CME

Alcoholic Liver Disease

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These recommendations provide a data-supported approach. They are based on the following: (i) a formal review and analysis of the recently published world literature on the topic (Medline search); (ii) American College of Physicians Manual for Assessing Health Practices and Designing Practice Guidelines (1); (iii) guideline policies, including the American Association for the Study of Liver Diseases (AASLD) Policy on the development and use of practice guidelines and the AGA Policy Statement on Guidelines (2); and (iv) the experience of the authors in the specified topic. Intended for use by physicians, these recommendations suggest preferred approaches to the diagnostic, therapeutic, and preventive aspects of care. They are intended to be flexible, in contrast to the standards of care, which are inflexible policies to be followed in every case. Specific recommendations are based on relevant published information. To more fully characterize the quality of evidence supporting the recommendations, the Practice Guideline Committee of the AASLD requires a Class (reflecting the benefit vs. risk) and Level (assessing the strength or certainty) of Evidence to be assigned and reported with each recommendation (Table 1, adapted from the American College of Cardiology and the American Heart Association Practice Guidelines) (3,4).

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PREVALENCE AND NATURAL HISTORY

Alcoholic liver disease (ALD) encompasses a spectrum of injury, ranging from simple steatosis to frank cirrhosis. It may well represent the oldest form of liver injury known to mankind. Evidence suggests that fermented beverages existed at least as early as the Neolithic period (cir. 10,000 BC) (5). Alcohol remains a major cause of liver disease worldwide. It is common for patients with ALD to share the risk factors for simultaneous injury from other liver insults (e.g., co-existing non-alcoholic fatty liver disease, or chronic viral hepatitis). Many of the natural history studies of ALD and even treatment trials were performed before these other liver diseases were recognized, or specific testing was possible. Thus, the individual effect of alcohol in some of these studies may have been confounded by the presence of these additional injuries. Despite this limitation, the data regarding ALD are robust enough to draw conclusions about the pathophysiology of this disease. The possible factors that can affect the development of liver injury include the dose, duration, and type of alcohol consumption, drinking patterns, gender, ethnicity, and associated risk factors, including obesity, iron overload, concomitant infection with viral hepatitis, and genetic factors.

Geographic variability exists in the patterns of alcohol intake throughout the world (6). Approximately two-thirds of the adult Americans drink alcohol (7). The majority drink small or moderate amounts and do so without evidence of clinical disease (8–10). A subgroup of drinkers, however, drink excessively, develop physical tolerance and withdrawal, and are diagnosed with alcohol dependence (11). A second subset, alcohol abusers and problem drinkers, are those who engage in harmful use of alcohol, which is defined by the development of negative social and health consequences of drinking (e.g., unemployment, loss of family, organ damage, accidental injury, or death) (12). Failure to recognize alcoholism remains a significant problem and impairs efforts at both the prevention and the management of patients with ALD (13,14). Although the exact prevalence is unknown, approximately 7.4% of adult Americans were estimated to meet the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, criteria for the diagnosis of alcohol abuse and/or alcohol dependence in 1994 (15); more recent data suggest 4.65% meet the criteria for alcohol abuse and 3.81% for alcohol dependence (16). In 2003, 44% of all deaths from liver disease were attributed to alcohol (17).

The population-level mortality from ALD is related to the per capita alcohol consumption obtained from national alcoholic beverage sales data. There are conflicting data regarding a possible lower risk of liver injury in wine drinkers (18,19). One epidemiological study has estimated that for every 1 l increase in per capita alcohol consumption (independent of the type of beverage), there was a 14% increase in cirrhosis in men and 8% increase in women (20). These data must be considered in the context of the limitations of measuring alcohol

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Table 1. Grading system for recommendations

Classification	Description
Class I	Conditions for which there is evidence and/or general agreement that a given diagnostic evaluation, procedure or treatment is beneficial, useful, and effective
Class II	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a diagnostic evaluation, procedure, or treatment
Class IIa	Weight of evidence/opinion is in favor of usefulness/efficacy
Class IIb	Usefulness/efficacy is less well established by evidence/opinion
Class III	Conditions for which there is evidence and/or general agreement that a diagnostic evaluation/procedure/treatment is not useful/effective and in some cases may be harmful
Level of evidence	
Level A	Data derived from multiple randomized clinical trials or meta-analyses
Level B	Data derived from a single randomized trial or nonrandomized studies
Level C	Only consensus opinion of experts, case studies, or standard of care

Table 2. Quantity of alcohol in a standard drink

	Amount (g)	Range (g)
USA	12	9.3–13.2
Canada	13.6	13.6
UK	9.5	8–10
Europe	9.8	8.7–10.0
Australia and New Zealand	9.2	6.0–11.0
Japan	23.5	21.2–28.0

Adapted from Turner (262).
To standardize, many authorities recommend conversion to grams of alcohol consumed. To convert concentrations of alcohol, usually listed in volume percent (equivalent to the volume of solute/volume of solution × 100), the percentage of alcohol by volume (% v/v) is multiplied by the specific gravity of alcohol, 0.79 g/ml (263).

use and defining ALD. The scientific literature has also used a variety of definitions of what constitutes a standard drink (**Table 2**). Most studies depend on interviews with patients or their families to quantify drinking patterns, a method that is subject to a number of biases, which may lead to invalid estimates of alcohol consumption (21).

Although there are limitations of the available data, the World Health Organization's Global Alcohol database, which has been in existence since 1996, has been used to estimate the worldwide patterns of alcohol consumption and allow comparisons of alcohol-related morbidity and mortality (22). The burden of alcohol-related disease is the highest in the developed world, where it may account for as much as 9.2% of all disability-adjusted life years. However, even in the developing regions of the world, alcohol accounts for a major portion of the global disease burden, and is projected to take on increasing importance in those regions over time (22,23).

DISEASE SPECTRUM

The spectrum of alcohol-related liver injury varies from simple steatosis to cirrhosis. These are not necessarily distinct stages of evolution of the disease, but rather, multiple stages that may be present simultaneously in a given individual (24,25). These are often grouped into three histological stages of ALD, including fatty liver or simple steatosis, alcoholic hepatitis (AH), and chronic hepatitis with hepatic fibrosis or cirrhosis (26). The latter stages may also be associated with a number of histological changes (which have varying degrees of specificity for ALD), including the presence of Mallory's hyaline, megamitochondria, or perivenular and perisinusoidal fibrosis (24).

Fatty liver develops in about 90% of individuals who drink more than 60 g/day of alcohol (27), but may also occur in individuals who drink less (28). Simple, uncomplicated fatty liver is usually asymptomatic and self-limited, and may be completely reversible with abstinence after about 4–6 weeks (29). However, several studies have suggested that progression to fibrosis and cirrhosis occurs in 5–15% of the patients despite abstinence (30,31). In one study, continued alcohol use (>40 g/day) increased the risk of progression to cirrhosis to 30%, and fibrosis or cirrhosis to 37% (32).

Fibrosis is believed to start in the perivenular area and is influenced by the amount of alcohol ingested (33,34). Perivenular fibrosis and deposition of fibronectin occur in 40–60% of the patients who ingest more than 40–80 g/day for an average of 25 years. Perivenular sclerosis has been identified as a significant and independent risk factor for the progression of alcoholic liver injury to fibrosis or cirrhosis (33,35). Progression of ALD culminates in the development of cirrhosis, which is usually micronodular, but may occasionally be mixed micro- and macronodular (36).

A subset of patients with ALD will develop severe AH, which has a substantially worse short-term prognosis (37). AH also represents a spectrum of disease, ranging from mild injury to severe, life-threatening injury, and often presents acutely against a background of chronic liver disease (38,39). The true prevalence is unknown, but histological studies of patients with ALD suggest that AH may be present in as many as 10–35% of hospitalized alcoholic patients (40–42). Typically, symptomatic patients present with advanced liver disease, with concomitant cirrhosis in more than 50% of the patients, and superimposed

acute decompensation. However, even patients with a relatively mild presentation are at high risk of progressive liver injury, with cirrhosis developing in up to 50% of the patients (43,44). The likelihood that AH will progress to permanent damage is increased among those who continue to abuse alcohol. Abstinence from alcohol in one small series did not guarantee complete recovery. Only 27% of the abstaining patients had histological normalization, whereas 18% progressed to cirrhosis, and the remaining patients had persistent AH when followed for up to 18 months (45).

RISK FACTORS

Unlike many other hepatotoxins, the likelihood of developing progressive alcohol-induced liver disease or cirrhosis is not completely dose-dependent, as it occurs in only a subset of patients. A number of risk factors that influence the risk of development and progression of liver disease have been identified.

The amount of alcohol ingested (independent of the form in which it is ingested) is the most important risk factor for the development of ALD (46). The relationship between the quantity of alcohol ingested and the development of liver disease is not clearly linear (47,48). However, a significant correlation exists between per capita consumption and the prevalence of cirrhosis (49). The risk of developing cirrhosis increases with the ingestion of >60–80 g/day of alcohol for ≥10 years in men, and >20 g/day in women (6,50). Yet, despite drinking at these levels, only 6–41% of the individuals develop cirrhosis (6,51). In a population-based cohort study of almost 7,000 subjects in two northern Italian communities, even among patients with very high daily alcohol intake (>120 g/day), only 13.5% developed ALD (50). The risk of cirrhosis or non-cirrhotic chronic liver disease increased with a total lifetime alcohol intake of >100 kg, or a daily intake of >30 g/day (50). The odds of developing cirrhosis or lesser degrees of liver disease with a daily alcohol intake of >30 g/day were 13.7 and 23.6, respectively, when compared with non-drinkers (50).

The type of alcohol consumed may influence the risk of developing liver disease. In a survey of over 30,000 persons in Denmark, drinking beer or spirits was more likely to be associated with liver disease than drinking wine (18).

Another factor that has been identified is the pattern of drinking. Drinking outside of meal times has been reported to increase the risk of ALD by 2.7-fold compared with those who consumed alcohol only at mealtimes (52). Binge drinking, defined by some researchers as five drinks for men and four drinks for women in one sitting, has also been shown to increase the risk of ALD and all-cause mortality (53,54).

Women have been found to be twice as sensitive to alcohol-mediated hepatotoxicity and may develop more severe ALD at lower doses and with shorter duration of alcohol consumption than men (55). Several studies have shown differing blood alcohol levels in women vs. men after consumption of equal amounts of alcohol (56). This might be explained by differences in the relative amounts of gastric alcohol dehydrogenase, a higher proportion of body fat in women, or changes in alcohol absorption with the menstrual cycle (57). Based on epidemiological evidence of a threshold effect of alcohol, a suggested 'safe' limit of alcohol intake had been 21 units per week in men and 14 units per week in women who have no other chronic liver disease (58,59) (wherein a unit is defined as the equivalent of 8 g of ethanol). However, other data suggest that a lower quantity may be toxic in women, implying a lower threshold of perhaps no more than 7 units per week (47). A higher risk of liver injury may be associated with an individual's racial and ethnic heritage (60). The rates of alcoholic cirrhosis are higher in African-American and Hispanic males compared with Caucasian males and the mortality rates are the highest in Hispanic males (61). These differences do not seem to be related to differences in the amounts of alcohol consumed (62).

The presence and extent of protein calorie malnutrition have an important role in determining the outcome of patients with ALD. Mortality increases in direct proportion to the extent of malnutrition, approaching 80% in patients with severe malnutrition (i.e., <50% of the normal) (63). Micronutrient abnormalities, such as hepatic vitamin A depletion or depressed vitamin E levels, may also potentially aggravate the liver disease (64). Diets rich in polyunsaturated fats promote alcohol-induced liver disease in animals (65), whereas diets high in saturated fats may be protective. Obesity and excess body weight have been associated with an increased risk of ALD (66,67).

In addition to environmental factors, genetic factors predispose to both alcoholism and ALD (68–70). Children of alcoholics raised in adopted families had a significantly higher rate of alcohol dependence than adopted children of non-alcoholics, who served as controls (18% vs. 5%) (71). In population-based studies, monozygotic twins were approximately twice as likely to drink as dizygotic twins; among those who drank, monozygotic twins were more likely to have a similar frequency and quantity of alcohol consumption (72). Moreover, monozyotic twins had a significantly higher prevalence of alcoholic cirrhosis than dizygotic twins (73).

Finally, polymorphisms of genes involved in the metabolism of alcohol (including alcohol dehydrogenase, acetaldehyde dehydrogenase, and the cytochrome P450 system) and in those that regulate endotoxin-mediated release of cytokines have been associated with ALD (74,75). However, specific genetic abnormalities for susceptibility to alcohol abuse and the development of ALD have not yet been firmly established.

There is a clear synergistic relationship between chronic viral hepatitis and alcohol, resulting in more advanced liver disease jointly than separately. The combination of HCV and alcohol predisposes to more advanced liver injury than alcohol alone (76,77), with disease at a younger age, more severe histological features, and a decreased survival (78). In a large-cohort study of the effect of heavy alcohol abuse in patients with post-transfusion hepatitis C, the risk of cirrhosis was elevated 30-fold (79). Although the precise toxic threshold for alcohol is not known, and may be lower and non-uniform among patients at

risk, it seems prudent in light of these data to advise patients with hepatitis C to abstain from consuming even moderate quantities of alcohol.

DIAGNOSIS

The diagnosis of ALD is based on a combination of features, including a history of significant alcohol intake, clinical evidence of liver disease, and supporting laboratory abnormalities (80). Unfortunately, the ability to detect these is constrained by patient and physician factors, as well as diagnostic laboratory shortcomings. Denial of alcohol abuse and underreporting of alcohol intake are common in these patients (81,82). Physicians underestimate alcohol-related problems and make specific recommendations even less frequently (83,84). Both the physical findings and laboratory evidence for ALD may be non-diagnostic, especially in patients with mild ALD or early cirrhosis (85). Therefore, the clinician must have a low threshold to raise the issue of possible ALD, and has to rely on indirect evidence of alcohol abuse, such as questionnaires, information from family members, or laboratory tests to strengthen or confirm a clinical suspicion (86).

