also defined (Table 1). Then, the revised version was circulated for further comments and it was refined through electronic communications among the experts. The revised contents were presented and discussed at the Asian-Pacific Association for the Study of the Liver meeting in Seoul, Korea, in March 2008. The following is the final version of the updated consensus and recommendations on the management of chronic hepatitis B.

Conceptual background

HBV, pathogenesis, and natural course

Chronic HBV infection is a serious clinical problem because of its worldwide distribution and potential adverse sequelae. It is particularly important in the Asian-Pacific region where the prevalence of HBV infection is high. In this part of the world, the majority of HBV infection prevalence is acquired perinatally or in early childhood, and some patients may be superinfected with other viruses that may influence the clinical outcomes.

Previous studies revealed the presence of two replication pathways, namely, episomal and integrated forms, and reverse transcription process in HBV infection [5]. It has been recognized that covalently closed circular DNA plays a key role in the maintenance of chronic HBV infection [6]. As HBV is not usually cytopathogenic by itself, chronic HBV infection is a dynamic state of interactions among the virus, hepatocytes, and the host immune system. The natural course of chronic HBV infection in this geographic region can be divided into (i) immune-tolerant phase, (ii) immune clearance phase, and (iii) residual or inactive phase. HBV reactivation and relapse of hepatitis may occur in some patients who are in the residual or inactive phase.

Patients in the immune-tolerant phase are usually young, hepatitis B e antigen (HBeAg) seropositive with high viral loads ($>2 \times 10^6$ to 2×10^7 IU/ml or $>10^7$ – 10^8 copies/ml) but normal serum alanine aminotransferase (ALT) and no or minimal clinicopathological changes. The results of a recent 5-year follow-up study have confirmed that adults in the immune-tolerant phase show minimal disease progression [7]. However, HBeAg-positive subjects older than 40 years with persistently “high normal” ALT may have significant hepatic necroinflammation or fibrosis [8]. During the immune clearance phase, hepatitis activity and even acute flares with serum ALT levels over 5 times upper limit of normal (ULN) may occur, and these may sometimes be complicated by hepatic decompensation. These ALT elevations and hepatitis flares are the result of host’s immune responses against HBV, such as HLA-class I antigen restricted cytotoxic T lymphocyte (CTL)-mediated response against HBV antigen(s) expressed on hepatocytes with resultant apoptosis and necrosis. Higher ALT levels, therefore, usually reflect more vigorous immune response against HBV and more extensive hepatocyte damage [9]. This is eventually followed by HBeAg seroconversion to its antibody (anti-HBe) and/or undetectable HBV-DNA. The estimated annual incidence of spontaneous HBeAg seroconversion was 2–15%, depending on factors such as age, ALT levels, and HBV genotype [9, 10]. Some patients may experience only transient and mild elevation of serum ALT levels before HBeAg seroconversion [11]. HBeAg

Table 1 Definition of frequently used terminology

Terminology	Definition
Alanine aminotransferase (ALT)	
High normal	Serum ALT levels between 0.5 and 1 times upper limit of normal reference (ULN).
Low normal	Serum ALT \leq 0.5 times ULN
Minimally raised	Serum ALT levels between 1 and 2 times ULN
Biochemical response	Normalization of serum ALT levels
Chronic HBV infection	HBsAg seropositive \geq 6 months
Clinical breakthrough	Virologic breakthrough with increased ALT levels or worsening histology
Drug resistance	
Genotypic resistance	Detection of mutations in the HBV genome, known to confer resistance, which develop during antiviral therapy
Phenotypic resistance	Decreased susceptibility (in vitro testing) to inhibition by antiviral drugs associated with genotypic resistance
Cross resistance	Mutation selected by one antiviral agent that also confers resistance to other antiviral agents
Hepatic decompensation	Significant liver function abnormality as indicated by raised serum bilirubin level and prolonged prothrombin time or occurrence of complications such as ascites
Hepatitis flare	Increase of serum ALT level to \geq 5 times ULN
Inactive chronic HBV infection	HBsAg (+) anti-HBe (+) with persistent normal serum ALT and HBV-DNA $<$ 2,000 IU/ml (10^4 copies/ml)
Undetectable serum HBV-DNA	Serum HBV-DNA levels below detection limit of a PCR-based assay
Virological response	
Maintained virologic response	Undetectable serum HBV-DNA and HBeAg seroconversion, if applicable, during therapy
Primary treatment failure	Reduction of serum HBV-DNA $<$ 1 log IU/ml at 12 weeks of oral antiviral therapy in a compliant patient
Viral breakthrough	$>$ 1 log IU/ml increase in serum HBV-DNA from nadir of initial response during therapy as confirmed 1 month later
Secondary treatment failure	Viral breakthrough in a compliant patient (due to drug resistance)
Sustained virologic response	Serum HBV-DNA $<$ 2,000 IU/ml (10^4 copies/ml) and HBeAg seroconversion, if applicable, for at least 6 months after stopping therapy
Complete response	Sustained virologic response with HBsAg seroclearance

seroconversion is followed by clinical remission (inactive chronic HBV infection) in the majority of patients. However, active hepatitis may relapse due to HBeAg seroreversion or occurrence of HBeAg-negative hepatitis. The estimated annual incidence of hepatitis relapse was 2.2–3.3% [11, 12], being higher in males, genotypes C infected, and those who have HBeAg seroconversion after age 40 [13]. A recent long-term follow-up study (mean = 12.3 years) involving 1,241 incidentally identified subjects with inactive chronic HBV infection showed a lower annual incidence of 1.5%, being significantly much lower in younger patients, especially those younger than 30 years [11]. All these findings suggest that earlier HBeAg seroconversion or shorter HBeAg-positive phase is associated with higher chance of sustained remission. Asymptomatic HBeAg-negative subjects with HBV-DNA $>$ 2,000 IU/ml may also experience hepatitis flares and disease progression such as in HBeAg-positive patients [10–15]. Since the immunopathogenesis of HBeAg-negative hepatitis is similar to that of HBeAg-positive hepatitis,

this phase can be viewed as a variant of immune clearance phase.

A prospective study involving 684 patients with chronic HBV infection showed that cirrhosis developed at an estimated annual incidence of 2.1%, and that age, the extent, severity, frequency of flares, and the duration of hepatic lobular alterations were factors for disease outcomes and HBV clearance [16]. Patients with chronic HBV infection with persistent HBeAg seropositivity have an even higher incidence (3.5% per year) of cirrhosis [17]. One study showed that 23% of the patients with HBeAg-negative hepatitis progressed to cirrhosis during a follow-up period of 9 years (range = 1–18.4) [12]. A recent Korean long-term follow-up study (mean = 120 months) involving 188 patients (52 HBeAg-negative patients) showed that age and persistent ALT elevation are independent factors for the development of cirrhosis, decompensation, and hepatocellular carcinoma (HCC) [18]. HCC develops at an annual incidence of 3–6% in patients with cirrhosis and far less frequently in

noncirrhotic patients [12, 19, 20]. Seropositivity for HBeAg and/or HBV-DNA > 2,000 IU/ml are significant risk factors for cirrhosis and HCC development, even in asymptomatic subjects with chronic HBV infection [21–25].

Spontaneous HBsAg seroclearance may occur after HBeAg seroconversion. A recent 11-year follow-up study in 1,965 asymptomatic anti-HBe positive subjects [age = 16–76 years (median = 34)] showed an annual HBsAg seroclearance rate of 1.2%. The cumulative HBsAg seroclearance rate was 8% at 10 years, increased disproportionately to 25% at 20 years, and 45% at 25 years of follow-up [26]. HBsAg seroclearance usually confers excellent prognosis [27]. However, HCC may still occur, although at a very low rate if cirrhosis has already developed before HBsAg seroclearance [27, 28].

Hepatitis B virus has been classified into at least eight genotypes on the basis of an intergroup divergence of 8% or more in the complete genome nucleotide sequence. Subtypes are identified within some genotypes, but their clinical significance remains to be determined. Each genotype has its distinct geographical and ethnic distribution, worldwide and within the Asian-Pacific region. HBV genotypes B and C are prevalent in East and South-East Asia, the Pacific Islands, and Pakistan, whereas HBV genotypes D and A are prevalent in India and genotype A in the Philippines. HBV genotype D is also found in the Pacific Islands. HBV genotypes B and C are prevalent in highly endemic areas where perinatal or vertical transmission plays an important role in spreading the virus, whereas genotypes A, D, E, F, and G are frequently found in areas where the main mode of transmission is horizontal. The clinical significance and virologic characteristics of HBV genotypes have only been reliably compared between genotypes B and C or genotypes A and D. In general, genotype B is associated with less progressive liver disease than genotype C, and genotype D has a less favorable prognosis than genotype A [29]. A recent study in 1,536 Alaskan natives with chronic HBV infection has shown that the median age for HBeAg clearance was less than 20 years for genotypes A, B, D, and F, but more than 40 years for genotype C, and that patients with genotypes C and F have significantly more frequent HBeAg reversion and higher risk of HCC [30]. Several studies have shown that genotype B is associated with spontaneous HBeAg seroconversion at a younger age, less active liver disease, slower progression to cirrhosis, and less frequent development of HCC than genotype C [10, 22, 29–34]. HBV genotype B has been shown to induce a greater Th₁ and lesser Th₂ response than genotype C, leading to a higher chance of HBeAg seroconversion [35]. A study from India indicated that genotype D is more often associated with HBeAg-negative chronic HBV infection and more severe

diseases and may predict the occurrence of HCC in young patients [36]. It has also been shown that recombinant genotypes lead to more severe disease.