Screening for alcohol abuse

Clinicians commonly fail to screen patients, and thus fail to recognize or treat alcoholism appropriately (87). Clinical history that may suggest alcohol abuse or alcohol dependence includes the pattern, type, and amount of alcohol ingested, as well as evidence of social or psychological consequences of alcohol abuse. These may be suggested by other injuries or past trauma, such as frequent falls, lacerations, burns, fractures, or emergency department visits (88). Biochemical tests have been considered to be less sensitive than questionnaires in screening for alcohol abuse (89,90), but may be useful in identifying relapse (91,92). Various questionnaires have been used to detect alcohol dependence or abuse, and include the CAGE, the Michigan Alcoholism Screening Test, and the Alcohol Use Disorders Identification Test (89,93). A structured interview, using instruments such as the Lifetime Drinking History, is often used as a gold standard for quantifying lifetime alchohol consumption (94).

The CAGE questionnaire was originally developed to identify hospitalized inpatients with alcohol problems, and remains among the most widely used screening instruments. It has been faulted, however, on several measures—it focuses on the consequences of alcohol consumption rather than on the amount of actual drinking, and it refers to lifetime patterns of behavior, rather than short-term or recent changes. Its virtues, however, include its ease of implementation—it is short (four questions), simple (yes/no answers), and can be incorporated into the clinical history or self-administered as a written document. As a result of its longevity, it has been tested in a wide range of populations.

One meta-analysis of its characteristics, using a cutoff of more than two positive responses, found an overall pooled sensitivity and specificity of 0.71 and 0.90, respectively (95). The CAGE questionnaire is familiar to most physicians, and has been suggested for use in general screening (96) (**Table 3**). The Alcohol Use Disorders Identification Test is a 10-item questionnaire developed by the World Health Organization to avoid ethnic and cultural bias (97) and focus on the identification of heavy drinkers. It has a higher sensitivity and specificity than shorter screening instruments (with sensitivity ranging from 51 to 97%, and specificity from 78 to 96% in primary care) (98). It has been suggested that it has three advantages over other screening tests: it may identify drinkers at risk who are not yet alcohol-dependent; it includes a measure of consumption; and lastly, it includes both current and lifetime drinking time spans. It is more likely to detect problem drinking before overt alcohol dependence or abuse might be diagnosed, and thus may be more robust and effective across a variety of populations (99–101). One possible algorithm for clinicians suggests asking about the quantity of alcohol consumed, and the number of heavy drinking days in the preceding year (i.e., ≥ 5 drinks/day for men or ≥ 4 drinks/day for women), as well as administering a version of the Alcohol Use Disorders Identification Test questionnaire (102) (**Table 4**). An Alcohol Use Disorders Identification Test score of ≥ 8, or having had ≥ 1 heavy drinking days constitutes a positive screening test, and should prompt further evaluation to rule out an alcohol use disorder (102).

Table 3. The CAGE questionnaire (264)

1. Have you ever felt you should cut down on your drinking?
2. Have people annoyed you by criticizing your drinking?
3. Have you ever felt bad or guilty about your drinking?
4. Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover (eye-opener)?

Scoring: Each response is scored as 0 or 1, with a higher score indicative of alcohol-related problems, and a total of ≥ 2 being clinically significant.

Regardless of which screening instrument is selected, however, it is important for clinicians to incorporate screening into their general practice (98,103). This may be especially important, as some data suggest that these screening instruments may improve the ability of physicians to predict long-term clinical outcomes, including hospitalization for alcohol-related diagnoses (104).

One particular biomarker in longstanding use, gamma glutamyl transpeptidase (GGT), has been evaluated in a number of settings, including large population surveys (105,106). Unfortunately, its low sensitivity and specificity limit the usefulness of elevated GGT to diagnose alcohol abuse (107–109), the levels of which may fluctuate with extensive liver injury (110). Lower levels of GGT (<100) or a total bilirubin/GGT ratio >1 has been described as a predictor of 1-year mortality in patients with alcoholic cirrhosis (110), although this has not consistently added the prognostic ability to other lab tests (111). However, in combination with other biomarkers, GGT may help add independent information in diagnosing alcohol abuse

Table 4. AUDIT questionnaire (102)

Question	0	1	2	3	4
1. How often do you have a drink containing alcohol?	Never	Monthly or less	2–4 Times a month	2–3 Times a week	4 Or more times a week
2. How many drinks containing alcohol do you have on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7–9	10 or more
3. How often do you have 5 or more drinks on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
4. How often during the last year have you found that you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
5. How often during the last year have you failed to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
8. How often during the last year have you been unable to remember what happened the night before because of your drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
9. Have you or someone else been injured because of your drinking?	No		Yes, but not in the last year		Yes, during the last year
10. Has a relative, friend, doctor, or other health-care worker been concerned about your drinking or suggested you cut down?	No		Yes, but not in the last year		Yes, during the last year

AUDIT, Alcohol Use Disorders Identification Test.
To score the AUDIT questionnaire, sum the scores for each of the 10 questions. A total ≥8 for men up to age 60, or ≥4 for women, adolescents, or men over the age of 60 is considered to be a positive screening test.

or problem drinking (112). Macrocytosis is seen in individuals abusing alcohol but lacks sensitivity. A combination of raised GGT and mean corpuscular volume or changes in these values over time in hospitalized patients may improve the sensitivity for diagnosing alcohol abuse. Multiple other candidate biomarkers that may detect alcohol use or abuse objectively have been studied (113,114). Carbohydrate-deficient transferrin has been the biomarker best studied, but has limited sensitivity and specificity (115). Its test characteristics are also influenced by a number of other factors, including age, gender, BMI, and other chronic liver diseases (116–118). Despite the enthusiasm about a possible quantitative, reliable assay of alcohol consumption or abuse, the lack of sensitivity and specificity prevent reliance on any single biomarker (119).

Diagnosis of ALD

The diagnosis of ALD is made by documentation of alcohol excess and evidence of liver disease (120). No single laboratory marker definitively establishes alcohol to be the etiology of liver disease. Furthermore, alcohol may be one of a number of factors causing liver injury, and the specific contributory role of alcohol alone may be difficult to assess in a patient with multifactorial liver disease. A number of laboratory abnormalities, including elevated serum aminotransferases, have been reported in patients with alcoholic liver injury, and used to diagnose ALD (121). Serum AST is typically elevated to a level of 2–6 times the upper limits of the normal in severe AH. Levels of AST >500 IU/l or ALT >200 IU/l are rarely seen with AH (other than alcoholic foamy degeneration or concomitant

acetaminophen overdose) (122), and should suggest another etiology. In about 70% of patients the AST/ALT ratio is >2, but this may be of greater value in patients without cirrhosis (123–125). Ratios >3 are highly suggestive of ALD (126).

Physical examination

Physical examination findings in patients with ALD may range from normal to those suggestive of advanced cirrhosis. As in other forms of chronic liver disease, physical examination features generally have low sensitivity, even for the detection of advanced disease or cirrhosis, although they may have higher specificity (127). Therefore, it has been suggested that the presence of these features may have some benefit in "ruling in" the presence of advanced disease (127). Features specific for ALD are perhaps even more difficult to identify. Palpation of the liver may be normal in the presence of ALD, and does not provide accurate information regarding liver volume (128). Certain physical examination findings have been associated with a higher likelihood of cirrhosis among alcoholics (129). Although some of the physical findings are more commonly observed in ALD (parotid enlargement, Dupuytren's contracture, and especially those signs associated with feminization) than in non-ALD, no single physical finding or constellation of findings is 100% specific or sensitive for ALD (130). Some of the physical examination features may also carry some independent prognostic information, with the presence of specific features associated with an increased risk of mortality over 1 year. These include (with their associated relative risks) hepatic encephalopathy (4.0), presence of visible veins across the anterior abdominal wall (2.2), edema (2.9), ascites (4.0), spider nevi (3.3), and weakness (2.1) (131). Although this is somewhat helpful clinically, findings from the physical examination must be interpreted with caution, as there is considerable heterogeneity in the assessment of each of these features when different examiners are involved (132). Several authors have reported the detection of a hepatic bruit in the setting of AH (133). This has been used in some centers as a diagnostic criterion for AH (134). However, the sensitivity, as well as the specificity of this finding is uncertain (135). In one series of 280 consecutive hospitalized patients, only 4 of 240 (or 1.7%) with AH and cirrhosis had an audible bruit (136). Caution about adopting this as a diagnostic criterion has therefore been advised (137).

It is important for physicians caring for these patients to recognize that ALD does not exist in isolation, and that other organ dysfunctions related to alcohol abuse may coexist with ALD, including cardiomyopathy (138,139), skeletal muscle wasting (140), pancreatic dysfunction, and alcoholic neurotoxicity (141). Evidence of these must be sought during the clinical examination, so that appropriate treatment may be provided (142).

Hepatic imaging

Imaging studies have been used to diagnose the presence of liver disease but do not have a role in establishing alcohol as the specific etiology of liver disease. However, the diagnosis of fatty change, established cirrhosis, and hepatocellular carcinoma may be suggested by ultrasound, CT scan, or magnetic resonance imaging and confirmed by other laboratory investigations (143,144). The major aim of imaging studies is to exclude other causes of abnormal liver tests in a patient who abuses alcohol, such as obstructive biliary pathology, or infiltrative and neoplastic diseases of the liver (145). Magnetic resonance imaging has been used as an adjunct to diagnose cirrhosis, and to distinguish end-stage liver disease related to viral hepatitis infection from ALD. Specific features that may be suggestive of alcoholic cirrhosis include a higher volume index of the caudate lobe, more frequent visualization of the right posterior hepatic notch, and smaller size of regenerative nodules of the liver in patients with cirrhosis on the basis of a comparison of ALD with chronic viral hepatitis (146). Although changes were identified on ultrasound and magnetic resonance imaging, it is unclear whether these results are generalizable (146,147).

Liver biopsy in ALD

Although not essential in the management of ALD, a liver biopsy is useful in establishing the diagnosis (144). As many as 20% of the patients with a history of alcohol abuse have a secondary or coexisting etiology for liver disease (148). In the absence of decompensated disease, clinical and biochemical indicators are poor markers of the severity of the liver disease and a biopsy is useful in establishing the stage and severity of the liver disease (144,149).

The histological features of alcohol-induced hepatic injury vary, depending on the extent and stage of injury. These may include steatosis (fatty change), lobular inflammation, periportal fibrosis, Mallory bodies, nuclear vacuolation, bile ductal proliferation, and fibrosis or cirrhosis (24). However, these may co-exist in the same biopsy, and are not individually pathognomonic of ALD. The clinical diagnosis of AH is made based on a typical presentation, with severe liver dysfunction in the context of excessive alcohol consumption, and the exclusion of other causes of acute and chronic liver disease. In a subset of patients with AH, a liver biopsy may show specific histological features, including confluent parenchymal necrosis, steatosis, deposition of intrasinusoidal and pericentral collagen, ballooning degeneration, and lobular inflammation affecting the perivenular regions in the earliest stages (34). The liver may be infiltrated with polymorphonuclear cells, typically clustered around cytoplasmic structures known as Mallory bodies (150), which represent aggregated cytokeratin intermediate filaments and other proteins. In addition to confirming the diagnosis and staging the extent of the disease, specific features on liver biopsy also convey prognostic importance. The severity of inflammation (i.e., degree of polymorphonuclear leukocyte infiltration) and cholestatic changes correlate with increasingly poor prognosis, and may also predict response to corticosteroid treatment in severe AH (151,152). Megamitochondria in AH may be associated with a milder form of AH, a lower incidence of cirrhosis, and fewer complications, with a good long-term survival (153). AH is associated with perivenular and pericellular fibrosis, which may be a harbinger of future

cirrhosis, especially in patients who continue to abuse alcohol or those who are co-infected with hepatitis C virus (33,154). Mallory bodies, giant mitochondria, neutrophilic infiltration, and fibrosis may be seen in conditions other than ALD (155).

Although a liver biopsy may not be practical in the management of all patients, it has been shown that physicians' clinical impression may correlate only moderately well with the histological findings on liver biopsy. Studies that have included a liver biopsy in all patients with presumed AH have shown histological confirmation in only 70–80% of the patients (156). However, the incentive to make a definitive histological diagnosis is partly dependent on the possible risks of a biopsy, as well as on the risks involved with particular treatments. If no treatment for ALD or AH is contemplated, based on noninvasive estimates of an individual patient's prognosis, it is usually not necessary to make a histological diagnosis. Alternatively, if an investigational treatment or a therapy with associated risk is contemplated, the risk–benefit ratio involved in pursuing a liver biopsy may change.

Recommendations:

1. Clinicians should discuss alcohol use with patients, and any suspicion of possible abuse or excess should prompt use of a structured questionnaire and further evaluation (Class I, level C).
2. For patients with a history of alcohol abuse or excess and evidence of liver disease, further laboratory tests should be done to exclude other etiologies and to confirm the diagnosis (Class I, level C).
3. Patients with ALD and suggestive symptoms should be screened for evidence of other end-organ damage, as appropriate (Class I, level C).
4. For patients with a clinical diagnosis of severe AH for whom medical treatment is contemplated, or for those in whom reasonable uncertainty exists regarding the underlying diagnosis, a liver biopsy should be considered. This decision will depend on local expertise and ability in performing a liver biopsy in patients with coagulopathy, the patient's severity of illness, and the type of therapy under consideration (Class I, level C).

PROGNOSTIC FACTORS

Prognosis in AH

Decisions regarding treatment are critically dependent on the ability to estimate a given patient's prognosis. Many individual clinical and laboratory features, along with specific histological features have also been tested as measures of disease prognosis. In AH, the Maddrey discriminant function, a disease-specific prognostic score, has been used to stratify a patient's severity of illness (157). The initial formula was derived in the context of clinical trials of AH, and later modified to Maddrey discriminant function (MDF) = 4.6 (patient's PT – control PT) + total bilirubin (mg/dl) (158). Patients with a score of ≥ 32 were at the highest risk of dying, with a 1-month mortality as high as 30–50% (151). In particular, those with evidence of both hepatic encephalopathy and an elevated discriminant function were at highest risk. Although relatively easy to use, and based on standard laboratory tests, several drawbacks to the use of the MDF have been noted. Although it is a continuous measure, its interpretation (using a threshold of 32) has converted it into an essentially categorical method of classification. Once patients have exceeded that threshold, their risk for dying is higher, but not specified. Dynamic models, which incorporate the changes in laboratory studies over time, have also been used to estimate the outcome in patients, including the change in bilirubin in the first week of hospitalization, which is significantly associated with the outcome of patients with AH treated with prednisolone (159).

Table 5 outlines some of the prognostic scoring systems used for patients with AH.

Table 5. Prognostic scoring systems used for patients with alcoholic hepatitis

Name	Derivation set	Elements				Test characteristics
1. Maddrey (modified) discriminant function (1989) (158)	n=66	MDF=4.6 (patient's PT – control PT) + total bilirubin (mg/dl)				Poor prognosis if score ≥32
2. MELD score (2001)[a] (160)	n=1,179	MELD score = $3.8 \times \log_e$(bilirubin in mg/dl) + $11.2 \times \log_e$(INR) + $9.6 \times \log_e$(creatinine mg/dl) + 6.4				Poor prognosis if >18
3. Glasgow alcoholic hepatitis score (2005) (161)	n=241	Score[b]:	1	2	3	
		Age	<50	≥50	—	Poor prognosis if score >8 (for score calculated on hospital day 1 or day 7)
		WCC	<15	≥15	—	
		Urea (mmol/l)	<5	≥5	—	
		PT ratio	<1.5	1.5–2.0	≥2	
		Bilirubin (mg/dl)	<7.3	7.3–14.6	>14.6	

MDF, Maddrey discriminant function; MELD, model for end-stage liver disease.
[a]The MELD score has also been used to estimate the 90-day mortality (166); an online calculator is available at http://www.mayoclinic.org/meld/mayomodel7.html.
[b]The GAH score is calculated by summing the points assigned for each of the five variables: age, white blood cell count, blood urea nitrogen, PT as a ratio of the patient's value to that of the control, and the bilirubin. This is done on hospital day 1 or on day 7.

Other scoring systems have also been proposed to stratify patients, including the combined clinical and laboratory index of the University of Toronto (131), the Beclere model (151), the model for end-stage liver disease (MELD) score (160), and the Glasgow AH Score (161). The diagnostic abilities of the latter two models have been tested against the MDF and other scoring systems for cirrhosis (such as the Child–Turcotte–Pugh score) in terms of specific test characteristics, including sensitivity and specificity, at least in some populations (162,163). Owing to the inherent trade-offs involved in setting test thresholds, optimal cut points are not clearly established for each of these indices. Some investigators have suggested specific cutoffs for these indices, including an MDF ≥ 32 or a MELD score >11, that seem to be roughly equivalent in their ability to detect patients with a poor prognosis, with similar sensitivity and specificity (162). Others have suggested higher MELD cutoffs of 18 (164), 19 (165), or 21 (166) (**Table 6**).

Several studies have also shown the utility of repeat testing and calculation of these indices during the course of hospitalization, including MELD or MDF score at 1 week, and degree of change. A change of ≥ 2 points in the MELD score in the first week has been shown to independently predict in-hospital mortality (164). The Glasgow AH Score was recently derived, and its test characteristics compared with the MDF and the MELD scores. Although it had an overall higher accuracy, it was substantially less sensitive for predicting the 1-month and 3-month mortality compared with either the MDF or the MELD (161). The degree of portal hypertension may be a sensitive marker for the severity of liver injury (167). A recently proposed scoring system combines measurements of a marker of portal hypertension, asymmetric dimethylarginine, and of its stereoisomer to predict the outcomes (168). This combined score has been compared with the Child–Turcotte–Pugh score, MELD, and MDF, and shown to have an overall sensitivity of 73% and a specificity of 83%, which were at least as good as those of other scoring systems (168). These results, however, require further validation.

As the aim of early detection of patients at highest risk of poor outcome requires maximization of the sensitivity of the test score, it would seem reasonable to use the MDF (with a cutoff of 32, and/or the presence of encephalopathy) to select patients for therapy.

Table 6. Comparisons of diagnostic indices

Author	Patient population	Outcome	AUROC
Sheth (162)	*N*=34 patients with alcoholic hepatitis hospitalized during 1997–2000. 21% 30-day mortality	MELD >11: Sensitivity 86% Specificity: 81% MDF $\geq$32: Sensitivity 86% Specificity 48%	MELD: 0.82 MDF: 0.86
Srikureja (164)	*N*=202 AH patients admitted during 1997–2002. 29 inpatient deaths	Admission MELD $\geq$18: Sensitivity 85% Specificity 84% Admission MDF $\geq$32: Sensitivity 83% Specificity 60% Admission CTP $\geq$12 Sensitivity 76% Specificity 80%	Admission MELD: 0.89 Admission CTP: 0.87 Admission DF: 0.81
Dunn (166)	*N*=73 AH patients admitted during 1995–2001. 16 deaths in 90 days. Outcome: 30-day mortality	Admission MELD >21: Sensitivity 75% Specificity 75% MDF >41: Sensitivity 75% Specificity 69	Admission MELD: 0.83 Admission MDF: 0.74
Soultati (165)	*N*=34 patients admitted during 2000–2005; 2 deaths/30 days, 5 deaths/90 days. Outcome: 30-day mortality	MELD $\geq$30.5: Sensitivity 1 Specificity 0.937 MDF $\geq$108.68 Sensitivity 1 Specificity 0.969	MELD: 0.969 MDF: 0.984

AH, alcoholic hepatitis; AUROC: area under the receiver operating characteristic curve, with optimal test results closest to 1; CTP, Child–Turcotte–Pugh score; DF, discriminant function; MDF, Maddrey discriminant function; MELD, model for end-stage liver disease.

Recommendation:

5. Patients presenting with a high clinical suspicion of AH should have their risk for poor outcome stratified using the Maddrey discriminant function, as well as other available clinical data. Evaluating a patient's condition over time with serial calculation of the MELD score is also justified (Class I, level B).

THERAPY

Therapy of ALD is based on the stage of the disease and the specific aims of treatment (169,170). Complications of cirrhosis, including evidence of hepatic failure (encephalopathy) as well as portal hypertension (ascites, variceal bleeding), are treated as in patients with non-ALD, with additional attention given to other organ dysfunctions associated specifically with alcohol (170).

Abstinence

Abstinence is the most important therapeutic intervention for patients with ALD (171). Abstinence has been shown to improve the outcome and histological features of hepatic injury, to reduce portal pressure and decrease progression to cirrhosis, and to improve survival at all stages in patients with ALD (171–174). However, this may be less likely to occur in female patients (172,175,176). This improvement can be relatively rapid, and in 66% of the patients abstaining from alcohol, significant improvement was observed in 3 months (177). Continued alcohol ingestion results in an increased risk of portal hypertensive bleeding, especially in patients who have previously bled, and worsens both short- and long-term survival (178).

Recidivism is a major risk in all patients at any time after abstinence (179,180). Estimates vary, depending on the time course of follow-up and the definition of recidivism (e.g., any alcohol consumption, vs. moderate-to-harmful drinking), but over the course of 1 year, relapse rates range from 67% to 81% (181). Therefore, several medications have been tried to help sustain abstinence. One of the first agents to be used, disulfiram, was approved by the Food and Drug Administration in 1983. However, a review of the published literature concluded that there was little evidence that disulfiram enhances abstinence (182), and based on its poor tolerability, its use has been largely supplanted by newer agents. Naltrexone, which was approved in 1995 for the treatment of alcoholism, is a pure opioid antagonist and controls the craving for alcohol. However, it has also been shown to cause hepatocellular injury. A Cochrane systematic review of the use of naltrexone and nalmefene (another opioid antagonist) in 29 RCTs concluded that short-term treatment with naltrexone lowers the risk of relapse (183). Acamprosate (acetylhomotaurine) is a novel drug with structural similarities to the inhibitory neurotransmitter gamma aminobutyric acid, and is associated with a reduction in withdrawal symptoms (184). In 15 controlled trials, acamprosate has been shown to reduce withdrawal symptoms, including alcohol craving, but its effects on survival are not yet known (185). Its effect is more pronounced in maintaining rather than inducing remission when used in combination with counseling and support. In detoxified alcoholics, it has been shown to decrease the rate of relapse, maintain abstinence, and decrease the severity of relapse when it occurs. It has not been shown to have a significant impact on alcoholics who have not been detoxified or become abstinent. Whether it has any additional effect in combination with naltrexone is controversial. A recent large randomized controlled clinical trial did not suggest substantial benefit of acamprosate compared with naltrexone or with intensive counseling in maintaining abstinence (186). There is a paucity of data about the use of these interventions in patients with advanced liver disease. One randomized clinical trial in patients with cirrhosis suggested benefit in achieving and maintaining abstinence with the use of baclofen, a gamma aminobutyric acid B receptor agonist (187).

Recommendations:

6. In patients with evidence of alcohol-induced liver disease, strict abstinence must be recommended, because continued alcohol use is associated with disease progression (Class I, level B).
7. Naltrexone or acamprosate may be considered in combination with counseling to decrease the likelihood of relapse in patients with alcohol abuse/dependence in those who achieve abstinence (Class I, level A).

Therapy for AH

The cornerstone of the therapy for AH is abstinence, although even patients who become abstinent have an increased risk of developing cirrhosis. However, the risk of cirrhosis is clearly higher in those who continue to drink (188,189), particularly among women (175,190). Although there are no clear dose–effect data, a threshold exists for the development of AH, with the risk increasing with consumption beyond 40 g of alcohol per day (46,191). Furthermore, after an episode of AH, there is no safe amount of alcohol consumption that can be recommended, as AH can persist or re-develop. There is a significant risk of recidivism in patients who attempt to cut back but not stop drinking altogether (192). Complete abstinence is therefore a reasonable lifetime recommendation.

The need to consider therapy is less urgent in patients with AH who have a low risk of complications as defined by an MDF score of <32, without hepatic encephalopathy, or a low MELD score (e.g., MELD <18), or a Glasgow AH Score of <8. This is particularly true in those whose liver score improves during hospitalization, with a decrease in total bilirubin, as they will likely improve spontaneously with abstinence and supportive care alone. For those with more severe disease and therefore a more dismal prognosis, however, medical treatment should be considered.

Nutrition therapy. The presence of significant protein calorie malnutrition is a common finding in alcoholics, as are deficiencies in a number of vitamins and trace minerals, including vitamins A, D, thiamine, folate, pyridoxine, and zinc (193). In a VA Cooperative study of 363 patients with AH, 100% of patients were found to have protein and/or combined protein calorie malnutrition, based on anthropometric and laboratory testing (194). Moreover, the severity of malnutrition correlated with the disease severity and outcomes (194).

This early finding was the motivation for a number of clinical trials of anabolic steroids, nutritional supplementation, or aggressive enteral feeding. Several of these studies showed an improvement in the biochemical markers of liver function or nutritional parameters, but were unable to show an improvement in short-term survival (195). However, at least in some trials subgroups of patients who achieved nutritional goals and positive nitrogen balance had improved survival compared with those who did not (196). As an example, in one study, the mortality rate was 3.3% in the 30 patients in whom positive nitrogen balance was achieved, but 58% in patients who remained in negative nitrogen balance (196).

The most recent study of nutritional therapy compared the outcomes of 35 patients who were randomized to 1 month of enteral tube feeding of 2,000 kcal/day with 40 mg of prednisone/day (197). No difference in mortality was noted, but the time course of deaths was different, with the patients randomized to enteral feeding dying at a median of 7 days, vs. 23 days in the steroid-treated group. Patients treated with nutritional support who survived past the first month seemed to have a decreased mortality compared with the steroid-treated patients (8% vs. 37%) (197). Although technically a negative study, the similar overall mortality rates in the treatment groups suggests a role for nutritional intervention (198), particularly in light of the relatively benign risk:benefit ratio. Based on these data, other

Table 7. Clinical trials of steroids in patients with alcoholic hepatitis

Author	Date	No. of patients	Intervention	Deaths: placebo	Deaths: steroid
Porter (265)	1971	20	Prednisolone: 40 mg intravenously × 10 days, then tapered: 4 mg/day × 1 week, 2 mg/day × 11 days, then 2 mg every 3rd day × 15 days	7/9	6/11
Helman (266)	1971	37	Prednisolone: 40 mg/day × 4 weeks, then tapered over 2 weeks	6/17	1/20
Campra (267)	1973	45	Prednisone: 0.5 mg kg × 3 weeks, then 0.25 mg/kg × 3 weeks	9/25	7/29
Blitzer (268)	1977	33	Prednisolone: 40 mg/day × 14 days, then 20 mg/day × 4 days; 10 mg/day × 4 days; 5 mg/day × 4 days	5/16	6/12
Lesesne (269)	1978	14	Prednisolone: 40 mg/day × 30 days, then tapered over 2 weeks	7/7	2/7
Shumaker (270)	1978	27	Prednisolone 80 mg/day × 4–7 days, then tapered off over 4 weeks	7/15	6/12
Maddrey (157)	1978	55	Prednisolone 40 mg/day × 30 days	6/31	1/24
Depew (271)	1980	28	Prednisolone 40 mg/day × 28 days, then tapered over 14 days	7/13	8/15
Theodossi (272)	1982	55	Prednisolone: 1 g × 3 days	16/28	17/27
Mendenhall (273)	1984	178	Prednisolone: 60 mg × 4 days; 40 mg/day × 4 days; 30 mg/day × 4 days; 20 mg/day × 4 days; 10 mg/day × 7 days; 5 mg/day × 7 days	50/88	55/90
Bories (274)	1987	45	Prednisolone 40 mg/day × 30 days	2/21	1/24
Carithers (158)	1989	66	Prednisolone 32 mg/day × 28 days, then 16 mg/day × 7 days, then 8 mg/day × 7 days	11/31	2/35
Ramond (275)	1992	61	Prednisolone: 40 mg/day × 28 days	16/29	4/32

societies have recommended oral or parenteral supplements for patients with AH at risk of undernutrition (199).

Steroids. The most extensively studied intervention in AH is the use of steroids, based on 13 clinical trials that date back almost 40 years (**Table 7**).