Due to the spontaneous error rate of viral reverse transcription, naturally occurring HBV mutations arise during the course of infection under the pressure of host immunity or specific therapy. Several HBV strains including mutations in precore, core promoter, and deletion mutation in pre-S/S genes have been reported to be associated with the pathogenesis of fulminant or progressive liver disease, including cirrhosis and HCC [29]. Patients harboring HBV genotype C have a higher HBV-DNA level, higher frequency of pre-S deletions, higher prevalence of core promoter A1762T and/or G1768/A mutations, and A1762T/G1764A double mutations than patients infected with HBV genotype B and have a significantly higher chance of developing HCC [21, 25, 29, 34, 37, 38]. A recent study revealed that a complex mutation pattern rather than a single mutation was associated with disease progression [38]. The role of these naturally occurring HBV mutations in the pathogenesis of liver disease progression requires further studies.

Concurrent infection with other virus(es)

Hepatitis B virus, hepatitis C virus (HCV), hepatitis delta virus (HDV), and human immunodeficiency virus (HIV) share similar transmission routes. Therefore, concurrent infection with these viruses may occur and complicate the natural course of chronic HBV infection. In general, concurrent infection with these viruses usually results in more severe and progressive liver disease and thus needs treatment [39].

Goals of treatment for chronic HBV infection

It is now clear that active HBV replication is the key driver of liver injury and disease progression, thus sustained viral suppression is of paramount importance [40]. Therefore, the primary aim of treatment for chronic HBV infection is to permanently suppress HBV replication. This decreases infectivity and pathogenicity of the virus. Reducing the pathogenicity of the virus results in reduced hepatic necroinflammation. Clinically, the short-term goal of treatment is to achieve “initial response” in terms of HBeAg seroconversion and/or HBV-DNA suppression, ALT normalization, and prevention of hepatic decompensation; to ensure “maintained/sustained response” to reduce hepatic necroinflammation and fibrosis during/after therapy. The ultimate long-term goal of therapy is to achieve “durable response” to prevent hepatic decompensation, reduce or prevent progression to cirrhosis and/or HCC, and prolong survival.

Currently available treatments

Currently, IFN- α , lamivudine, adefovir, entecavir, telbivudine, and PegIFN- α 2a have been licensed globally. Clevudine has been approved in Korea. Thymosin α_1 has also been approved in many countries in Asia.

IFN-based therapy

Conventional IFN Conventional IFN- α has been used for the treatment of chronic HBV infection for more than two decades. IFN- α has a dual mode of action: antiviral and immunomodulatory. Early controlled studies have shown that a 4- to 6-month course of conventional IFN- α at a dose of 5 MU daily or 10 MU 3 times weekly achieved HBeAg loss in approximately 33% of HBeAg-positive patients in comparison with 12% of controls. Smaller dosage (5–6 MU 3 times weekly) has been used in Asian patients with similar efficacy. Treatment of longer than 12 months' duration may improve the rate of HBeAg seroconversion, particularly in those with lower HBV-DNA levels after 16 weeks of treatment. Retreatment of relapsed patients with IFN- α showed a response rate of 20–40%. When HBeAg seroconversion to anti-HBe is achieved, it is sustained in more than 80% of cases [41].

Children with chronic HBV infection and high ALT levels respond to IFN- α at rates similar to adults. A recent study involving 108 Italian children, however, showed that there was no significant difference in the overall long-term outcomes in IFN- α -treated and untreated patients, and no patient developed end-stage liver disease or HCC during 12 years (range = 5–23) of follow-up [42].

The HBeAg seroconversion rate is lower in patients with lower baseline ALT levels. This rate may be improved by corticosteroid priming before IFN therapy. The recovery of immune function following steroid withdrawal may result in ALT flares and enhance the effect of IFN. A meta-analysis involving 790 patients in 13 randomized trials showed that this approach was associated with significantly more frequent loss of HBeAg ($P = 0.03$) and HBV-DNA ($P = 0.0008$), particularly in Asian patients with lower ALT levels and when lower dose of corticosteroid was used [43]. Severe adverse effects have been reported with this approach in patients with advanced liver disease.

IFN- α therapy resulted in end-of-treatment biochemical and virological response in up to 90% of patients with HBeAg-negative hepatitis. Sustained response rates, however, were disappointing: 10–15% with 4–6 months of treatment; 22% with 12 months of treatment; and 30% with 24 months of treatment. A study from Taiwan showed that 6–10 months' IFN therapy in HBeAg-negative patients had an end-of-treatment response of 57% (vs. 18% of controls) and 6 months' sustained response of 30% (vs. 7%).

Long-term follow-up studies suggest that IFN-induced HBeAg seroconversion is durable, increases over time, results in less cirrhosis development [17], better overall survival, and survival free of hepatic decompensation [17, 44]. The incidence of HCC is also lower in treated patients, especially among responders [17, 40, 45]. High HBsAg loss rate observed after IFN- α therapy in Italian patients was not observed in Asian patients [17].

A meta-analysis involving 1,505 cirrhotic patients in seven trials favored IFN therapy in reducing HCC, although significant heterogeneity of the trials made these results less conclusive. However, it has been shown that IFN- α therapy in compensated cirrhotic patients is safe and even more effective than noncirrhotic patients [20]. This finding suggests that the benefit of IFN therapy in reducing HCC might be evident upon longer follow-up. A subgroup analysis in a recent long-term follow-up study did show that HCC incidence was reduced significantly in IFN-treated cirrhotic patients [17].

The main advantage of IFN- α therapy is that a course of finite duration may achieve sustained off-therapy response in a proportion of patients with both HBeAg-positive and HBeAg-negative chronic HBV infections. However, IFN treatment is usually associated with adverse effects, especially influenza-like symptoms, fatigue, neutropenia, thrombocytopenia, and depression. These are usually tolerable, but may require dose modification and premature cessation of treatment [41].

PegIFN- α In an Asian study, a 24-week course of weekly PegIFN- α 2a (40 kD) gave a higher HBeAg seroconversion (33% vs. 25%; $P > 0.05$) and combination response (HBeAg loss, HBV-DNA $< 5 \times 10^5$ copies/ml, and normal ALT) rate (24% vs. 12%; $P = 0.036$) at 6 months after the end of treatment than conventional IFN- α 2a. This benefit was noted even in patients with a rather low likelihood of response to conventional IFN [46]. In large-scale phase III international multicenter studies involving 814 HBeAg-positive patients (>85% were Asians) and 564 HBeAg-negative patients (>60% were Asians), PegIFN- α 2a (40 kD) monotherapy 180 μ g once weekly for 48 weeks resulted in ALT normalization in 41% and 59% patients, HBV-DNA < 80 IU/ml (< 400 copies/ml) in 14% and 19% patients, and HBsAg seroclearance in 3% and 3% patients, respectively. HBeAg seroconversion occurred in 32% and HBV-DNA levels were less than 20,000 IU/ml ($< 10^5$ copies/ml) in 32% of HBeAg-positive patients, whereas HBV-DNA levels remained less than 4,000 IU/ml (2×10^4 copies/ml) in 43% of HBeAg-negative patients when assessed 6 months after cessation of therapy. PegIFN- α 2a was found to be superior to lamivudine, with respect to sustained HBeAg seroconversion and HBV-DNA suppression, in both HBeAg-positive and

HBeAg-negative patients [47, 48]. These responses were sustained in up to 90% when assessed 3 years after end of therapy [49]. The 6 months' sustained HBeAg seroconversion rate is similar to that obtained after 6 months' therapy in an earlier phase II study. A 4-arm head-to-head randomized control study using 90 and 180 µg of PegIFN- α 2a for 6 or 12 months is ongoing.

Several studies using PegIFN- α 2b showed similar efficacy [41]. One study showed that peg-IFN α 2b was safe and effective in patients with advanced fibrosis or cirrhosis as those with early stage of fibrosis [50]. Patients with chronic HBV infection who are lamivudine refractory and those who are lamivudine naïve respond similarly to PegIFN- α 2b therapy [51].

High baseline ALT, low baseline HBV-DNA and HBeAg levels, and high-grade necroinflammatory activity are predictors of response to IFN and PegIFN- α therapy [41]. ALT flares followed by decrease in HBV-DNA levels and decline of HBeAg levels during PegIFN- α therapy were predictors of response at the end of follow-up [52, 53]. Baseline ALT, baseline HBV-DNA, and HBV genotype influence the combined response (ALT normalization and HBV-DNA $< 4 \times 10^3$ IU/ml [$< 2 \times 10^4$ copies/ml]) at 24 weeks posttreatment in patients with HBeAg-negative chronic HBV infection with a 48-week course of PegIFN- α 2a with or without lamivudine [54].

Studies using conventional IFN therapy have shown that patients with HBV genotypes A and B infection have a higher HBeAg seroconversion rate than patients with HBV genotypes C and D infection, respectively [29]. These findings were confirmed by recent studies using PegIFN, where HBeAg seroconversion occurred more often in patients with HBV genotypes A (40%–47%) and B (30%–44%) than those with HBV genotypes C (28%–30%) and D (20%–25%) infection [46, 55]. Significantly better response in genotype B infected patients (31% vs. 17.5% of genotype C infected; $P < 0.05$) was observed in earlier 6-month PegIFN- α 2a trial [46] but not in the recent 12-month trial [47]. This may suggest that longer PegIFN therapy may be required to enhance the response of the patients with more difficult-to-treat situations such as in genotype C or D infected patients.