Most of these trials were small, and therefore had only limited statistical power to detect even moderate treatment effects; five suggested an improvement in outcome, with decreased short-term mortality in steroid-treated patients compared with placebo-treated patients, whereas eight showed no effect. It is important to note, however, that these trials used varying inclusion and exclusion criteria, dosing, and were conducted in a variety of patient populations. Three meta-analyses have analyzed data from these trials, and showed an improvement in survival in the treated patients (200–202); one meta-regression, however, using a different statistical weighting of the varying trials, was unable to show any difference (203). The most recent meta-analysis of these data did not show a statistically significant effect of steroids on mortality among all patients

treated, although it did show an effect of steroids in the subgroup of patients with hepatic encephalopathy and/or an MDF score ≥ 32 (204). The presence of substantial statistical heterogeneity in this subgroup of studies prevented the authors from reporting an overall beneficial effect. The implication of this finding is unclear, as statistical heterogeneity among subgroups is a function of both clinical differences and/or methodological differences among studies, and these analyses may be reflect bias or confounding (205). One potential approach to resolve this is the use of individual patient data across clinical trials, which represents the "gold standard" approach to meta-analysis (206). Although it is impractical to retrieve and combine primary data from all the clinical trials in this field, in which large variation in studies over time exists, this approach was pursued using a combined dataset, using pooled primary data from three placebo-controlled trials in patients with comparable measures of disease severity (i.e., an MDF ≥ 32). The results showed a significant increase in short-term survival among the treated patients compared with the control patients: 84.6% vs. 65% (207). This represents a modest absolute reduction in risk, but a 30% reduction in the relative risk, and translates into a number needed to treat of 5—i.e., five patients need to be treated to avert one death. This last meta-analysis also excluded a recent trial comparing steroids with a combination of anti-oxidants, which showed a similar protective effect of corticosteroids among treated patients (208). Although it is possible that anti-oxidants themselves may be detrimental (209), the doses used seem unlikely to account for the differences in survival, and the consistency of the data suggests a protective effect of steroids.

Although the doses and durations of steroid treatment used in the clinical trials were variable, the best available evidence suggests a dose of prednisolone (40 mg/day for 4 weeks, then tapered over 2–4 weeks, or stopped, depending on the clinical situation) should be used in favor of prednisone (210).

An important issue in all studies of medical therapy, and one that has been recognized for some time in this literature, is the possibility that these therapies may not be effective at an advanced stage of disease. Just as there is a threshold for the use of steroids (i.e., identifying patients at high risk of mortality defined by an MDF score ≥ 32), there may also be a ceiling beyond which medical therapies aimed at decreasing the inflammatory cascade may cause more harm than benefit. One study examined this issue, and suggested that patients with a MDF >54 were at a higher mortality risk from use of steroids than from not being treated (63). This cutoff, however, needs to be confirmed.

One recently derived model used six variables to predict the six-month mortality in patients who were universally treated with steroids (including age, renal insufficiency (serum creatinine >1.3 or creatinine clearance <40), albumin, prothrombin time, bilirubin, and change in bilirubin over 1 week), and showed an improved prognostic ability compared with MDF or GAH scores (211). This model, available on the internet (www.lillemodel.com), may allow identification of patients who are at high risk to be treated with other interventions.

Anti-cytokine therapy. A wealth of evidence suggests that dysregulated cytokines, including tumor necrosis factor alpha (TNF-α) and a host of downstream cytokines have a pivotal role in the pathophysiology of AH. Thus, several agents have been studied that affect the immunologic milieu, targeting specific cytokines, and TNF-α in particular.

Among the first agents to be studied was pentoxifylline, an oral phosphodiesterase inhibitor that also inhibits the production of TNF-α, among other cytokines. A randomized placebo-controlled clinical trial tested pentoxifylline in 101 patients with clinical evidence of severe AH (212). The in-hospital mortality in the treated patients was 40% lower than in the placebo arm, with the bulk of the reduction related to a substantially lower likelihood of developing hepatorenal syndrome. The hepatorenal syndrome was responsible for 50% of the 12 deaths in the treatment arm, compared with 91.7% of the 24 deaths in the placebo group.

Other specific inhibitors of TNF that have been studied include infliximab, a monoclonal chimeric anti-TNF antibody, and etanercept, a fusion protein containing the ligand-binding portion of the human TNF receptor fused to the Fc portion of human IgG1 (213). In the first clinical trial of infliximab, 20 patients with biopsy-proven AH and an MDF score between 32 and 55 (based on the original Maddrey score, which showed an increased mortality at a score >93) were randomized to either 5 mg/kg of infliximab plus 40 mg/day of prednisone ($n=11$) or prednisone alone (214). No substantial difference in overall mortality was found, but substantial decreases in other prognostic markers, including cytokine levels and MDF scores, were seen in patients treated with the combination therapy. Another trial, which was performed at 19 centers in France, randomized 36 patients with biopsy-proven AH and an MDF ≥ 32 to prednisolone (40 mg/day for 4 weeks), vs. prednisolone along with infliximab (10 mg/kg, given at study entry, and again at 2 and 4 weeks after entry) (215). The trial was stopped prematurely after seven deaths had occurred in the infliximab group, compared with three in the prednisolone arm. Four of the seven deaths in the infliximab arm were related to infectious etiologies, compared with one in the prednisolone group. The design, and, in particular, the dose of infliximab chosen in the study, has been criticized as predisposing to these infections (216). The utility of etanercept (given six times over three weeks) was tested in 48 patients with moderate-to-severe AH (MELD score >15); unfortunately, no significant difference in 1-month mortality was seen in the treated patients compared with patients given placebo, and an increased mortality was seen at 6 months (217).

Although a strong rationale remains for the use of anti-TNF therapy in AH, there is also a theoretical basis for minimizing TNF inhibition, as it has a role in liver regeneration as well as apoptosis (218). Thus, in light of the poor clinical outcomes observed in the largest of the infliximab trials and the etanercept study, the use of these parenteral TNF

inhibitors should be confined to clinical trials, and recommendations regarding specific therapy will need to await the results of these trials. There are no substantive clinical data comparing the use of steroids or nutrition with specific anti-TNF therapies.

Combination therapy. Although it is assumed that each of these different treatments may operate through independent mechanisms, there are only minimal data regarding the comparative benefit of sequential therapies or combined approaches. One study tested the use of pentoxifylline in 29 patients with severe AH (MDF ≥ 32) who did not respond to steroids based on a drop in bilirubin level after 1 week of prednisolone treatment. Compared with previously treated patients (who were continued on steroids despite lack of bilirubin response), there was no improvement in 2-month survival—arguing against a two-step strategy with an early switch to pentoxifylline (219). Several older studies had examined the role of anabolic steroids with nutritional interventions (based on the presumption that both interventions acted through a similar mechanism, i.e., by correction of protein calorie malnutrition) (220). One pilot study evaluated the role of steroids in combination with enteral nutrition in 13 patients with severe AH, and found an overall mortality of 15%—possibly an improvement from that expected (221). With the advent of new therapies, it is necessary to reconsider the risk–benefit ratio of medical treatment. It has been suggested that it may be possible to use less toxic therapies at a lower threshold of disease severity (222). However, the exact role of these new therapies—and the threshold for their use—is still undefined.

Other treatments. Many other therapeutic interventions have been studied in AH, but have not been able to show convincing benefit, including trials of anti-oxidants (vitamin E, silymarin, combination anti-oxidants), anti-fibrotics (colchicine), anti-thyroid drugs (PTU), promoters of hepatic regeneration (insulin and glucagons), anabolic steroids (oxandrolone and testosterone), as well as calcium channel blockers (amlodipine), polyunsaturated lecithin, and a number of complementary and alternative medicines (reviewed in O'Shea and McCullough (223)). In addition to medical treatment directed at the underlying pathophysiological abnormalities, several studies have tested other aggressive interventions in patients with AH, such as a molecular adsorbent recirculating system (224). Although the results of early studies were optimistic, with better than predicted outcomes in treated patients, a further case series was less promising (225). Case reports have also described the outcome of patients with severe AH treated with leukocytapharesis after failing to improve substantially on steroids (226,227). These reports are promising, but recommendations regarding their appropriate use must await results of comparative studies of outcomes in these patients.

A proposed treatment algorithm for AH is shown in **Figure 1**.

Recommendations:

8. All patients with AH should be counseled to completely abstain from alcohol (Class I, level B).
9. All patients with AH or advanced ALD should be assessed for nutritional deficiencies (protein-calorie malnutrition), as well as vitamin and mineral deficiencies. Those with severe disease should be treated aggressively with enteral nutritional therapy (Class I, level B).
10. Patients with mild-to-moderate AH—defined as a Maddrey score of < 32, without hepatic encephalopathy, and with improvement in serum bilirubin or decline in the MDF during the first week of hospitalization—should be monitored closely, but will likely not require nor benefit from specific medical interventions other than nutritional support and abstinence (Class III, level A).
11. Patients with severe disease (MDF score of ≥ 32, with or without hepatic encephalopathy) and lacking contraindications to steroid use should be considered for a 4-week course

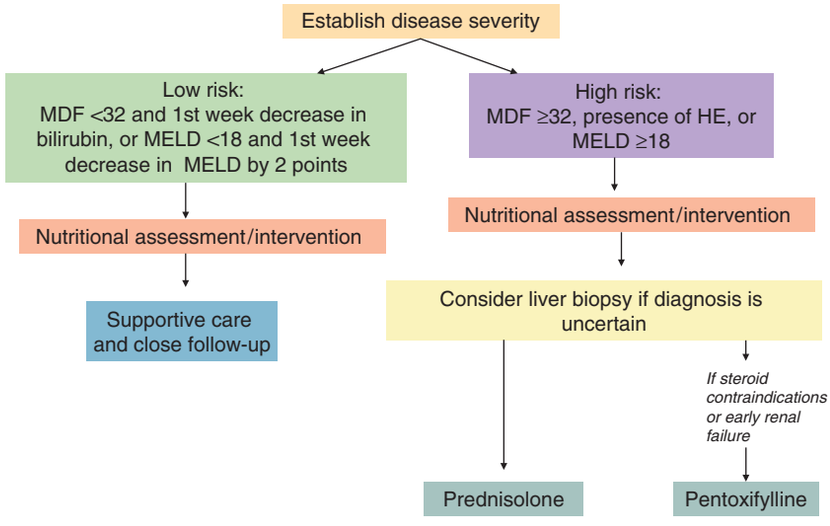

Figure 1. Proposed algorithm for alcoholic hepatitis. MDF, Maddrey discriminant function; MELD, model for end-stage liver disease.

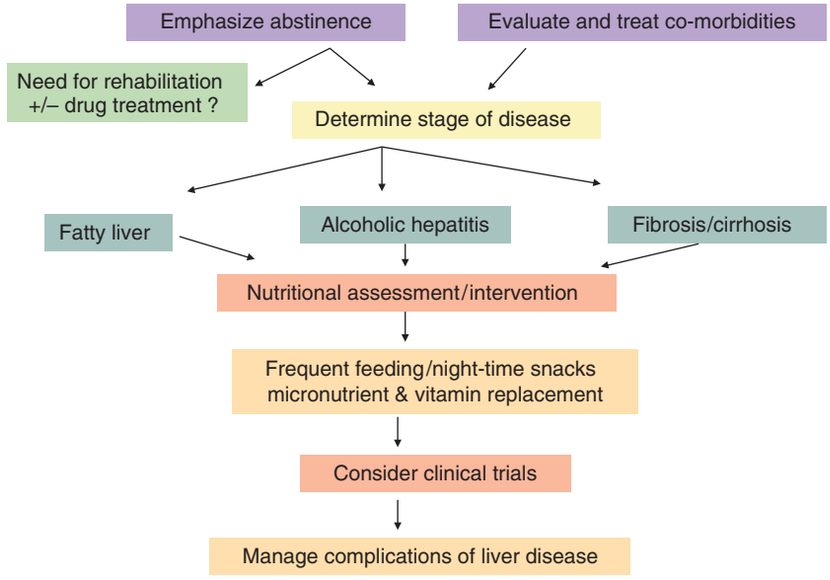

Figure 2. Proposed therapeutic algorithm for the long-term management of alcoholic liver disease.

of prednisolone (40 mg/day for 28 days, typically followed by discontinuation or a 2-week taper) (Class I, level A).

12. Patients with severe disease (i.e., a MDF ≥ 32) could be considered for pentoxifylline therapy (400 mg orally 3 times daily for 4 weeks), especially if there are contra-indications to steroid therapy (Class I, level B).

Long-term management of ALD

A proposed algorithm for the management of ALD is shown in **Figure 2**.

Nutritional therapy. Protein calorie malnutrition is common in ALD, is associated with an increased rate of major complications of cirrhosis (infection, encephalopathy, and ascites), and indicates a poor prognosis (194).

A total of 13 studies (7 randomized and 6 open-label studies) have examined the effect of oral or enteral nutritional supplementation in patients with alcoholic cirrhosis, with interventions that ranged from 3 days to 12 months (reviewed in Stickel *et al.* (228)). Most of these studies are limited by small sample sizes and short durations of therapy. In one study, enteral feeding for 3–4 weeks in 35 hospitalized, severely malnourished, or decompensated patients with alcoholic cirrhosis seemed to improve the survival ($P < 0.065$), hepatic encephalopathy, liver tests, and Child–Pugh score, as compared with controls who received a standard oral diet (197). In longer-term studies, equinitrogenous amounts of dietary branched chain amino acids (BCAA) were compared with casein supplements for 3–6 months in patients with chronic hepatic encephalopathy (229), and shown to improve encephalopathy, nitrogen balance, and serum bilirubin compared with casein. Intake of supplemental protein and of 1,000 kilocalories in decompensated patients with alcoholic cirrhosis has also been shown to reduce hospitalizations for infections over a 1-year period (230).

Long-term aggressive nutritional therapy by the enteral or oral route in patients with alcoholic cirrhosis is supported by studies that have shown improved nutritional status (231,232). Although controversial, this may possibly prevent the complications of cirrhosis (195,233). Multiple feedings, emphasizing breakfast and a nighttime snack, with a regular oral diet at higher-than-usual dietary intakes (1.2–1.5 g/kg for protein and 35–40 kcal/kg for energy) seem beneficial (234,235). Finally, during intermittent acute illness or exacerbations of the underlying chronic liver disease, an above-normal protein intake (1.5 g per kg body weight) and kilocalorie intake (40 kilocalories per kg) improves the protein calorie malnutrition (233), and should be considered in the treatment of these patients.