IFN combination with other agents Studies using IFN- α or PegIFN- α and lamivudine combination in comparison with IFN- α or PegIFN- α or lamivudine monotherapy in HBeAg-positive and HBeAg-negative patients showed that combination therapy had greater on-treatment viral suppression and higher rates of sustained response than lamivudine monotherapy, but there was no difference in sustained off-treatment response when compared with IFN- α or PegIFN- α monotherapy [47, 48]. To date, there has been no large clinical trial that confirms the benefits of

PegIFN- α plus nucleoside or nucleotide analogue therapy over PegIFN- α monotherapy [41].

Sequential therapy with lamivudine 100 mg daily for 4 weeks followed by PegIFN- α 2b 1.0 µg/kg per week for a further 24 weeks ($n = 36$ patients) compared with PegIFN- α 2b monotherapy for 24 weeks ($n = 27$ patients) in patients with HBeAg-positive chronic HBV infection showed a significantly higher rate of HBV-DNA undetectability ($< 4,700$ copies/ml) (50% vs. 14.8%) and higher rates of HBeAg clearance (38.9% vs. 14.8%) at 6 months posttherapy [56].

A randomized controlled trial in 96 patients showed that lymphoblastoid IFN 5 MU in combination with thymosin α -1 1.6 mg 3 times weekly for 24 weeks increased HBeAg loss 1 year after the end of treatment with marginal significance in comparison with IFN monotherapy (45.8% vs. 28%; $P = 0.067$) [57].

IFN-based therapy: overall conclusions The advantages of IFN-based therapy include finite duration of treatment with modest response, long-term benefit, and no resistance. PegIFN may eventually replace conventional IFN because of higher efficacy and more convenient once weekly administration. The optimal duration (6 vs. 12 months) of PegIFN therapy in HBeAg-positive patients is under study. Perhaps patients infected with HBV genotype C or D may require longer treatment.

Other immunomodulating agents

Thymosin α -1 A few studies have evaluated the efficacy of thymosin α -1 ($T\alpha_1$), an immunomodulating agent that enhances the Th₁ immune response, natural killer T cells, and CD8⁺ CTL activity against HBV. A Taiwanese study showed that therapy with subcutaneous $T\alpha_1$ 1.6 mg twice weekly for 6 months resulted in a significantly higher HBeAg seroconversion rate (40% vs. 9% in controls) when assessed 12 months after the end of therapy [58]. A 6-month therapy in Chinese HBeAg-negative patients also showed a response rate of 42% (11/26) [59]. Patients infected with genotype B HBV showed a significantly better response (52%) than patients infected with genotype C (24%) HBV [60]. A response rate of 22% was also observed in a Japanese study involving 316 patients, mostly infected with genotype C HBV [61]. A meta-analysis including 353 patients from five trials showed that the odds ratio for virological response to $T\alpha_1$ at the end of treatment, 6, and 12 months posttreatment were 0.56 (0.2–1.52), 1.67 (0.83–3.37), and 2.67 (1.25–5.68), respectively, with a significantly increasing virological response over time after discontinuation of thymosin therapy [62]. The number of patients included in thymosin α -1 trials was relatively small in comparison with recent trials using

PegIFN or nucleoside analogues. More well-designed, large-scale studies are needed to confirm its efficacy. The main advantages of thymosin α -1 are fixed duration of therapy and minimal side effects.

Therapeutic vaccines Various therapeutic vaccines were used in an attempt to restore the virus-specific host immune response. However, none of them demonstrated sufficient clinical efficacy. In a recent open-label controlled study, 195 HBeAg-positive patients were randomized to receive 12 doses of HBsAg with AS02 adjuvant candidate vaccine plus lamivudine daily for 52 weeks or lamivudine daily alone. Despite induction of a vigorous HBsAg-specific lymphoproliferative response, cytokine production, and anti-HBs antibodies, therapeutic vaccination with an adjuvanted HBsAg vaccine combined with lamivudine did not demonstrate superior clinical efficacy than lamivudine alone [63].

Direct antiviral agents

Lamivudine, adefovir, entecavir, and telbivudine are highly effective in inhibiting HBV replication and have been approved worldwide for the treatment of chronic HBV infection. These agents are prodrugs and need intracellular activation before they can exert their therapeutic action.

The efficacy of treatment with these four drugs is compared in Table 2. Clevudine has been approved only in Korea. Tenofovir and other new nucleoside analogues are in various stages of appraisal.

Lamivudine Lamivudine, an L-nucleoside analogue, at a daily dose of 100 mg is effective in suppressing HBV-DNA with ALT normalization and histologic improvement in both HBeAg-positive and HBeAg-negative patients [64]. HBeAg seroconversion is achieved in 35–65% of HBeAg-positive patients after 5 years of therapy; the rate being proportional to the levels of ALT prior to treatment and highest in patients with ALT levels over 5 times ULN. This suggests that patients with a more vigorous immune response to HBV respond better to the direct antiviral effect of lamivudine [65]. The HBeAg seroconversion rate is similar in patients with HBV genotype B or C infection. Children treated with lamivudine for 1 year with dosages adjusted for body weight (3 mg/kg) showed similar response to adults, and the drug has been found to be safe during 3 years of continuous therapy [66]. In the absence of HBeAg seroconversion, hepatitis flares may occur if lamivudine is stopped. Lamivudine can be stopped after HBeAg seroconversion. Sustained HBeAg seroconversion to anti-HBe occurs in ~80% of patients after cessation of lamivudine therapy [64]. The durability of response is

Table 2 Comparisons of viral responses among four antiviral agents in treatment-naïve patients with chronic hepatitis B

	Lamivudine		Adefovir dipivoxil		Entecavir		Telbivudine	
	e(+)	e(-)	e(+)	e(-)	e(+)	e(-)	e(+)	e(-)
HBV-DNA (-log)								
Year 1	5.4 ^a	4.5 ^b	3.6	3.7	6.9 ^a	5.0 ^b	5.7 ^c	4.4 ^c
	5.4 ^c	4.1 ^c	[1.0]	[1.4]				
Undetectable								
Year 1	36% ^a	72% ^b	21%	61%	67% ^a	90% ^b	60% ^c	88% ^c
	40% ^c	71% ^c	[0%]	[0%]				
Year 2	39%* ^d	NA	NA	71%	80%* ^d	NA	56% ^c	82% ^c
	39% ^c	57% ^c						
Year 3	20%	40%	NA	77%**	89%*	NA	NA	NA
HBeAg seroconversion								
Year 1	18% ^a	NA	12%	NA	21% ^a	NA	23% ^c	NA
	22% ^c		[6%]					
Year 2	26%*	NA	29%	NA	31%*	NA	30% ^c	NA
	25% ^c							
Year 3	40%	NA	NA	NA	NA	NA	NA	NA
Genotypic resistance								
Year 1	13% ^a	6% ^b	0%	0%*	0% ^a	0% ^b	5% ^c	2% ^c
	11% ^c	11% ^c						
Year 2	38% ^d	31%	NA	3%*	0% ^d	NA	25% ^c	11% ^c
	40% ^c	26% ^c						
Year 3	57%	57%	NA	11%*	~1%	NA	NA	NA

^{a-c} Data from same randomized controlled trials (a: [86]; b: [87]; c: [90]; d: [88]; e: [64])

Abbreviations: *, cumulative incidence; [-], data of untreated controls; **, HBV-DNA < 1,000 copies/ml
 HBV: hepatitis B virus; e: hepatitis B e antigen; NA: not available

particularly low in patients with genotype C HBV infection, older patients, and if treatment is maintained for less than 4–8 months after HBeAg seroconversion [67]. Acute flares of hepatitis may occur in patients with the reappearance of HBeAg and detectable HBV-DNA (HBeAg seroreversion). In pediatric patients, the durability of HBeAg seroconversion increased from 82% to more than 90% in those who had received lamivudine for 52 weeks and more than 2 years, respectively [66].

The antiviral and therapeutic impact of lamivudine in patients with HBeAg-negative chronic HBV infection is similar to that in HBeAg-positive patients. Sustained antiviral response is obtained in only 15–20% of cases after 1 year of treatment [63]. Lamivudine therapy for 6–12 months resulted in 81% maintained virologic response in a study involving 85 Taiwanese HBeAg-negative patients with pretreatment ALT > 5 times ULN, and sustained virologic response was observed in 39% of these patients 12 months after stopping lamivudine therapy [68]. In a study involving 50 Chinese-Canadian patients, 2-year treatment with lamivudine resulted in maintained virologic response in 37 (74%) patients. Therapy was stopped in these 37 patients when undetectable HBV-DNA and normal ALT levels were documented on three separate occasions at least 3 months apart. Relapse was noted in 50% of these patients (86% of them infected with genotype C HBV) 1 year after cessation of therapy [69]. In a Hong Kong Chinese study, 2-year lamivudine treatment in 89 HBeAg-negative patients showed a maintained complete response (normal ALT and HBV-DNA < 2×10^3 IU/ml [$<10^4$ copies/ml]) rate of 56% and a sustained response rate of 26% 6 months posttherapy [70]. These three studies show that about 50% of the patients who achieved maintained response have sustained off-therapy response.

Lamivudine is well tolerated and is safe for use, even in patients with decompensated cirrhosis [20, 64]. Long-term therapy in viremic patients with advanced fibrosis or cirrhosis delays clinical progression by reducing the rate of hepatic decompensation and HCC development, even in patients with low or normal ALT levels [71].