Recommendation:

13. Patients with alcoholic cirrhosis should receive frequent interval feedings, emphasizing a nighttime snack and morning feeding, to improve the nitrogen balance (Class I, level A).

Medical therapies. A number of other agents have been tested in patients with ALD, including propylthiouracil, which was thought to decrease the hypermetabolic state induced by alcohol (236,237). A Cochrane review of six randomized controlled trials of PTU in ALD, with a total of 710 patients administered either PTU or placebo, did not show any benefit of PTU over placebo on the total or liver-related mortality, complications of liver disease, or liver histology in patients with ALD (238). A possible benefit of supplementation with *S*-adenosyl L-methionine, a precursor to glutathione, has also been studied extensively (239). One trial showed a statistically significant improvement in survival in patients with Childs A and B cirrhosis randomized to *S*-adenosyl L-methionine compared with placebo (240). Despite a strong theoretical rationale, and a number of supportive clinical trials (239,241), a Cochrane

review of published data, based on nine randomized controlled trials with 434 patients in different stages of ALD, did not show any significant benefit of *S*-adenosyl L-methionine on total mortality, liver-related mortality, complications, or liver transplantation (LT) in patients with ALD (242).

Colchicine, which has both anti-inflammatory and antifibrotic properties, has also been tested in alcoholic cirrhosis after several small clinical trials, and has suggested improvement in fibrosis on serial liver biopsies in treated patients (243,244). However, a systematic meta-analysis of 15 randomized trials with 1,714 patients (including patients with alcoholic fibrosis, AH, and/or alcoholic cirrhosis, as well as patients with viral induced or cryptogenic fibrosis and/or cirrhosis) by the Cochrane group (245) showed no benefit of treatment on overall mortality, liver-related mortality, liver tests, or histology. In addition, there was an increased risk of adverse effects related to colchicine therapy.

Emerging data suggest a role for TNF-α-mediated apoptosis in AH, and therapy targeting this cytokine to inhibit apoptosis may be effective (246). Thalidomide, misoprostol, adiponectin, and probiotics have been shown to have anti-cytokine properties in preliminary reports (247–250). Although promising, these treatments cannot be considered as standard treatment for ALD and AH until further evidence of efficacy has been obtained.

Complementary and alternative medicine treatment options. Various alternative treatment options have been tested in the therapy of ALD.

Silymarin, the presumed active ingredient in milk thistle, is postulated to protect patients from ALD on the basis of its antioxidant properties. Six published trials of the use of silymarin in patients with ALD (251) have tested its effects on normalizing liver tests and on improving liver histology. One study suggested a possible survival benefit compared with placebo (252). However, a Cochrane systematic review and a meta-analysis of the 13 published studies of silymarin in ALD and other liver diseases found that the overall methodological quality of the studies was low. Based on the few high-quality trials, it was concluded that milk thistle does not significantly influence the course of patients with ALD (253).

Recommendations:

14. PTU and colchicine should not be used in the treatment of patients with ALD; *S*-adenosyl L-methionine should be used only in clinical trials (Class III, level A).
15. The use of complementary or alternative medicines in the treatment of either acute or chronic alcohol-related liver disease has shown no convincing benefit and should not be used out of the context of a clinical trial (Class III, level A).

LT for ALD

ALD is the second most common indication for LT for chronic liver disease in the Western world (254). Despite this, it is estimated that as many as 95% of patients with end stage liver disease related to alcohol are never formally evaluated for their candidacy for LT (255). This is attributed to perceptions that ALD is self-induced, the possibility of recidivism or non-compliance, and the shortage of organs (179).

A 6-month period of abstinence has been recommended as a minimal listing criterion (256). This time period allows chemical dependency issues to be addressed; in patients with recent alcohol consumption, it may also allow sufficient clinical improvement to make LT unnecessary. This requirement for a fixed abstinence period has not been shown to accurately predict future drinking by alcoholic candidates for LT (257). Despite some data suggesting that patients with ALD were more ill at the time of LT, and were likely to have prolonged intensive care unit stays and increased blood product requirements (258), the overall survival rates are generally similar between alcohol-related and non-alcohol-related LTX recipients (259).

Patients transplanted for ALD are highly likely to drink after transplantation (259). It has been suggested that the consequences of alcohol use are minimal for many recipients, because the amounts consumed are small and infrequent, but there are little reliable data to support this contention. Rates of recidivism between 11–49% (defined as any alcohol consumption after transplantation) at 3–5 years after LT have been reported (179,260). In general, however, only a small fraction of those who undergo LT for ALD revert to heavy alcohol use or abuse (255). Poor follow-up and non-compliance with therapy are observed in only a minority of patients, and graft rejection rates are similar for patients with ALD compared with non-ALD patients (254,259).

An important issue that is still unresolved is the role of LT in patients with AH, who are generally excluded from transplant (256). In one study using retrospective histological analysis of the explanted liver, superimposed AH did not worsen the outcome after LT (261). The availability of living donor transplantation and extended criteria donor LT are likely to heighten the debate on this issue.

Recommendation:

16. The appropriate patients with end-stage liver disease secondary to alcoholic cirrhosis should be considered for LT just as other patients with decompensated liver disease, after a careful evaluation of their medical and psychosocial candidacy. In addition, this evaluation should include a formal assessment of the likelihood of long-term abstinence (Class I, level B).

CONFLICT OF INTEREST

Guarantor of the article: Arthur J. McCullough, MD.
Specific author contributions: Design, literature review, drafting of the manuscript, and manuscript review/revision: Robert O'Shea and Srinivasan Dasarathy; design, manuscript review/revision, and approval of the final version: Arthur J. McCullough.
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REFERENCES

1. Eddy DM. A Manual For Assessing Health Practices and Designing Practice Guidelines: The Explicit Approach. American College of Physicians: Philadelphia, 1992.

2. American Gastroenterological Association. Policy statement on the use of medical practice guidelines by managed care organizations and insurance carriers. Gastroenterology 1995;108:925–6.
3. Methodology Manual for ACC/AHA Guideline Writing Committees: Methodologies and Policies from the ACC/AHA Task Force on Practice Guidelines April 2006, 2006.
4. Shiffman RN, Shekelle P, Overhage JM *et al.* Standardized reporting of clinical practice guidelines: a proposal from the Conference on Guideline Standardization. Ann Intern Med 2003;139:493–8.
5. Patrick CH. Alcohol, Culture, and Society. Duke University Press: Durham, 1952.
6. Mandayam S, Jamal MM, Morgan TR. Epidemiology of alcoholic liver disease. Semin Liver Dis 2004;24:217–32.
7. Welte J, Barnes G, Wieczorek W *et al.* Alcohol and gambling pathology among U.S. adults: prevalence, demographic patterns and comorbidity. J Stud Alcohol 2001;62:706–12.
8. Caetano R, Tam T, Greenfield T *et al.* DSM-IV alcohol dependence and drinking in the U.S. population: a risk analysis. Ann Epidemiol 1997;7:542–9.
9. Tam TW, Midanik LT. The effect of screening on prevalence estimates of alcohol dependence and social consequences. J Stud Alcohol 2000;61:617–21.
10. Greenfield TK, Midanik LT, Rogers JD. A 10-year national trend study of alcohol consumption, 1984–1995: is the period of declining drinking over? Am J Public Health 2000;90:47–52.
11. Hasin D, Paykin A, Meydan J *et al.* Withdrawal and tolerance: prognostic significance in DSM-IV alcohol dependence. J Stud Alcohol 2000;61:431–8.
12. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 4th edn., American Psychiatric Association: Washington, DC, 1994.
13. Chick J, Erickson CK. Conference summary: Consensus Conference on Alcohol Dependence and the Role of Pharmacotherapy in its Treatment. Alcohol Clin Exp Res 1996;20:391–402.
14. Kitchens JM. Does this patient have an alcohol problem? JAMA 1994;272:1782–7.
15. Grant BF, Harford TC, Dawson DA *et al.* Prevalence of DSM-IV alcohol abuse and dependence: United States, 1992. Alcohol Health Res World 1992;18:243–8.
16. National Institute of Health (US); National Institute on Alcohol Abuse and Alcoholism (US); CSR, Incorporated. Alcohol Use and Alcohol Use Disorders in the United States: Main Findings from the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). National Institutes of Health, National Institute on Alcohol Abuse and Alcoholism: Bethesda, MD, 2006.
17. Yoon YH, Yi HY. Surveillance report #75: liver cirrhosis mortality in the United States, 1970–2003. National Institute on Alcohol Abuse and Alcoholism: Bethesda, MD, 2006.
18. Becker U, Gronbaek M, Johansen D *et al.* Lower risk for alcohol-induced cirrhosis in wine drinkers. Hepatology 2002;35:868–75.
19. Pelletier S, Vaucher E, Aider R *et al.* Wine consumption is not associated with a decreased risk of alcoholic cirrhosis in heavy drinkers. Alcohol Alcohol 2002;37:618–21.
20. Corrao G, Ferrari P, Zambon A *et al.* Are the recent trends in liver cirrhosis mortality affected by the changes in alcohol consumption? Analysis of latency period in European countries. J Stud Alcohol 1997;58:486–94.
21. Midanik L. The validity of self-reported alcohol consumption and alcohol problems: a literature review. Br J Addict 1982;77:357–82.
22. World Health Organization. Global Status Report on Alcohol 2004 2004. World Health Organization: Geneva.
23. Ezzati M, Lopez A, Rodgers A, *et al.*, The Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. Lancet 2002;360:1347–60.
24. Lefkowitch JH. Morphology of alcoholic liver disease. Clin Liver Dis 2005;9:37–53.
25. Mendez-Sanchez N, Meda-Valdes P, Uribe M. Alcoholic liver disease. An update. Ann Hepatol 2005;4:32–42.
26. MacSween RN, Burt AD. Histologic spectrum of alcoholic liver disease. Semin Liver Dis 1986;6:221–32.
27. Crabb DW. Pathogenesis of alcoholic liver disease: newer mechanisms of injury. Keio J Med 1999;48:184–8.
28. Lieber CS, Jones DP, Decarli LM. Effects of prolonged ethanol intake: production of fatty liver despite adequate diets. J Clin Invest 1965;44:1009–21.
29. Mendenhall CL. Anabolic steroid therapy as an adjunct to diet in alcoholic hepatic steatosis. Am J Dig Dis 1968;13:783–91.
30. Leevy CM. Fatty liver: a study of 270 patients with biopsy proven fatty liver and review of the literature. Medicine (Baltimore) 1962;41:249–76.
31. Sorensen TI, Orholm M, Bentsen KD *et al.* Prospective evaluation of alcohol abuse and alcoholic liver injury in men as predictors of development of cirrhosis. Lancet 1984;2:241–4.
32. Teli MR, Day CP, Burt AD *et al.* Determinants of progression to cirrhosis or fibrosis in pure alcoholic fatty liver. Lancet 1995;346:987–90.
33. Worner TM, Lieber CS. Perivenular fibrosis as precursor lesion of cirrhosis. JAMA 1985;254:627–30.
34. Savolainen V, Perola M, Lalu K *et al.* Early perivenular fibrogenesis--precirrhotic lesions among moderate alcohol consumers and chronic alcoholics. J Hepatol 1995;23:524–31.
35. Nakano M, Worner TM, Lieber CS. Perivenular fibrosis in alcoholic liver injury: ultrastructure and histologic progression. Gastroenterology 1982;83:777–85.
36. MacSween RN, Scott AR. Hepatic cirrhosis: a clinico-pathological review of 520 cases. J Clin Pathol 1973;26:936–42.
37. Orrego H, Blake JE, Blendis LM *et al.* Prognosis of alcoholic cirrhosis in the presence and absence of alcoholic hepatitis. Gastroenterology 1987;92:208–14.
38. Alcoholic liver disease: morphological manifestations. Review by an international group. Lancet 1981;1:707–11.
39. Ishak KG, Zimmerman HJ, Ray MB. Alcoholic liver disease: pathologic, pathogenetic and clinical aspects. Alcohol Clin Exp Res 1991;15:45–66.
40. Christoffersen P, Nielsen K. Histological changes in human liver biopsies from chronic alcoholics. Acta Pathol Microbiol Scand A 1972;80:557–65.
41. Mendenhall CL. Alcoholic hepatitis. Clin Gastroenterol 1981;10:417–41.
42. Trabut JB, Plat A, Thepot V *et al.* Influence of liver biopsy on abstinence in alcohol-dependent patients. Alcohol Alcohol 2008;43:559–63.
43. Alexander JF, Lischner MW, Galambos JT. Natural history of alcoholic hepatitis. II. The long-term prognosis. Am J Gastroenterol 1971;56:515–25.
44. Bird GL, Williams R. Factors determining cirrhosis in alcoholic liver disease. Mol Aspects Med 1988;10:97–105.
45. Galambos JT. Natural history of alcoholic hepatitis. 3. Histological changes. Gastroenterology 1972;63:1026–35.
46. Savolainen VT, Liesto K, Mannikko A *et al.* Alcohol consumption and alcoholic liver disease: evidence of a threshold level of effects of ethanol. Alcohol Clin Exp Res 1993;17:1112–7.
47. Becker U, Deis A, Sorensen TI *et al.* Prediction of risk of liver disease by alcohol intake, sex, and age: a prospective population study. Hepatology 1996;23:1025–9.
48. Kamper-Jorgensen M, Gronbaek M, Tolstrup J *et al.* Alcohol and cirrhosis: dose--response or threshold effect? J Hepatol 2004;41:25–30.
49. Ramstedt M. Per capita alcohol consumption and liver cirrhosis mortality in 14 European countries. Addiction 2001;96 (Suppl 1): S19–33.
50. Bellentani S, Saccoccio G, Costa G *et al.* Drinking habits as cofactors of risk for alcohol induced liver damage. The Dionysos Study Group. Gut 1997;41:845–50.
51. Day CP. Who gets alcoholic liver disease: nature or nurture? J R Coll Physicians Lond 2000;34:557–62.
52. Lu XL, Luo JY, Tao M *et al.* Risk factors for alcoholic liver disease in China. World J Gastroenterol 2004;10:2423–6.
53. Wechsler H, Austin SB. Binge drinking: the five/four measure. J Stud Alcohol 1998;59:122–4.
54. Barrio E, Tome S, Rodriguez I *et al.* Liver disease in heavy drinkers with and without alcohol withdrawal syndrome. Alcohol Clin Exp Res 2004;28:131–6.
55. Sato N, Lindros KO, Baraona E *et al.* Sex difference in alcohol-related organ injury. Alcohol Clin Exp Res 2001;25:40S–5S.
56. Baraona E, Abittan CS, Dohmen K *et al.* Gender differences in pharmacokinetics of alcohol. Alcohol Clin Exp Res 2001;25:502–7.
57. Frezza M, di PC, Pozzato G *et al.* High blood alcohol levels in women. The role of decreased gastric alcohol dehydrogenase activity and first-pass metabolism. N Engl J Med 1990;322:95–9.
58. Lelbach WK. Epidemiology of alcoholic liver disease. Prog Liver Dis 1976;5:494–515.
59. Lelbach WK. Quantitative aspects of drinking in alcoholic liver cirrhosis. In Khanna JM, Israel Y, Kalant H (eds). Alcoholic Liver Pathology. Volume Toronto. Alcoholism and Drug Addiction Research Foundation of Ontario: Toronto, 1975, 118.
60. Stewart SH. Racial and ethnic differences in alcohol-associated aspartate aminotransferase and gamma-glutamyltransferase elevation. Arch Intern Med 2002;162:2236–9.
61. Stinson FS, Grant BF, Dufour MC. The critical dimension of ethnicity in liver cirrhosis mortality statistics. Alcohol Clin Exp Res 2001;25:1181–7.
62. Wickramasinghe SN, Corridan B, Izaguirre J *et al.* Ethnic differences in the biological consequences of alcohol abuse: a comparison between south Asian and European males. Alcohol Alcohol 1995;30:675–80.