After 6–9 months of lamivudine therapy, viral breakthrough may occur following the emergence of HBV mutations that are resistant to lamivudine. These HBV-variant species have mutations in the YMDD motif of the polymerase gene (rtM204I and rtM204V with or without rtL180M). The incidence increases with increasing duration of therapy, up to 70% among patients treated with lamivudine continuously for 5 years. Other factors associated with the emergence of rtM204 I/V include baseline HBV-DNA, ALT, and/or hepatitis activity, sex and body mass index, and initial virologic response. Recent studies have shown that detectable HBV-DNA at month 6 was associated with higher resistance rate [64, 70]. The

emergence of genotypic resistance is usually followed by a more than 1 log increase of HBV-DNA from nadir (viral breakthrough). With continuation of therapy, ALT elevation (biochemical breakthrough) occurs in more than 90% of patients after documented viral breakthrough [72, 73]. Hepatitis flares may develop and can occasionally result in hepatic decompensation [74]. New and distinct mutants may be selected during continuing lamivudine therapy and elicit further hepatitis flares [75]. The initial histologic improvement may be reversed in patients with rtM204 I/V [76]. The benefit of long-term therapy in preventing disease progression in patients with advanced fibrosis or cirrhosis also decreased after emergence of rtM204 I/V [71, 77]. The decision on long-term lamivudine therapy must therefore take into consideration the potential clinical benefits, possible risk associated with drug-resistant mutations, and the durability of response after stopping therapy.

Combination therapy using lamivudine with adefovir, telbivudine, IFN, or PegIFN has not demonstrated significant efficacy advantage in controlled trials. These combinations, however, lower the rates of resistant mutations than lamivudine monotherapy [64]. A pilot study in 30 Taiwanese patients showed that a short course of prednisolone priming enhanced Th₁ response and efficacy subsequent to lamivudine therapy [78]. “Lamivudine pulse” therapy has resulted in sustained HBeAg and HBV-DNA loss in 31% of 27 patients with chronic HBV infection and normal ALT levels [79]. This approach could be dangerous in patients with advanced fibrosis or cirrhosis.

Adefovir dipivoxil Adefovir dipivoxil is a synthetic acyclic adenine nucleotide analogue. It is a potent inhibitor of HBV reverse transcriptase in the wild-type HBV as well as in lamivudine-, telbivudine-, and entecavir-resistant mutants.

Two large international multicenter double-blinded, placebo-controlled studies have shown that oral adefovir dipivoxil 10 mg daily for 48 weeks is effective in HBV-DNA suppression, ALT normalization, and histologic improvement in patients with both HBeAg-positive and HBeAg-negative chronic HBV infections. In HBeAg-positive patients, HBeAg loss and HBeAg seroconversion increased from 12% (control 6%) after 1 year to 40% after 3 years' therapy [64]. Up to 240 weeks of adefovir therapy in naïve HBeAg-negative patients resulted in HBV-DNA < 200 IU/ml in 67% of patients, ALT normalization in 69% of patients, improvement in necroinflammation in 83% of patients, and regression of fibrosis in 73% of patients, respectively [80]. Response to adefovir was similar in Asian and Caucasian patients. Integrated analysis from all phase III clinical trials showed that HBV genotype does not influence virologic response to adefovir dipivoxil regardless of HBeAg serostatus [64].

The safety profile of 10 mg of adefovir dipivoxil was similar to placebo in patients with compensated chronic HBV infection. Renal laboratory abnormalities reported with 30 mg of adefovir dipivoxil were not observed with 10 mg of dosage during the 1-year study period. Reversible increase in serum creatinine of more than 0.5 mg/dL (maximum 1.5 mg/dl) was reported in 3% of patients when therapy was extended to 5 years [80]. Most patients with decompensated chronic HBV infection, including patients with pre- and post-liver transplant, have some degree of underlying renal insufficiency. Studies on these patients showed increases in serum creatinine levels by 0.5 mg/dl or more from baseline in 16% of them by week 48, 31% by week 96, and 1% required discontinuation due to renal failure [64].

Sequenced RT domain of HBV-DNA polymerase identified rtN236T and rtA181T/V mutations with decreased susceptibility to adefovir dipivoxil in patients on adefovir therapy for more than 1 year. The overall incidence of adefovir-resistant mutation is low. Integrated incidence rate was 0%, 3%, and 11%, 18%, and 29% at the end of each successive year of therapy in HBeAg-negative patients. HBV-DNA > 200 IU/ml (10^3 copies/ml) at week 48 were predictive of the emergence of adefovir-resistant mutations (49% vs. 6% of those 10^3 copies/ml) during 192 weeks of adefovir treatment [80]. Adefovir dipivoxil-resistant rtN236T mutant remains susceptible to L-nucleoside analogues lamivudine, emtricitabine, telbivudine, and entecavir in vitro and may argue for their combination in therapy. The rtA181T/V HBV is resistant to adefovir and all the L-nucleoside analogues, but sensitive to entecavir [73].

One year of adefovir dipivoxil monotherapy or in combination with lamivudine reduced serum HBV-DNA levels in most patients with lamivudine-resistant mutants (median reduction = 3.6 \log_{10} to 4.6 \log_{10} copies/ml). Switching to adefovir dipivoxil monotherapy in lamivudine-resistant patients appeared effective and safe, even in patients with liver decompensation [81]. The rate of resistant mutation, however, is higher under such circumstances (up to 30% by the end of year 2) than adefovir monotherapy in lamivudine-naïve patients [82]. A 3-year study of 145 lamivudine-resistant HBV-infected patients showed that add-on adefovir led to undetectable HBV-DNA in 80% and normal ALT in 84% of patients, and none developed virologic and clinical breakthrough during 12–74 months of therapy [83]. Add-on adefovir in patients with HBV-DNA >math>10^7</math> copies/ml is associated with insufficient virologic response [82, 84], and should therefore be instituted as soon as genotypic resistance is detected and before the serum HBV-DNA levels increase to a level too high to be suppressed successfully [85].

The high genetic barrier to resistance and the ability to suppress most lamivudine-resistant mutants (rtM204 V/I)

makes adefovir dipivoxil an attractive drug. Renal toxicity is rare with the dose of 10 mg and few patients had significant elevation of serum creatinine levels of more than 0.5 mg/dl in clinical studies. Caution must be exercised in treating patients with renal impairment.

Entecavir Entecavir is a cyclopentyl guanosine analogue with potent selective inhibition of the priming, DNA-dependent synthesis, and reverse transcription functions of HBV polymerase. In a viral kinetic study comparing entecavir to adefovir in HBeAg-positive patients with high viral load, entecavir showed significantly greater HBV-DNA reduction as early as day 10, HBV-DNA reduction was -6.23 log versus -4.42 log at week 12 and -7.28 log vs. -5.08 log at week 48, respectively [64]. Pivotal phase III randomized lamivudine controlled trials showed that 1-year entecavir (0.5 mg/day) is superior to lamivudine in reducing HBV-DNA in both HBeAg-positive (-6.9 log vs. -5.4 log; $P < 0.0001$; HBV-DNA < 300 copies/ml in 67% vs. 36%) [86] and HBeAg-negative patients (-5.0 log vs. -4.5 log; $P < 0.001$; HBV-DNA < 300 copies/ml in 90% vs. 72%) [87]. HBeAg seroconversion rate was 21% (68% in patients with pretherapy ALT > 5 times ULN). Extending entecavir therapy to 96 weeks for partial responders at week 48 resulted in an increase in the rate of HBV-DNA < 60 IU/ml (<300 copies/ml) to 74%, ALT normalization increased to 79%, and a cumulative HBeAg seroconversion rate of 31% [88]. The corresponding rate was 91%, 86%, and additional 16%, respectively, after extending entecavir therapy to 192 weeks [64].

Switching to entecavir monotherapy (1 mg/day) is initially effective in lamivudine-resistant patients (-5.11 log vs. -0.48 log reduction in lamivudine controls; $P < 0.001$) and safe without risk of ALT flares. HBeAg loss was documented in 10% of lamivudine-resistant HBeAg-positive patients (vs. 3% in lamivudine controls; $P = 0.028$) [89]. Entecavir has a high genetic barrier, and drug resistance requires at least three mutations including rtL180M and rtM204 V, plus a mutation at one of the following codons: rtT184, rtS202, and/or rtM250 [73]. Therefore, entecavir therapy in lamivudine-refractory patients is associated with a higher entecavir resistance rate [88, 89]. The cumulative probability of a virologic breakthrough from entecavir resistance through 4 years is at least 0.8% in lamivudine-naïve patients and 39.5% in lamivudine-refractory patients [64, 73].

Telbivudine Telbivudine is an orally bioavailable L-nucleoside with potent and specific anti-HBV activity. In clinical trials, telbivudine gave more potent HBV suppression than lamivudine or adefovir. In the phase III randomized lamivudine controlled trial in 1,371 patients (446 HBeAg negative, 1,040 Asians), significantly greater

HBV-DNA reduction with telbivudine 600 mg/day was evident by week 12 (-5.71 log vs. -5.42 log in HBeAg-positive patients and -4.36 log vs. -4.08 log in HBeAg-negative patients). HBV-DNA reduction persisted through week 52 with greater histologic response, larger proportions of patients with undetectable HBV-DNA (60.0% vs. 40.4% in HBeAg-positive patients and 88.3% vs. 71.4% in HBeAg-negative patients), and less resistance (5.0% vs. 11% in HBeAg-positive patients and 2.3% vs. 10.7% in HBeAg-negative patients) than lamivudine. The C-domain mutation rtM204I and the B-domain mutation rtA181T/V are the common mutations associated with telbivudine resistance. The HBeAg seroconversion rate was similar between telbivudine- and lamivudine-treated patients. The study also showed that 41% of HBeAg-positive patients with undetectable HBV-DNA at week 24 underwent HBeAg seroconversion by week 52 versus 4% for patients with HBV-DNA $> 2,000$ IU/ml at week 24. Only 1% of HBeAg-positive patients with undetectable HBV-DNA and 2% of patients with HBV-DNA < 200 IU/ml ($< 10^3$ copies/ml) at week 24 developed drug resistance by week 52, whereas 11% of patients with HBV-DNA $> 10^4$ copies/ml at week 24 became resistant at week 52. The corresponding figures for drug resistance in HBeAg-negative patients was 0%, 6%, and 30%, respectively [90]. Two-year telbivudine therapy was significantly superior to lamivudine in both HBeAg-positive and HBeAg-negative patients for all direct measures of antiviral effect, including serum HBV-DNA reduction from baseline (-5.7 vs. -4.4 in HBeAg-positive patients and -5.0 vs. -4.2 in HBeAg-negative patients), PCR negativity (56% vs. 39% in HBeAg-positive patients and 82% vs. 57% in HBeAg-negative patients), HBeAg seroconversion in patients with ALT ≥ 2 times ULN (36% vs. 27%; $P = 0.022$), and viral resistance (25% vs. 40% in HBeAg-positive patients and 11% vs. 26% in HBeAg-negative patients; $P < 0.001$). Week 24 HBV-DNA levels also emerged as a strong predictor of week 104 efficacy outcomes [64].