63. Mendenhall C, Roselle GA, Gartside P *et al.* Relationship of protein calorie malnutrition to alcoholic liver disease: a reexamination of data from two Veterans Administration Cooperative Studies. Alcohol Clin Exp Res 1995;19:635–41.
64. Leevy CM, Moroianu SA. Nutritional aspects of alcoholic liver disease. Clin Liver Dis 2005;9:67–81.
65. Mezey E. Dietary fat and alcoholic liver disease. Hepatology 1998;28:901–5.
66. Iturriaga H, Bunout D, Hirsch S *et al.* Overweight as a risk factor or a predictive sign of histological liver damage in alcoholics. Am J Clin Nutr 1988;47:235–8.
67. Naveau S, Giraud V, Borotto E *et al.* Excess weight risk factor for alcoholic liver disease. Hepatology 1997;25:108–11.
68. Uhl GR, Liu QR, Walther D *et al.* Polysubstance abuse-vulnerability genes: genome scans for association, using 1,004 subjects and 1,494 single-nucleotide polymorphisms. Am J Hum Genet 2001;69:1290–300.
69. Brown K. Alcohol hepatotoxicity: a genotypic predisposition? Am J Gastroenterol 1992;87:677–8.
70. Day CP, Bassendine MF. Genetic predisposition to alcoholic liver disease. Gut 1992;33:1444–7.
71. Goodwin DW, Schulsinger F, Hermansen L *et al.* Alcohol problems in adoptees raised apart from alcoholic biological parents. Arch Gen Psychiatry 1973;28:238–43.
72. Kaprio J, Koskenvuo M, Langinvainio H *et al.* Social and genetic influences on drinking patterns of adult men: a study of 5,638 Finnish twin brothers. Alcohol Alcohol Suppl 1987;1:373–7.
73. Reed T, Page WF, Viken RJ *et al.* Genetic predisposition to organ-specific endpoints of alcoholism. Alcohol Clin Exp Res 1996;20:1528–33.
74. McClain CJ, Song Z, Barve SS *et al.* Recent advances in alcoholic liver disease. IV. Dysregulated cytokine metabolism in alcoholic liver disease. Am J Physiol Gastrointest Liver Physiol 2004;287:G497–502.
75. Monzoni A, Masutti F, Saccoccio G *et al.* Genetic determinants of ethanol-induced liver damage. Mol Med 2001;7:255–62.
76. Degos F. Hepatitis C and alcohol. J Hepatol 1999;31 (Suppl 1): 113–8.
77. Monto A, Patel K, Bostrom A *et al.* Risks of a range of alcohol intake on hepatitis C-related fibrosis. Hepatology 2004;39:826–34.
78. Befrits R, Hedman M, Blomquist L *et al.* Chronic hepatitis C in alcoholic patients: prevalence, genotypes, and correlation to liver disease. Scand J Gastroenterol 1995;30:1113–8.
79. Harris DR, Gonin R, Alter HJ *et al.* The relationship of acute transfusion-associated hepatitis to the development of cirrhosis in the presence of alcohol abuse. Ann Intern Med 2001;134:120–4.
80. Levitsky J, Mailliard ME. Diagnosis and therapy of alcoholic liver disease. Semin Liver Dis 2004;24:233–47.
81. Grant BF. Barriers to alcoholism treatment: reasons for not seeking treatment in a general population sample. J Stud Alcohol 1997;58:365–71.
82. Eckardt MJ, Rawlings RR, Martin PR. Biological correlates and detection of alcohol abuse and alcoholism. Prog Neuropsychopharmacol Biol Psychiatry 1986;10:135–44.
83. McQuade WH, Levy SM, Yanek LR *et al.* Detecting symptoms of alcohol abuse in primary care settings. Arch Fam Med 2000;9:814–21.
84. D'Amico EJ, Paddock SM, Burnam A *et al.* Identification of and guidance for problem drinking by general medical providers: results from a national survey. Med Care 2005;43:229–36.
85. Sharpe PC. Biochemical detection and monitoring of alcohol abuse and abstinence. Ann Clin Biochem 2001;38:652–64.
86. Umbricht-Schneiter A, Santora P, Moore RD. Alcohol abuse: comparison of two methods for assessing its prevalence and associated morbidity in hospitalized patients. Am J Med 1991;91:110–8.
87. Moore RD, Bone LR, Geller G *et al.* Prevalence, detection, and treatment of alcoholism in hospitalized patients. JAMA 1989;261:403–7.
88. Prytz H, Melin T. Identification of alcoholic liver disease or hidden alcohol abuse in patients with elevated liver enzymes. J Intern Med 1993;233:21–6.
89. Girela E, Villanueva E, Hernandez-Cueto C *et al.* Comparison of the CAGE questionnaire vs. some biochemical markers in the diagnosis of alcoholism. Alcohol Alcohol 1994;29:337–43.
90. Levine J. The relative value of consultation, questionnaires and laboratory investigation in the identification of excessive alcohol consumption. Alcohol Alcohol 1990;25:539–53.
91. Helander A, Eriksson CJ. Laboratory tests for acute alcohol consumption: results of the WHO/ISBRA Study on State and Trait Markers of Alcohol Use and Dependence. Alcohol Clin Exp Res 2002;26:1070–7.
92. Aalto M, Seppa K. Use of laboratory markers and the audit questionnaire by primary care physicians to detect alcohol abuse by patients. Alcohol Alcohol 2005;40:520–3.
93. Soderstrom CA, Smith GS, Kufera JA *et al.* The accuracy of the CAGE, the Brief Michigan Alcoholism Screening Test, and the Alcohol Use Disorders Identification Test in screening trauma center patients for alcoholism. J Trauma 1997;43:962–9.
94. Skinner HA, Sheu WJ. Reliability of alcohol use indices. The Lifetime Drinking History and the MAST. J Stud Alcohol 1982;43:1157–70.
95. Aertgeerts B, Buntinx F, Kester A. The value of the CAGE in screening for alcohol abuse and alcohol dependence in general clinical populations: a diagnostic meta-analysis. J Clin Epidemiol 2004;57:30–9.
96. Bataille V, Ruidavets JB, Arveiler D *et al.* Joint use of clinical parameters, biological markers and CAGE questionnaire for the identification of heavy drinkers in a large population-based sample. Alcohol Alcohol 2003;38:121–7.
97. Saunders JB, Aasland OG, Babor TF *et al.* Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption--II. Addiction 1993;88:791–804.
98. Fiellin DA, Reid MC, O'Connor PG. Screening for alcohol problems in primary care: a systematic review. Arch Intern Med 2000;160:1977–89.
99. MacKenzie D, Langa A, Brown TM. Identifying hazardous or harmful alcohol use in medical admissions: a comparison of audit, cage and brief mast. Alcohol Alcohol 1996;31:591–9.
100. Bradley KA, Bush KR, McDonell MB *et al.* Screening for problem drinking: comparison of CAGE and AUDIT. J Gen Intern Med 1998;13:379–88.
101. Steinbauer JR, Cantor SB, Holzer CE III *et al.* Ethnic and sex bias in primary care screening tests for alcohol use disorders. Ann Intern Med 1998;129:353–62.
102. Helping Patients Who Drink Too Much: A Clinician's Guide. US Department of Health and Human Services, National Institute of Health, National Institute on Alcohol Abuse and Alcoholism, 2005.
103. US Preventive Services Task Force (USPSTF). Screening and behavioral counselling interventions in primary care to reduce alcohol misuse. Recommendation Statement 2004.
104. Au DH, Kivlahan DR, Bryson CL *et al.* Alcohol screening scores and risk of hospitalizations for GI conditions in men. Alcohol Clin Exp Res 2007;31:443–51.
105. Yersin B, Nicolet JF, Dercrey H *et al.* Screening for excessive alcohol drinking. Comparative value of carbohydrate-deficient transferrin, gamma-glutamyltransferase, and mean corpuscular volume. Arch Intern Med 1995;155:1907–11.
106. Conigrave KM, Degenhardt LJ, Whitfield JB *et al.* CDT, GGT, and AST as markers of alcohol use: the WHO/ISBRA collaborative project. Alcohol Clin Exp Res 2002;26:332–9.
107. Sillanaukee P, Massot N, Jousilahti P *et al.* Dose response of laboratory markers to alcohol consumption in a general population. Am J Epidemiol 2000;152:747–51.
108. Alte D, Luedemann J, Rose HJ *et al.* Laboratory markers carbohydrate-deficient transferrin, gamma-glutamyltransferase, and mean corpuscular volume are not useful as screening tools for high-risk drinking in the general population: results from the Study of Health in Pomerania (SHIP). Alcohol Clin Exp Res 2004;28:931–40.
109. Reynaud M, Schellenberg F, Loisequx-Meunier MN *et al.* Objective diagnosis of alcohol abuse: compared values of carbohydrate-deficient transferrin (CDT), gamma-glutamyl transferase (GGT), and mean corpuscular volume (MCV). Alcohol Clin Exp Res 2000;24:1414–9.
110. Poynard T, Zourabichvili O, Hilpert G *et al.* Prognostic value of total serum bilirubin/gamma-glutamyl transpeptidase ratio in cirrhotic patients. Hepatology 1984;4:324–7.
111. Naveau S, Poynard T, Abella A *et al.* Prognostic value of serum fibronectin concentration in alcoholic cirrhotic patients. Hepatology 1985;5:819–23.
112. Chen J, Conigrave KM, Macaskill P *et al.* Combining carbohydrate-deficient transferrin and gamma-glutamyltransferase to increase diagnostic accuracy for problem drinking. Alcohol Alcohol 2003;38:574–82.
113. Hannuksela ML, Liisanantti MK, Nissinen AE *et al.* Biochemical markers of alcoholism. Clin Chem Lab Med 2007;45:953–61.
114. Hartmann S, Aradottir S, Graf M *et al.* Phosphatidylethanol as a sensitive and specific biomarker: comparison with gamma-glutamyl transpeptidase, mean corpuscular volume and carbohydrate-deficient transferrin. Addict Biol 2007;12:81–4.
115. Bortolotti F, De PG, Tagliaro F. Carbohydrate-deficient transferrin (CDT) as a marker of alcohol abuse: a critical review of the literature 2001–2005. J Chromatogr B Analyt Technol Biomed Life Sci 2006;841:96–109.
116. Wurst FM, Alling C, Aradottir S *et al.* Emerging biomarkers: new directions and clinical applications. Alcohol Clin Exp Res 2005;29:465–73.

117. Hock B, Schwarz M, Domke I *et al.* Validity of carbohydrate-deficient transferrin (%CDT), gamma-glutamyltransferase (gamma-GT) and mean corpuscular erythrocyte volume (MCV) as biomarkers for chronic alcohol abuse: a study in patients with alcohol dependence and liver disorders of non-alcoholic and alcoholic origin. Addiction 2005;100:1477–86.
118. Anttila P, Jarvi K, Latvala J *et al.* Biomarkers of alcohol consumption in patients classified according to the degree of liver disease severity. Scand J Clin Lab Invest 2005;65:141–51.
119. Center for Substance Abuse Treatment. The role of biomarkers in the treatment of alcohol use disorders. Substance Abuse Treatment Advisory, Vol 5 (4), September 2006. Accessed online at: http://www.kap.samhsa.gov/products/manuals/advisory/pdfs/0609_biomarkers.pdf.
120. Menon KV, Gores GJ, Shah VH. Pathogenesis, diagnosis, and treatment of alcoholic liver disease. Mayo Clin Proc 2001;76:1021–9.
121. Nalpas B, Vassault A, Charpin S *et al.* Serum mitochondrial aspartate aminotransferase as a marker of chronic alcoholism: diagnostic value and interpretation in a liver unit. Hepatology 1986;6:608–14.
122. Uchida T, Kao H, Quispe-Sjogren M *et al.* Alcoholic foamy degeneration--a pattern of acute alcoholic injury of the liver. Gastroenterology 1983;84:683–92.
123. Nanji AA, French SW, Mendenhall CL. Serum aspartate aminotransferase to alanine aminotransferase ratio in human and experimental alcoholic liver disease: relationship to histologic changes. Enzyme 1989;41:112–5.
124. Cohen JA, Kaplan MM. The SGOT/SGPT ratio--an indicator of alcoholic liver disease. Dig Dis Sci 1979;24:835–8.
125. Niemela O. Biomarkers in alcoholism. Clin Chim Acta 2007;377:39–49.
126. Nyblom H, Berggren U, Balldin J *et al.* High AST/ALT ratio may indicate advanced alcoholic liver disease rather than heavy drinking. Alcohol Alcohol 2004;39:336–9.
127. de BG, Graviss EA. A systematic review of the diagnostic accuracy of physical examination for the detection of cirrhosis. BMC Med Inform Decis Mak 2001;1:6.
128. Leung NW, Farrant P, Peters TJ. Liver volume measurement by ultrasonography in normal subjects and alcoholic patients. J Hepatol 1986;2:157–64.
129. Hamberg KJ, Carstensen B, Sorensen TI *et al.* Accuracy of clinical diagnosis of cirrhosis among alcohol-abusing men. J Clin Epidemiol 1996;49:1295–301.
130. Cozzolino G, Francica G, Lonardo A *et al.* Variability of the clinical and laboratory aspects in the presentation of chronic liver diseases in relation to their etiology. Analysis of a case study and review of the literature. Minerva Med 1985;76:753–60.
131. Orrego H, Israel Y, Blake JE *et al.* Assessment of prognostic factors in alcoholic liver disease: toward a global quantitative expression of severity. Hepatology 1983;3:896–905.
132. Espinoza P, Ducot B, Pelletier G *et al.* Interobserver agreement in the physical diagnosis of alcoholic liver disease. Dig Dis Sci 1987;32:244–7.
133. Goldstein LI. Enlarged, tortuous arteries and hepatic bruit. JAMA 1968;206:2518–20.
134. Han SH, Rice S, Cohen SM *et al.* Duplex Doppler ultrasound of the hepatic artery in patients with acute alcoholic hepatitis. J Clin Gastroenterol 2002;34:573–7.
135. Sherman HI, Hardison JE. The importance of a coexistent hepatic rub and bruit. A clue to the diagnosis of cancer in the liver. JAMA 1979;241:1495.
136. Zoneraich S, Zoneraich O. Diagnostic significance of abdominal arterial murmurs in liver and pancreatic disease. A phonoarteriographic study. Angiology 1971;22:197–205.
137. Naylor CD. The rational clinical examination. Physical examination of the liver. JAMA 1994;271:1859–65.
138. Klatsky AL, Chartier D, Udaltsova N *et al.* Alcohol drinking and risk of hospitalization for heart failure with and without associated coronary artery disease. Am J Cardiol 2005;96:346–51.
139. Lazarevic AM, Nakatani S, Neskovic AN *et al.* Early changes in left ventricular function in chronic asymptomatic alcoholics: relation to the duration of heavy drinking. J Am Coll Cardiol 2000;35:1599–606.
140. Preedy VR, Adachi J, Ueno Y *et al.* Alcoholic skeletal muscle myopathy: definitions, features, contribution of neuropathy, impact and diagnosis. Eur J Neurol 2001;8:677–87.
141. Estruch R, Nicolas JM, Villegas E *et al.* Relationship between ethanol-related diseases and nutritional status in chronically alcoholic men. Alcohol Alcohol 1993;28:543–50.
142. Anderson P, Cremona A, Paton A *et al.* The risk of alcohol. Addiction 1993;88:1493–508.
143. Schiano TD, Bodian C, Schwartz ME *et al.* Accuracy and significance of computed tomographic scan assessment of hepatic volume in patients undergoing liver transplantation. Transplantation 2000;69:545–50.
144. Bird GL. Investigation of alcoholic liver disease. Baillieres Clin Gastroenterol 1993;7:663–82.
145. Vilgrain V. Ultrasound of diffuse liver disease and portal hypertension. Eur Radiol 2001;11:1563–77.
146. Okazaki H, Ito K, Fujita T *et al.* Discrimination of alcoholic from virus-induced cirrhosis on MR imaging. Am J Roentgenol 2000;175:1677–81.
147. Awaya H, Mitchell DG, Kamishima T *et al.* Cirrhosis: modified caudate-right lobe ratio. Radiology 2002;224:769–74.
148. Levin DM, Baker AL, Riddell RH *et al.* Nonalcoholic liver disease. Overlooked causes of liver injury in patients with heavy alcohol consumption. Am J Med 1979;66:429–34.
149. Poynard T, Ratziu V, Bedossa P. Appropriateness of liver biopsy. Can J Gastroenterol 2000;14:543–8.
150. Hall PD. Pathological spectrum of alcoholic liver disease. Alcohol Alcohol Suppl 1994;2:303–13.
151. Mathurin P, Duchatelle V, Ramond MJ *et al.* Survival and prognostic factors in patients with severe alcoholic hepatitis treated with prednisolone. Gastroenterology 1996;110:1847–53.
152. Nissenbaum M, Chedid A, Mendenhall C *et al.* Prognostic significance of cholestatic alcoholic hepatitis. VA Cooperative Study Group #119. Dig Dis Sci 1990;35:891–6.
153. Chedid A, Mendenhall CL, Tosch T *et al.* Significance of megamitochondria in alcoholic liver disease. Gastroenterology 1986;90:1858–64.
154. Tanaka T, Yabusako T, Yamashita T *et al.* Contribution of hepatitis C virus to the progression of alcoholic liver disease. Alcohol Clin Exp Res 2000;24:112S–6S.
155. Diehl AM, Goodman Z, Ishak KG. Alcohollike liver disease in nonalcoholics. A clinical and histologic comparison with alcohol-induced liver injury. Gastroenterology 1988;95:1056–62.
156. Mathurin P, Poynard T, Ramond MJ *et al.* Interet de la biopsie hepatique pour la selection des sujets suspects d'hepatitealcoolique aigue. Gastroenterol Clin Biol 1992;16:A231.
157. Maddrey WC, Boitnott JK, Bedine MS *et al.* Corticosteroid therapy of alcoholic hepatitis. Gastroenterology 1978;75:193–9.
158. Carithers RL Jr, Herlong HF, Diehl AM *et al.* Methylprednisolone therapy in patients with severe alcoholic hepatitis. A randomized multicenter trial. Ann Intern Med 1989;110:685–90.
159. Mathurin P, Abdelnour M, Ramond MJ *et al.* Early change in bilirubin levels is an important prognostic factor in severe alcoholic hepatitis treated with prednisolone. Hepatology 2003;38:1363–9.
160. Kamath PS, Wiesner RH, Malinchoc M *et al.* A model to predict survival in patients with end-stage liver disease. Hepatology 2001;33:464–70.
161. Forrest EH, Evans CD, Stewart S *et al.* Analysis of factors predictive of mortality in alcoholic hepatitis and derivation and validation of the Glasgow alcoholic hepatitis score. Gut 2005;54:1174–9.
162. Sheth M, Riggs M, Patel T. Utility of the Mayo End-Stage Liver Disease (MELD) score in assessing prognosis of patients with alcoholic hepatitis. BMC Gastroenterol 2002;2:2.
163. Said A, Williams J, Holden J *et al.* Model for end stage liver disease score predicts mortality across a broad spectrum of liver disease. J Hepatol 2004;40:897–903.
164. Srikureja W, Kyulo NL, Runyon BA *et al.* MELD score is a better prognostic model than Child-Turcotte-Pugh score or Discriminant Function score in patients with alcoholic hepatitis. J Hepatol 2005;42:700–6.
165. Soultati AS, Dourakis SP, Alexopoulou A *et al.* Predicting utility of a model for end stage liver disease in alcoholic liver disease. World J Gastroenterol 2006;12:4020–5.
166. Dunn W, Jamil LH, Brown LS *et al.* MELD accurately predicts mortality in patients with alcoholic hepatitis. Hepatology 2005;41:353–8.
167. Rincon D, Lo IO, Ripoll C *et al.* Prognostic value of hepatic venous pressure gradient for in-hospital mortality of patients with severe acute alcoholic hepatitis. Aliment Pharmacol Ther 2007;25:841–8.
168. Mookerjee RP, Malaki M, Davies NA *et al.* Increasing dimethylarginine levels are associated with adverse clinical outcome in severe alcoholic hepatitis. Hepatology 2007;45:62–71.
169. Sougioultzis S, Dalakas E, Hayes PC *et al.* Alcoholic hepatitis: from pathogenesis to treatment. Curr Med Res Opin 2005;21:1337–46.
170. Lieber CS. New concepts of the pathogenesis of alcoholic liver disease lead to novel treatments. Curr Gastroenterol Rep 2004;6:60–5.
171. Pessione F, Ramond MJ, Peters L *et al.* Five-year survival predictive factors in patients with excessive alcohol intake and cirrhosis. Effect of alcoholic hepatitis, smoking and abstinence. Liver Int 2003;23:45–53.

172. Borowsky SA, Strome S, Lott E. Continued heavy drinking and survival in alcoholic cirrhotics. Gastroenterology 1981;80:1405–9.
173. Brunt PW, Kew MC, Scheuer PJ *et al.* Studies in alcoholic liver disease in Britain. I. Clinical and pathological patterns related to natural history. Gut 1974;15:52–8.
174. Luca A, Garcia-Pagan JC, Bosch J *et al.* Effects of ethanol consumption on hepatic hemodynamics in patients with alcoholic cirrhosis. Gastroenterology 1997;112:1284–9.
175. Pares A, Caballeria J, Bruguera M *et al.* Histological course of alcoholic hepatitis. Influence of abstinence, sex and extent of hepatic damage. J Hepatol 1986;2:33–42.
176. Powell WJ Jr, Klatskin G. Duration of survival in patients with Laennec's cirrhosis. Influence of alcohol withdrawal, and possible effects of recent changes in general management of the disease. Am J Med 1968;44:406–20.
177. Veldt BJ, Laine F, Guillygomarc'h A *et al.* Indication of liver transplantation in severe alcoholic liver cirrhosis: quantitative evaluation and optimal timing. J Hepatol 2002;36:93–8.
178. Kelly JP, Kaufman DW, Koff RS *et al.* Alcohol consumption and the risk of major upper gastrointestinal bleeding. Am J Gastroenterol 1995;90:1058–64.
179. Mackie J, Groves K, Hoyle A *et al.* Orthotopic liver transplantation for alcoholic liver disease: a retrospective analysis of survival, recidivism, and risk factors predisposing to recidivism. Liver Transpl 2001;7:418–27.
180. Miguet M, Monnet E, Vanlemmens C *et al.* Predictive factors of alcohol relapse after orthotopic liver transplantation for alcoholic liver disease. Gastroenterol Clin Biol 2004;28:845–51.
181. Miller WR, Walters ST, Bennett ME. How effective is alcoholism treatment in the United States? J Stud Alcohol 2001;62:211–20.
182. Pharmacotherapy for Alcohol Dependence. Summary, Evidence Report/Technology Assessment: Number 3, January 1999. Agency for Health Care Policy and Research: Rockville, MD. http://www.ahrq.gov/clinic/epcsums/alcosumm.htm.
183. Srisurapanont M, Jarusuraisin N. Opioid antagonists for alcohol dependence. Cochrane Database Syst Rev 2005. Art. No. CD001867.
184. Palmer AJ, Neeser K, Weiss C *et al.* The long-term cost-effectiveness of improving alcohol abstinence with adjuvant acamprosate. Alcohol Alcohol 2000;35:478–92.
185. Mason BJ. Acamprosate in the treatment of alcohol dependence. Expert Opin Pharmacother 2005;6:2103–15.
186. Anton RF, O'Malley SS, Ciraulo DA *et al.* Combined pharmacotherapies and behavioral interventions for alcohol dependence: the COMBINE study: a randomized controlled trial. JAMA 2006;295:2003–17.
187. Addolorato G, Leggio L, Ferrulli A *et al.* Effectiveness and safety of baclofen for maintenance of alcohol abstinence in alcohol-dependent patients with liver cirrhosis: randomised, double-blind controlled study. Lancet 2007;370:1915–22.
188. Galambos JT. Alcoholic hepatitis: its therapy and prognosis. Prog Liver Dis 1972;4:567–88.
189. Chedid A, Mendenhall CL, Gartside P *et al.* Prognostic factors in alcoholic liver disease. VA Cooperative Study Group. Am J Gastroenterol 1991;86:210–6.
190. Saunders JB, Davis M, Williams R. Do women develop alcoholic liver disease more readily than men? Br Med J (Clin Res Ed) 1981;282:1140–3.
191. Kondili LA, Taliani G, Cerga G *et al.* Correlation of alcohol consumption with liver histological features in non-cirrhotic patients. Eur J Gastroenterol Hepatol 2005;17:155–9.
192. Pendery ML, Maltzman IM, West LJ. Controlled drinking by alcoholics? New findings and a reevaluation of a major affirmative study. Science 1982;217:169–75.
193. Mezey E. Interaction between alcohol and nutrition in the pathogenesis of alcoholic liver disease. Semin Liver Dis 1991;11:340–8.
194. Mendenhall CL, Anderson S, Weesner RE *et al.* Protein-calorie malnutrition associated with alcoholic hepatitis. Veterans Administration Cooperative Study Group on Alcoholic Hepatitis. Am J Med 1984;76:211–22.
195. Nompleggi DJ, Bonkovsky HL. Nutritional supplementation in chronic liver disease: an analytical review. Hepatology 1994;19:518–33.
196. Calvey H, Davis M, Williams R. Controlled trial of nutritional supplementation, with and without branched chain amino acid enrichment, in treatment of acute alcoholic hepatitis. J Hepatol 1985;1:141–51.
197. Cabre E, Rodriguez-Iglesias P, Caballeria J *et al.* Short- and long-term outcome of severe alcohol-induced hepatitis treated with steroids or enteral nutrition: a multicenter randomized trial. Hepatology 2000;32:36–42.
198. Foody W, Heuman DD, Mihas AA *et al.* Nutritional therapy for alcoholic hepatitis: new life for an old idea. Gastroenterology 2001;120:1053–4.
199. Plauth M, Cabre E, Riggio O *et al.* ESPEN guidelines on enteral nutrition: liver disease. Clin Nutr 2006;25:285–94.
200. Daures JP, Peray P, Bories P *et al.* Corticoid therapy in the treatment of acute alcoholic hepatitis. Results of a meta-analysis. Gastroenterol Clin Biol 1991;15:223–8.
201. Reynolds TB, Benhamou JP, Blake J *et al.* Treatment of alcoholic hepatitis. Gastroenterol Int 1989;2:208–16.
202. Imperiale TF, McCullough AJ. Do corticosteroids reduce mortality from alcoholic hepatitis? A meta-analysis of the randomized trials. Ann Intern Med 1990;113:299–307.
203. Christensen E, Gluud C. Glucocorticoids are ineffective in alcoholic hepatitis: a meta-analysis adjusting for confounding variables. Gut 1995;37:113–8.
204. Rambaldi A, Saconato HH, Christensen E *et al.* Systematic review: glucocorticosteroids for alcoholic hepatitis--a Cochrane Hepato-Biliary Group systematic review with meta-analyses and trial sequential analyses of randomized clinical trials. Aliment Pharmacol Ther 2008;27:1167–78.
205. Higgins J, Thompson S, Deeks J *et al.* Statistical heterogeneity in systematic reviews of clinical trials: a critical appraisal of guidelines and practice. J Health Serv Res Policy 2002;7:51–61.
206. Sutton AJ, Higgins JP. Recent developments in meta-analysis. Stat Med 2008;27:625–50.
207. Mathurin P, Mendenhall CL, Carithers RL Jr *et al.* Corticosteroids improve short-term survival in patients with severe alcoholic hepatitis (AH): individual data analysis of the last three randomized placebo controlled double blind trials of corticosteroids in severe AH. J Hepatol 2002;36:480–7.
208. Phillips M, Curtis H, Portmann B *et al.* Antioxidants vs. corticosteroids in the treatment of severe alcoholic hepatitis--a randomised clinical trial. J Hepatol 2006;44:784–90.
209. O'Shea R, McCullough AJ. Steroids or cocktails for alcoholic hepatitis. J Hepatol 2006;44:633–6.
210. Uribe M, Schalm SW, Summerskill WH *et al.* Oral prednisone for chronic active liver disease: dose responses and bioavailability studies. Gut 1978;19:1131–5.
211. Louvet A, Naveau S, Abdelnour M *et al.* The Lille model: a new tool for therapeutic strategy in patients with severe alcoholic hepatitis treated with steroids. Hepatology 2007;45:1348–54.
212. Akriviadis E, Botla R, Briggs W *et al.* Pentoxifylline improves short-term survival in severe acute alcoholic hepatitis: a double-blind, placebo-controlled trial. Gastroenterology 2000;119:1637–48.
213. Menon KV, Stadheim L, Kamath PS *et al.* A pilot study of the safety and tolerability of etanercept in patients with alcoholic hepatitis. Am J Gastroenterol 2004;99:255–60.
214. Spahr L, Rubbia-Brandt L, Frossard JL *et al.* Combination of steroids with infliximab or placebo in severe alcoholic hepatitis: a randomized controlled pilot study. J Hepatol 2002;37:448–55.
215. Naveau S, Chollet-Martin S, Dharancy S *et al.* A double-blind randomized controlled trial of infliximab associated with prednisolone in acute alcoholic hepatitis. Hepatology 2004;39:1390–7.
216. Mookerjee RP, Tilg H, Williams R *et al.* Infliximab and alcoholic hepatitis. Hepatology 2004;40:499–500.
217. Boetticher NC, Peine CJ, Kwo P *et al.* A randomized, double-blinded, placebo-controlled multicenter trial of etanercept in the treatment of alcoholic hepatitis. Gastroenterology 2008;135:1953–60.
218. Schwabe RF, Brenner DA. Mechanisms of liver injury. I. TNF-alpha-induced liver injury: role of IKK, JNK, and ROS pathways. Am J Physiol Gastrointest Liver Physiol 2006;290:G583–9.
219. Louvet A, Diaz E, Dharancy S *et al.* Early switch to pentoxifylline in patients with severe alcoholic hepatitis is inefficient in non-responders to corticosteroids. J Hepatol 2008;48:465–70.
220. Bonkovsky HL, Fiellin DA, Smith GS *et al.* A randomized, controlled trial of treatment of alcoholic hepatitis with parenteral nutrition and oxandrolone. I. Short-term effects on liver function. Am J Gastroenterol 1991;86:1200–8.
221. Alvarez MA, Cabre E, Lorenzo-Zuniga V *et al.* Combining steroids with enteral nutrition: a better therapeutic strategy for severe alcoholic hepatitis? Results of a pilot study. Eur J Gastroenterol Hepatol 2004;16:1375–80.
222. Kulkarni K, Tran T, Medrano M *et al.* The role of the discriminant factor in the assessment and treatment of alcoholic hepatitis. J Clin Gastroenterol 2004;38:453–9.
223. O'Shea RS, McCullough AJ. Treatment of alcoholic hepatitis. Clin Liver Dis 2005;9:103–34.
224. Jalan R, Sen S, Steiner C *et al.* Extracorporeal liver support with molecular adsorbents recirculating system in patients with severe acute alcoholic hepatitis. J Hepatol 2003;38:24–31.
225. Wolff B, Machill K, Schumacher D *et al.* MARS dialysis in decompensated alcoholic liver disease: a single-center experience. Liver Transpl 2007;13:1189–92.