In another 1-year randomized adefovir controlled trial in 135 HBeAg-positive patients, significantly greater HBV-DNA reduction with telbivudine was evident at week 24 (-6.30 log vs. -4.97 log, undetectable HBV-DNA in 39% vs. 12%; ≥ 3 log copies/ml in 50% vs. 78% of patients) and week 52 (-6.56 log vs. -5.99 log; undetectable HBV-DNA 60% vs. 40% of patients). The HBeAg seroconversion rate at week 52 of treatment was also higher in telbivudine-treated patients than in adefovir-treated patients (28% vs. 19%; $P = 0.34$). A predictive analysis of response showed that week 24 serum HBV-DNA < 200 vs. ≥ 200 IU/ml (< 3 log₁₀ vs. ≥ 3 log₁₀ copies/ml) correlated with undetectable HBV-DNA (95% vs. 24%) and HBeAg seroconversion rate (41% vs. 14%) at year 1.

Patients with viral breakthrough at year 1 had HBV-DNA > 200 IU/ml (> 3 log₁₀ copies/ml) at week 24 [91].

Increase in creatine kinase levels was observed more frequently in recipients of telbivudine, of whom 7.5% (vs. 3.1% in lamivudine-treated controls) had grade 3 or 4 elevation (a level of > 7 times ULN). Two-thirds of grade 3 or 4 creatine kinase elevations decreased spontaneously to grade 2 or lower during continued treatment. Symptomatic myopathy was reported in 1 patient after 11 months of telbivudine therapy, and resolved over a period of 9–12 months after stopping telbivudine [90].

Other emerging direct antivirals *Clevudine* is a pyrimidine analogue with potent and sustained antiviral activity against HBV. Clevudine 30 mg/day for 24 weeks resulted in end-of-treatment HBV-DNA reduction of 5.10 log₁₀ copies/ml, undetectable HBV-DNA in 59%, ALT normalization in 68.2%, and HBeAg loss in 24% of 243 HBeAg-positive patients [92]. The same regimen resulted in end-of-therapy HBV-DNA reduction of 4.25 log₁₀ copies/ml, undetectable HBV-DNA in 92%, and ALT normalization in 75% of 86 HBeAg-negative patients; HBV suppression sustained as HBV-DNA was 3.11 log₁₀ copies/ml, with undetectable HBV-DNA in 80.3% and normal ALT in 70.5% of patients 24 weeks after stopping clevudine [93]. No significant difference was reported in these efficacy parameters among the patients with different pretreatment ALT levels [92]. Substitutions rtA181A/T and rtA181T without viral breakthrough were detected in 5 (2.7%) of the 182 HBeAg-positive patients [92], but none in HBeAg-negative patients [93].

Tenofovir disoproxil fumarate is an acyclic adenine nucleotide that exerts a strong and early suppression of HBV with or without lamivudine-associated mutations. It has been approved for use in the treatment of HIV infection. Tenofovir 300 mg/day is more potent than adefovir 10 mg/day but without comparable renal toxicity. Clinical studies have shown that administration of tenofovir 300 mg daily has stronger antiviral effect against lamivudine-resistant HBV than adefovir 10 mg daily [94, 95]. Phase III randomized adefovir controlled trial in HBeAg-positive patients has shown that tenofovir has better efficacy than adefovir with respect to histologic improvement (74% vs. 68%), HBV-DNA reduction to less than 400 copies/ml (76% vs. 13%; $P < 0.001$), ALT normalization (69% vs. 54%; $P = 0.02$), and HBeAg seroconversion (21% vs. 18%; $P = 0.36$). Tenofovir also achieved combined virologic and histologic response in a higher proportion of HBeAg-negative patients (71% vs. 49%; $P < 0.001$) [96]. Tenofovir appears to be a very promising drug and is likely to get approval for use in the treatment of chronic HBV infection and replace adefovir in the near future.

Therapy with direct antiviral agent(s): overall conclusions The successive generation of nucleos(t)ide analogues has improved potency and raised genetic barrier to resistant mutations (Table 2). Although there is no head-to-head comparison among these 4 drugs, the results of published pivotal trials suggest that entecavir is the most potent agent, followed by telbivudine, lamivudine, and adefovir in terms of HBV-DNA reduction during a 1-year treatment period. Histologic improvement and documented regression of advanced fibrosis and cirrhosis among the responders is an important achievement. Reduction in the progression of disease and HCC development after 3 years of lamivudine therapy for patients with advanced fibrosis is a proof for therapeutic aim. Increased antiviral potency of these drugs, however, does not correlate with increase in HBeAg loss or HBeAg seroconversion. Resistance is a major concern during long-term therapy. The incidence at 1 and 2 years is highest with lamivudine, followed by telbivudine, then adefovir and tenofovir, and almost none with entecavir. In choosing a direct antiviral agent to initiate therapy, resistance profile is a crucial factor to consider other than the potency and cost. The “roadmap” concept for using on-treatment HBV-DNA level as a predictor for drug resistance may be useful when patients are treated with agents with high resistance rate [97]. Pharmacoeconomic studies would be helpful in individual countries in Asia-Pacific region because cost is one of the most important factors in the choice of drug for initial therapy [98].

Special groups of patients

Pregnancy

IFN-based therapy is contraindicated in pregnancy because of its antiproliferative effect. Among the direct antiviral agents, telbivudine is classified as category B drug (no risk in animal studies, but unknown in human), whereas lamivudine, adefovir and entecavir are classified as category C drugs (teratogenic in animal, but unknown in human) by the US FDA [99]. The stage of the mother’s liver disease and potential benefit of treatment must be weighed against the small risk to the fetus. IFN-based therapy is preferable in women in the childbearing age, and pregnancy is discouraged during IFN therapy. No firm recommendation can be made on the use of nucleos(t)ide analogues in the prevention of transmission from viremic mothers because of the lack of sufficient data and conflicting results with regard to efficacy and adverse events. Women with chronic HBV infection who become pregnant while on direct antiviral therapy can continue treatment with category B drugs [3].

Patients with concurrent HCV, HDV, or HIV infection

Patients with concurrent HCV, HDV, or HIV infections tend to have a higher incidence of cirrhosis, HCC, and mortality. Insufficient data exist to reach firm conclusions on the management of patients with HCV and/or HDV infections. However, it is generally agreed that the dominant virus should be identified before designing therapeutic strategy. If HBV is dominant, treatment should be aimed toward this virus. If HCV is dominant, standard IFN or PegIFN therapy in combination with ribavirin can achieve a sustained HCV clearance rate comparable to that in HCV mono-infection. Lamivudine is ineffective in patients with chronic HDV infection. Small randomized controlled trials using 3–9 MU of IFN for 3–24 months showed a biochemical and virologic response in up to 70% of the patients with chronic HDV infection. Sustained response was noted in less than 20% of patients. Higher doses of IFN- α (9 MU thrice weekly) for 12 months have been found to inhibit HDV-RNA, normalize ALT, and improve histology in patients with chronic HDV infection. ALT response sustained in 50% of the patients and the long-term outcomes and survival improved significantly even in patients with liver cirrhosis [100]. IFN in combination with lamivudine therapy tends to increase response rate compared with IFN monotherapy [101]. Two small studies using weight-based PegIFN- α 2b (1.5 μ g/kg weekly) for 6 and 12 months, respectively, showed discrepant results [100].

In patients with concurrent HIV infection and CD4⁺ counts of more than 500 cells/ μ L, treatment options include agents without anti-HIV activity: IFN, adefovir, and telbivudine. IFN-based therapy or adefovir is preferred because of the absence of resistance in the former and a low resistance profile in the later. Both lamivudine and tenofovir are active against HBV and HIV and can be used in combination as part of the highly active antiretroviral therapy (HAART) in patients who need both anti-HBV and anti-HIV therapies. In patients with low CD4 count and active liver disease, HBV should be treated first to avoid the risk of immune reconstitution syndrome that usually occurs with HIV treatment.

Patients with hepatic decompensation

Patients with hepatic decompensation should be considered for treatment because it may both improve their clinical status and even remove them from liver transplant lists. IFN does not benefit patients with Child’s B or C cirrhosis. Moreover, significant adverse effects due to serious bacterial infections and possible exacerbation of liver disease occur even with low doses. Lamivudine is well tolerated and results in clinical improvement or stabilization,

especially in patients who have completed a minimum of 6 months' treatment [102, 103]. Early treatment is recommended to improve outcomes. Selection of resistant mutants with resultant biochemical dysfunction, reduction in efficacy, and rapid clinical deterioration in this group of patients is a real concern with early treatment [20]. Adding adefovir to 128 lamivudine-resistant patients with decompensated cirrhosis and 196 lamivudine-resistant patients with recurrent HBV infection after liver transplantation was associated with 3–4 log reduction in serum HBV-DNA levels throughout the treatment period [104]. However, renal dysfunction is a potential problem in patients with hepatic decompensation. Close monitoring of renal function is, therefore, required if this drug is being used for such patients. Entecavir, telbivudine, and tenofovir are being evaluated as a primary treatment modality in patients with decompensated liver disease. Given the similar mechanisms of action and safety profile, the more potent entecavir, telbivudine, and tenofovir are anticipated to be more effective than or at least as effective as lamivudine in this clinical setting with lower or nearly no incidence of drug resistance and no problem with nephrotoxicity.

Pediatric patients

Children with elevated ALT levels respond to IFN and lamivudine in a similar manner to adults. A small study in children and adolescents (aged 2–17) showed that adefovir is generally well tolerated at a dose of 0.3 mg/day for those aged 2–11, and 10 mg for those aged 12–17 [105]. Newer agents such as PegIFN and other nucleos(t)ide analogues have not yet been studied, but are likely to be as effective in children as in adults with chronic HBV infection. Long-term safety and drug resistance are more important concerns in children than in adults. As already mentioned, recent long-term follow-up study showed that IFN therapy provided little benefit in comparison with untreated children [42]. Therefore, drug therapy is usually not recommended in pediatric patients because of the apparent lack of long-term benefits and attending risks of starting drug therapy, unless there is an absolute indication such as in the setting of ensuing or overt hepatic decompensation.

Patients on immunosuppression or chemotherapy

Reactivation of HBV replication with decompensation has been reported in 20–50% of patients with chronic HBV infection undergoing cancer chemotherapy or immunosuppressive therapy, especially those containing high-dose steroid regimen. Reactivation commonly occurs after the first 2–3 cycles of chemotherapy. High viral load at baseline is the most important risk factor for HBV reactivation [106]. HBV reactivation following transarterial

chemoembolization was also observed in 34% of 83 patients with HCC [107]. Lamivudine is effective in the treatment of HBV reactivation in HBsAg-positive organ transplantation recipients and cancer patients undergoing chemotherapy, particularly if it is used preemptively. Prophylactic use of lamivudine within 1 week before the start and continued at least 12 weeks after end of chemotherapy, and when white blood cell count has normalized, can reduce HBV reactivation frequency and severity of flares and improve survival [106].

The impact of immunosuppressive therapy on patients with occult HBV infection is poorly characterized. In a recent study involving 244 consecutive HBsAg-negative lymphoma patients who received chemotherapy, 8 (3.3%) developed de novo HBV-related hepatitis and 3 with fulminant hepatic failure, following a 100-fold increase in serum HBV-DNA levels. These patients responded to lamivudine, but one died of hepatic failure. These findings suggest that even in an HBV endemic area, the occurrence of de novo HBV-related hepatitis after chemotherapy is low. It was suggested that HBsAg-negative patients, especially those receiving rituximab plus steroid-containing regimen, should be closely monitored to facilitate early commencement of nucleoside/nucleotide analogues [108].

Liver transplantation for chronic HBV infection

Liver transplantation has become a cost-effective treatment of liver failure and HCC with excellent 5-year survival. Improving economies and live related liver donation have allowed a rapid expansion of liver transplantation within the Asia-Pacific region where hepatitis B is the most common indication for both acute and chronic liver failure. Acute or chronic HBV infection accounts for most cases of acute liver failure in this region, whereas more than 80% of cases of chronic liver failure and HCC are caused by chronic HBV infection. Although HBV recurrence can be prevented in 60% of cases by high-dose (10,000 U/month) intravenous hepatitis B immunoglobulin (HBIG), this therapy is prohibitively expensive (US\$50,000 per annum, lifelong) and is ineffective in transplant candidates with detectable HBV-DNA. Suppression of pretransplant viral replication significantly reduces the risk of posttransplant recurrence. In addition, viral suppression rescues some patients with decompensated cirrhosis, thereby removing the need for future transplant [103].

Antiviral therapy should be commenced in all potential liver transplant candidates with decompensated HBV cirrhosis and detectable HBV-DNA. However, posttransplant HBV recurrence may still occur despite antiviral prophylaxis and is usually due to lamivudine resistance [1]. Adefovir and entecavir are available for rescue therapy for

lamivudine resistance, and de novo use of these agents may minimize the problems of drug resistance. Combination lamivudine/HBIg prophylaxis reduces recurrence rates of HBV infection to less than 5% and is associated with 5-year patient and graft survival rates of 85% and 80%, respectively. A recent long-term (median = 62 months) follow-up study involving 147 patients has shown that lamivudine plus low-dose intramuscular HBIg (400–800 U daily for 1 week, then monthly) appears as effective as lamivudine plus high-dose intravenous HBIg, but is less than 10% the cost (US\$4,000) [109]. A recent study suggested that late HBIg substitution by adefovir (at least 12 months posttransplant) can prevent late HBV recurrence at less cost [110]. In a prospective open-labeled study, lamivudine plus adefovir combination from the time of listing was well tolerated, prevented lamivudine resistance prior to transplant, rescued some patients from the need for transplantation, and prevented recurrent HBV infection following liver transplantation, regardless of baseline HBV-DNA status [111]. Both studies demonstrate that lamivudine plus adefovir combination prophylaxis has similar efficacy to current lamivudine plus HBIg prophylaxis but without the cost and inconvenience of long-term monthly HBIg administration. There is emerging data that HBIg ± lamivudine prophylaxis can be replaced by lamivudine monotherapy 12 months posttransplant in certain “low-risk” patient groups. These include patients who were HBV-DNA negative (hybridization assay) before pretransplant lamivudine therapy was started and patients with sustained protective levels of anti-HBs production following posttransplant vaccination.

Adoptive immune transfer may result in de novo anti-HBs production in recipients of live related liver graft from an HBV immune donor. A liver from anti-HBc(+) donor carries a significant risk of de novo HBV infection if transplanted into an HBV-naïve recipient. This risk becomes negligible if the recipient receives long-term prophylaxis with either lamivudine or HBIg or if the recipient is seronegative for HBsAg but positive for anti-HBs.

Issues and recommendations

Based on this background information, the following issues and recommendations for management of chronic HBV infection are listed. The recommendations were based on evidences graded as I (at least 1 well-designed, randomized control trial), II (well-designed cohort or case-controlled studies), III (case series, case reports, or flawed clinical trials), and IV (opinions of respected authorities based on clinical experience, descriptive studies, or reports of expert committees).

General management

Before active therapy, a thorough evaluation of the patient is essential. A complete blood cell count, biochemical tests, and HBV replication status should be part of the initial evaluation. Besides drug therapy directed at liver disease, counseling of the patient is also very important and even crucial for a successful antiviral therapy. This should include information on the infectivity/transmission of HBV and preventive measures for family members and sexual contacts (e.g., vaccination); advice on lifestyle such as activity, diet, alcohol use, risk behaviors, and factors that predispose to superinfection with other hepatitis virus(es) and their prevention; the importance and need for careful follow-up and long-term monitoring, and possible therapy. Health-related quality of life assessment has shown that patients with chronic HBV infection attribute a wide range of negative psychological, social, and physical symptoms to their condition even in the absence of cirrhosis or cancer [112]. These symptoms should be considered in the counseling process. The indications, risks/benefits, advantages/disadvantages, cost, and possible problems of each therapeutic option should be explained in detail. The therapy should be tailored for individual needs. Careful assessment on an individual basis, including likelihood of response and economic factors of individual patients, is absolutely essential before starting therapy. HBV genotyping may be considered, but is not mandatory.

Recommendation 1: *Thorough evaluation and counseling are mandatory before considering drug therapy (II).*

Indications for treatment

Available information suggests that patients with persistently normal ALT levels usually have minimal histologic changes and respond poorly, in terms of HBeAg seroconversion, when treated with currently available drugs. Therefore, no drug treatment is recommended for this group of patients unless they have evidence of advanced fibrosis or cirrhosis [113]. However, they should be followed up every 3 months for the first year, and then monitored every 3 months if HBeAg positive and every 6 months if HBeAg negative. Surveillance for HCC using ultrasonography and serum α -fetoprotein every 3–6 months is also important for high-risk HBV-infected persons (male, age >40, cirrhotic, positive family history of serious liver disease) [114]. Patients with active HBV replication (positive HBeAg and/or HBV-DNA) and raised ALT levels are candidates for treatment. Liver biopsy is recommended before therapy to assess the necroinflammatory grade, determine the fibrotic stage, and exclude other possible causes of raised ALT levels as a guide to the indication for

antiviral treatment. A liver biopsy should be considered in patients older than 40 [115], especially those with high normal ALT levels [8].

Recommendation 2: Patients with viral replication but persistently normal or minimally elevated ALT levels should not be treated, except in patients with advanced fibrosis or cirrhosis. They need adequate follow-up and HCC surveillance every 3–6 months (I).