226. Tsuji Y, Kumashiro R, Ishii K *et al.* Severe alcoholic hepatitis successfully treated by leukocytapheresis: a case report. Alcohol Clin Exp Res 2003;27:26S–31S.
227. Okubo K, Yoshizawa K, Okiyama W *et al.* Severe alcoholic hepatitis with extremely high neutrophil count successfully treated by granulocytapheresis. Intern Med 2006;45:155–8.
228. Stickel F, Hoehn B, Schuppan D *et al.* Review article: nutritional therapy in alcoholic liver disease. Aliment Pharmacol Ther 2003;18:357–73.
229. Marchesini G, Dioguardi FS, Bianchi GP *et al.* Long-term oral branched-chain amino acid treatment in chronic hepatic encephalopathy. A randomized double-blind casein-controlled trial. The Italian Multicenter Study Group. J Hepatol 1990;11:92–101.
230. Hirsch S, Bunout D, de la MP *et al.* Controlled trial on nutrition supplementation in outpatients with symptomatic alcoholic cirrhosis. J Parenter Enteral Nutr 1993;17:119–24.
231. Smith J, Horowitz J, Henderson JM *et al.* Enteral hyperalimentation in undernourished patients with cirrhosis and ascites. Am J Clin Nutr 1982;35:56–72.
232. Kearns PJ, Young H, Garcia G *et al.* Accelerated improvement of alcoholic liver disease with enteral nutrition. Gastroenterology 1992;102:200–5.
233. Lochs H, Plauth M. Liver cirrhosis: rationale and modalities for nutritional support--the European Society of Parenteral and Enteral Nutrition consensus and beyond. Curr Opin Clin Nutr Metab Care 1999;2:345–9.
234. Swart GR, Zillikens MC, van Vuure JK *et al.* Effect of a late evening meal on nitrogen balance in patients with cirrhosis of the liver. Br Med J 1989;299:1202–3.
235. Zillikens MC, van den Berg JW, Wattimena JL *et al.* Nocturnal oral glucose supplementation. The effects on protein metabolism in cirrhotic patients and in healthy controls. J Hepatol 1993;17:377–83.
236. Mezey E. Commentary on the hypermetabolic state and the role of oxygen in alcohol-induced liver injury. Recent Dev Alcohol 1984;2:135–41.
237. Orrego H, Blake JE, Blendis LM *et al.* Long-term treatment of alcoholic liver disease with propylthiouracil. N Engl J Med 1987;317:1421–7.
238. Rambaldi A, Gluud C. Propylthiouracil for alcoholic liver disease. Cochrane Database Syst Rev 2002 Art. No. CD002800.
239. Lieber CS. S-adenosyl-L-methionine: its role in the treatment of liver disorders. Am J Clin Nutr 2002;76:1183S–7S.
240. Mato JM, Camara J, Fernandez de PJ *et al.* S-adenosylmethionine in alcoholic liver cirrhosis: a randomized, placebo-controlled, double-blind, multicenter clinical trial. J Hepatol 1999;30:1081–9.
241. Martinez-Chantar ML, Garcia-Trevijano ER, Latasa MU *et al.* Importance of a deficiency in S-adenosyl-L-methionine synthesis in the pathogenesis of liver injury. Am J Clin Nutr 2002;76:1177S–82S.
242. Rambaldi A, Gluud C. S-adenosyl-L-methionine for alcoholic liver diseases. Cochrane Database Syst Rev 2006 Art. No. CD002235.
243. Kershenobich D, Uribe M, Suarez GI *et al.* Treatment of cirrhosis with colchicine. A double-blind randomized trial. Gastroenterology 1979;77:532–6.
244. Morgan TR, Weiss DG, Nemchausky B *et al.* Colchicine treatment of alcoholic cirrhosis: a randomized, placebo-controlled clinical trial of patient survival. Gastroenterology 2005;128:882–90.
245. Rambaldi A, Gluud C. Colchicine for alcoholic and non-alcoholic liver fibrosis and cirrhosis. Cochrane Database Syst Rev 2005 Art. No. CD002148.
246. Day CP. Apoptosis in alcoholic hepatitis: a novel therapeutic target? J Hepatol 2001;34:330–3.
247. Austin AS, Mahida YR, Clarke D *et al.* A pilot study to investigate the use of oxpentifylline (pentoxifylline) and thalidomide in portal hypertension secondary to alcoholic cirrhosis. Aliment Pharmacol Ther 2004;19:79–88.
248. Yokota T, Oritani K, Takahashi I *et al.* Adiponectin, a new member of the family of soluble defense collagens, negatively regulates the growth of myelomonocytic progenitors and the functions of macrophages. Blood 2000;96:1723–32.
249. Li Z, Yang S, Lin H *et al.* Probiotics and antibodies to TNF inhibit inflammatory activity and improve nonalcoholic fatty liver disease. Hepatology 2003;37:343–50.
250. Loguercio C, Federico A, Tuccillo C *et al.* Beneficial effects of a probiotic VSL#3 on parameters of liver dysfunction in chronic liver diseases. J Clin Gastroenterol 2005;39:540–3.
251. Mullen KD, Dasarathy S. Potential new therapies for alcoholic liver disease. Clin Liver Dis 1998;2:851–81.
252. Ferenci P, Dragosics B, Dittrich H *et al.* Randomized controlled trial of silymarin treatment in patients with cirrhosis of the liver. J Hepatol 1989;9:105–13.
253. Rambaldi A, Jacobs BP, Iaquinto G *et al.* Milk thistle for alcoholic and/or hepatitis B or C liver diseases--a systematic cochrane hepato-biliary group review with meta-analyses of randomized clinical trials. Am J Gastroenterol 2005;100:2583–91.
254. Burra P, Lucey MR. Liver transplantation in alcoholic patients. Transpl Int 2005;18:491–8.
255. O'Grady JG. Liver transplantation alcohol related liver disease: (deliberately) stirring a hornet's nest!. Gut 2006;55:1529–31.
256. Lucey MR, Brown KA, Everson GT *et al.* Minimal criteria for placement of adults on the liver transplant waiting list: a report of a national conference organized by the American Society of Transplant Physicians and the American Association for the Study of Liver Diseases. Transplantation 1998;66:956–62.
257. Perney P, Bismuth M, Sigaud H *et al.* Are preoperative patterns of alcohol consumption predictive of relapse after liver transplantation for alcoholic liver disease? Transpl Int 2005;18:1292–7.
258. Bellamy CO, DiMartini AM, Ruppert K *et al.* Liver transplantation for alcoholic cirrhosis: long term follow-up and impact of disease recurrence. Transplantation 2001;72:619–26.
259. Zetterman RK. Liver transplantation for alcoholic liver disease. Clin Liver Dis 2005;9:171–81.
260. Newton SE. Recidivism and return to work posttransplant. Recipients with substance abuse histories. J Subst Abuse Treat 1999;17:103–8.
261. Mathurin P. Is alcoholic hepatitis an indication for transplantation? Current management and outcomes. Liver Transpl 2005;11:S21–4.
262. Turner C. How much alcohol is in a 'standard drink'? An analysis of 125 studies. Br J Addict 1990;85:1171–5.
263. Brick J. Standardization of alcohol calculations in research. Alcohol Clin Exp Res 2006;30:1276–87.
264. Ewing JA. Detecting alcoholism. The CAGE questionnaire. JAMA 1984;252:1905–7.
265. Porter HP, Simon FR, Pope CE *et al.* Corticosteroid therapy in severe alcoholic hepatitis. A double-blind drug trial. N Engl J Med 1971;284:1350–5.
266. Helman RA, Temko MH, Nye SW *et al.* Alcoholic hepatitis. Natural history and evaluation of prednisolone therapy. Ann Intern Med 1971;74:311–21.
267. Campra JL, Hamlin EM Jr, Kirshbaum RJ *et al.* Prednisone therapy of acute alcoholic hepatitis. Report of a controlled trial. Ann Intern Med 1973;79:625–31.
268. Blitzer BL, Mutchnick MG, Joshi PH *et al.* Adrenocorticosteroid therapy in alcoholic hepatitis. A prospective, double-blind randomized study. Am J Dig Dis 1977;22:477–84.
269. Lesesne HR, Bozymski EM, Fallon HJ. Treatment of alcoholic hepatitis with encephalopathy. Comparison of prednisolone with caloric supplements. Gastroenterology 1978;74:169–73.
270. Shumaker JB, Resnick RH, Galambos JT *et al.* A controlled trial of 6-methylprednisolone in acute alcoholic hepatitis. With a note on published results in encephalopathic patients. Am J Gastroenterol 1978;69:443–9.
271. Depew W, Boyer T, Omata M *et al.* Double-blind controlled trial of prednisolone therapy in patients with severe acute alcoholic hepatitis and spontaneous encephalopathy. Gastroenterology 1980;78:524–9.
272. Theodossi A, Eddleston AL, Williams R. Controlled trial of methylprednisolone therapy in severe acute alcoholic hepatitis. Gut 1982;23:75–9.
273. Mendenhall CL, Anderson S, Garcia-Pont P *et al.* Short-term and long-term survival in patients with alcoholic hepatitis treated with oxandrolone and prednisolone. N Engl J Med 1984;311:1464–70.
274. Bories P, Guedj JY, Mirouze D *et al.* Treatment of acute alcoholic hepatitis with prednisolone. 45 patients. Presse Med 1987;16:769–72.
275. Ramond MJ, Poynard T, Rueff B *et al.* A randomized trial of prednisolone in patients with severe alcoholic hepatitis. N Engl J Med 1992;326:507–12.