Fig. 1 Algorithm for the management of hepatitis B e antigen (HBeAg)-positive patients with chronic hepatitis B infection. AFP: alphafetoprotein; ALT: alanine aminotransferase; HBV: hepatitis B virus; HCC: hepatocellular carcinoma; ULN: upper limit of normal; LT: liver transplantation

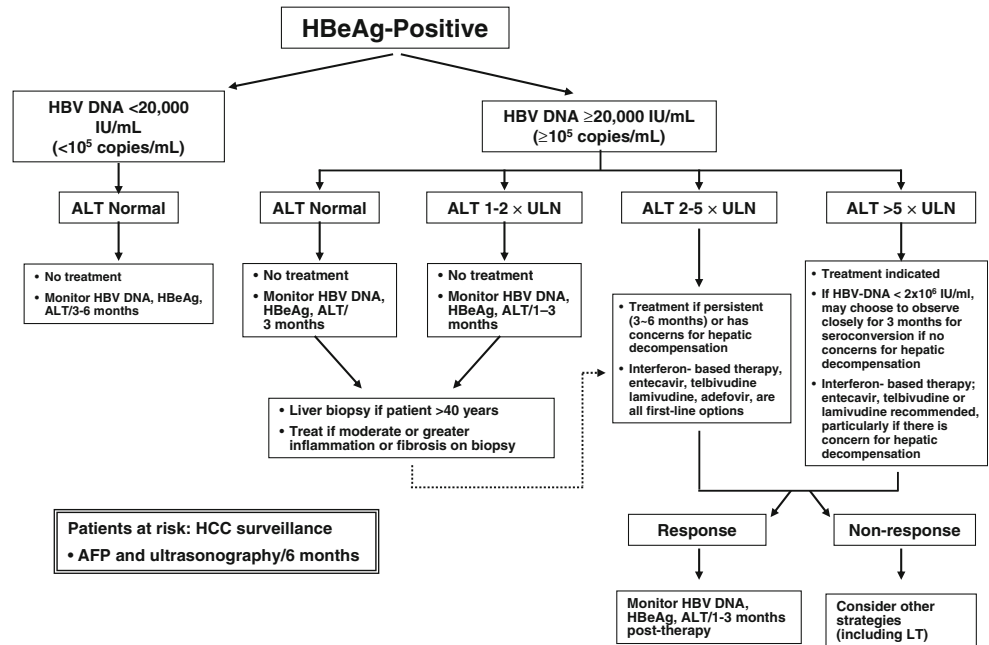
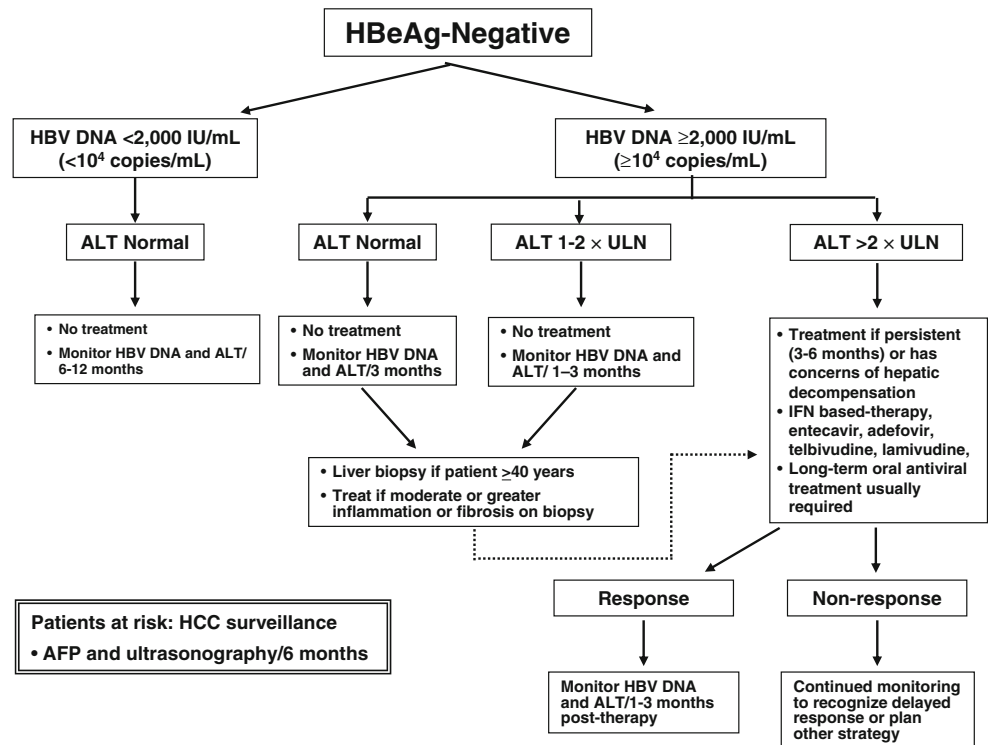


Fig. 2 Algorithm for the management of hepatitis B e antigen (HBeAg)-negative patients with chronic hepatitis B infection. AFP: alphafetoprotein; ALT: alanine aminotransferase; HBV: hepatitis B virus; HCC: hepatocellular carcinoma; ULN: upper limit of normal

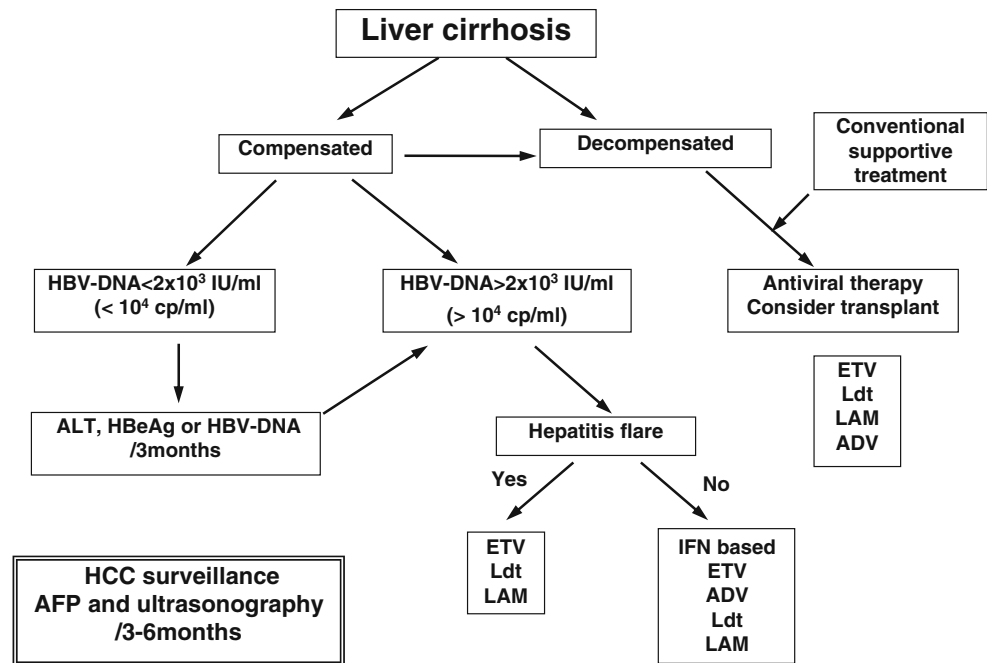


Recommendation 3: Prior to therapy, liver biopsy is recommended in patients with HBV replication and raised ALT levels, or those with high normal ALT levels and older than 40 (II).

Time to start treatment (Figs. 1–3)

Treatment may be started if patients have persistently elevated ALT level ≥ 2 times ULN (at least 1 month between observations).

Fig. 3 Algorithm for the management of chronic hepatitis B infection with liver cirrhosis. ADV: adefovir; AFP: alphafetoprotein; ALT: alanine aminotransferase; ETV: entecavir; HBeAg: hepatitis B e antigen; HBV: hepatitis B virus; HCC: hepatocellular carcinoma; IFN: interferon; LAM: lamivudine; Ldt: telbivudine



Patients with a rising trend in ALT (from normal or minimally elevated levels) or with ALT > 5 times ULN may be developing an exacerbation and severe hepatitis or hepatic decompensation may follow, particularly those with increasing serum HBV-DNA > 10⁸ copies/ml [116] or in patients with advanced fibrosis [20]. They should be monitored closely for weekly or biweekly serum bilirubin levels and prothrombin time measurement. Treatment must be initiated in time to prevent the development or deterioration of hepatic decompensation. Such exacerbations, particularly in patients with declining serum HBV-DNA levels or a level less than 10⁶ copies/ml, may also precede spontaneous HBeAg seroconversion and may be followed by disease remission [9]. Due to this, it is reasonable to delay treatment for an observation period of 3 months if there is no concern about hepatic decompensation.

Recommendation 4: Chronic HBV-infected patients with ALT > 2 times ULN and HBV-DNA > 2.0 × 10⁴ IU/ml (10⁵ copies/ml) if HBeAg positive or > 2.0 × 10³ IU/ml (10⁴ copies/ml) if HBeAg negative should be considered for treatment (I). Treatment should be started as early as possible in case of impending or overt hepatic decompensation (II). Otherwise, 3–6 months' observation is recommended (II).

Which drugs or strategy?

Drugs currently approved for the treatment of chronic HBV infection have relatively limited sustained long-term efficacy. Therefore, the probability of sustained response, age

of patient, severity of liver disease, likelihood of drug resistance, adverse events, and complications need to be carefully considered. Conventional IFN or PegIFN-α2a, lamivudine, adefovir, entecavir, and telbivudine can all be considered for initial therapy in patients without liver decompensation. The rates of sustained response seem to be higher with IFN-α and PegIFN-α2a than with direct antiviral agents, and response can be achieved with a defined duration of treatment [117]. Cirrhotic patients respond to IFN or PegIFN better than, or at least as good as, their noncirrhotic counterparts. IFN-based therapy has more side effects and requires closer monitoring.

For viremic patients (both HBeAg positive and HBeAg negative, adults and children) with ALT > 5 times ULN, entecavir, telbivudine, or lamivudine is recommended if there is a concern about hepatic decompensation because of its rapidity of action. IFN-based therapy is also more effective in patients with higher ALT levels; it is generally not preferred in such circumstances because its therapeutic effect is not immediate and the patient may become decompensated.

For HBeAg-positive patients with an ALT level between 2 and 5 times ULN, the choice between IFN-based therapy and direct antiviral agents is less clear and either agent may be used. Theoretically, this group of patients has not mounted a high enough immune response against HBV, and thus need immunomodulation.

Corticosteroid priming before IFN or lamivudine therapy is generally not recommended and should be used cautiously and only in expert centers and not in patients with advanced disease.

Twelve-month IFN or PegIFN- α 2a induces higher sustained response rates than direct antiviral agents in HBeAg-negative patients with intermittent or persistent ALT elevation, moderate to severe inflammation, fibrosis on biopsy, and serum HBV-DNA > 2,000 IU/ml (10^4 copies/ml). Direct antiviral agents provide other options, but long-term therapy is required and therefore the drug resistance profile of the drug to be used should be considered. The long-term (>5 years) effect of IFN therapy is better known than direct antiviral agents.

The decision as to which agent to be used should be an individual one, based on disease severity, history of flares, hepatic function, the rapidity of drug action, resistance profile, side effects, costs of the drugs, and patient choice.

PegIFN- α 2b has been approved for the treatment of chronic HBV infection in a few countries. This IFN has not been well studied in HBeAg-negative patients.

Recommendation 5: *Patients can be treated with conventional IFN 5–10 MU 3 times per week or PegIFN- α 2a 90–180 μ g weekly (I), entecavir 0.5 mg daily (I), adefovir 10 mg daily (I), telbivudine 600 mg daily (I), or lamivudine 100 mg daily (I). Thymosin α 1 1.6 mg 2 times per week can also be used (I). Lamivudine is recommended if there is a concern regarding ensuing or overt hepatic decompensation (II). Entecavir and telbivudine may also be used in this situation (IV).*

How to monitor?

To achieve the most cost-effective treatment, adequate monitoring during and after treatment is crucial. HBV-DNA measurements should be done using assays standardized/validated to report against the WHO IU/ml reference standard. If affordable, drug-resistant testing should also be considered.

Recommendation 6: *During therapy, ALT HBeAg and/or HBV-DNA should be monitored at least every 3 months (I). Renal function should be monitored if adefovir is used (I). During IFN therapy, monitoring of adverse effects is mandatory (I).*

Recommendation 7: *After the end of therapy, levels of ALT and HBV-DNA should be monitored monthly for the first 3 months to detect early relapse, and then every 3 (for cirrhotic patients and those who remain HBeAg/HBV-DNA positive) to 6 months (for responders) (II). For nonresponders, further monitoring of HBV markers is required to both recognize a delayed response and plan retreatment when indicated (II).*

When to stop therapy?

The recommended duration of IFN-based therapy for patients with HBeAg-positive hepatitis infection is

6–12 months irrespective of whether or not response has occurred. For HBeAg-negative patients, 12 months' therapy is required. A 6- to 12-month observation period after the end of IFN therapy is also recommended to both detect delayed response and establish whether a response is sustained, and thus whether retreatment or other therapy is required. The recommended duration of thymosin α 1 therapy is 6 months, with 12 months' observation after end of therapy.

Since the incidence of drug resistance increases with increasing duration of direct antiviral therapy, therapy can be stopped if the patient has undergone HBeAg seroconversion with HBV-DNA loss measured at two consecutive occasions at least 6 months apart. For those who remain HBeAg positive, the decision to continue or stop therapy should be evaluated individually on the basis of clinical/virologic response and disease severity. If resistant mutations emerge, early rescue therapy with other agents is indicated. For HBeAg-negative patients, the optimal duration of treatment is unknown and the decision to stop therapy should be determined by clinical response and severity of the underlying liver disease.

Recommendation 8: *For conventional IFN, the current recommended duration of therapy is 4–6 months for HBeAg-positive patients (II) and at least a year for HBeAg-negative patients (I). For PegIFN, the recommended duration is at least 6 month for HBeAg-positive patients (II) and 12 months for HBeAg-negative patients (I). For thymosin α 1, the recommended duration of therapy is 6 months for both HBeAg-positive (I) and HBeAg-negative patients (II).*

Recommendation 9: *For oral antiviral agents: In HBeAg-positive patients, treatment can be stopped when HBeAg seroconversion with undetectable HBV-DNA has been documented on 2 separate occasions at least 6 months apart (II). In HBeAg-negative patients, it is not clear how long this treatment should be continued, but treatment discontinuation can be considered if undetectable HBV-DNA has been documented on three separate occasions 6 months apart. (II).*

What to do for patients in special circumstances?

Female patients in the childbearing age

When treatment is indicated in women in the childbearing age, both the drug property and the duration of dosing should be considered.

Recommendation 10: *For female patients of childbearing age, IFN-based therapy is preferred for nonpregnant women and pregnancy is discouraged during IFN therapy.*

Women who become pregnant while on oral antiviral drug(s) can continue treatment with category B drug(s) (VI).

Patients with concurrent HIV infection

All HIV-infected patients with active HBV replication and elevated serum ALT levels may be considered for treatment. Treatment needs to be individualized according to the patient's HIV status. If the infection does not fulfill treatment criteria, IFN-based therapy or adefovir monotherapy is preferred. Lamivudine or tenofovir monotherapy is not recommended in this setting because of the risk of HIV resistance. HAART containing lamivudine/tenofovir or its equivalent combination is recommended if treatment is being continued for infection.

Recommendation 11: Adefovir, telbivudine, or IFN (if $CD_4 > 500$) is preferred if patient's HIV infection does not require treatment. If infection requires treatment, tenofovir or lamivudine/tenofovir combination should be included in the active antiretroviral therapy (II).

Patients with concurrent HCV or HDV infection

It is important to determine which virus is dominant before designing the treatment strategy.

Recommendation 12: In patients with concurrent HCV or HDV infection, determine which virus is dominant and treat the patients accordingly (III).

Patients with decompensated liver disease

IFN is usually contraindicated in patients with decompensated liver disease. Direct antiviral agent with potent and prompt HBV suppressive action should be used immediately.

Recommendation 13: Lamivudine is the agent of choice for treatment-naïve patients with obvious or impending hepatic decompensation (II). Entecavir and telbivudine can also be used (IV).

Patients undergoing immunosuppression or chemotherapy

HBV reactivation is a serious complication in patients undergoing immunosuppression or chemotherapy. Lamivudine therapy is effective when instituted early, before the occurrence of clinical jaundice and decompensation. Results are significantly better if lamivudine is used before starting chemotherapy [118]. Prophylactic treatment using other antiviral agent has not been reported.

Recommendation 14: Before receiving immunosuppression or chemotherapy, patients should be screened for HBsAg (III). If HBsAg positive, prophylactic therapy with lamivudine before the start and up to at least 12 weeks after the end of immunosuppression or chemotherapy is recommended (I). Other direct antiviral agents can also be used (IV).

Patients with drug resistance

Once drug resistance is evident by a more than 1 log IU/ml increase of HBV-DNA from nadir, rescue therapy should be instituted as early as possible.

Recommendation 15: For patients who develop drug resistance while on lamivudine, add-on adefovir therapy is indicated (I); switching to entecavir (1 mg/day) is an option (I). For lamivudine-naïve patients who develop drug resistance while on adefovir, add-on or switching to lamivudine, telbivudine, or entecavir is indicated (III). For patients who develop drug resistance while on telbivudine, add-on adefovir therapy is indicated (IV). Switching to IFN-based therapy is an option (III).

Patients in the setting of liver transplantation

Nucleos(t)ide analogues are effective in pretransplant treatment, prevention (in combination with HBIg) of posttransplant HBV recurrence, and treatment of posttransplant HBV-related allograft infection. Adequate use of these agents has improved the outcome.

Recommendation 16–1: Nucleos(t)ide analogue(s) should be commenced in all patients with HBV-associated liver failure who are listed for transplantation and have detectable HBV-DNA. Lamivudine plus low-dose HBIg (400–800 U i.m. daily for 1 week, followed by 400–800 U monthly for long term) provides safe and effective prophylaxis against HBV reinfection of the allograft (II). Alternatively, lamivudine + adefovir prophylaxis can be considered (II).

Recommendation 16–2: Late (at least 12 months post-transplant) HBIg substitution by adefovir provides safe and cost-effective prophylaxis (II). Late conversion to lamivudine monotherapy may be considered in “low-risk” patients (I).

Recommendation 16–3: HBV-naïve patient receiving a liver from anti-HBc(+) donor should receive long-term prophylaxis with either lamivudine or HBIg (III).

Unresolved issues and areas for further study

Despite recent advances in the treatment of chronic HBV infection, the results are still unsatisfactory. In particular, the following issues remain unsettled:

1. Should HBV genotyping be routine in designing treatment plan?
2. What should be done if on-treatment response to direct antiviral agents (at 24 week?) is not satisfactory?
3. What should be the treatment strategy for children with chronic HBV infection? “Necessity” or “likelihood to respond”?
4. Is there more effective therapy for patients with chronic HDV infection?
5. What is the role of corticosteroid withdrawal, lamivudine pulse therapy, or other immunomodulating agents and modes of immunomodulation?
6. What is the optimal combination therapy to enhance efficacy?
7. Cost-effectiveness of each therapeutic strategy.

The development of new drugs and new strategies, especially combination or sequential antiviral therapy, is the highest priority in further improving the outcomes of treatment.

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