

NUTRITIONAL SUPPLEMENTATION

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Introduction

There are two sources of liver damage with *chronic hepatitis C*. One is from the infection itself. The other is from the *immune system's* attempt to fight the virus. Even if you eat a healthy, balanced diet that provides a broad spectrum of nutrients, there is may still be an important role for *nutritional supplements*. *Antioxidants*, *amino acids*, and fatty acids may help moderate liver damage in people living with *hepatitis C*.

A process called *oxidative stress* plays a role in the progression of chronic hepatitis C. Oxidative stress occurs when *free radicals* (unstable electrons and oxygen molecules) move through the liver causing *inflammation* and scarring. Free radicals form naturally in the body, especially when the immune system attacks an invader. The process is accelerated in chronic viral infections. The amount of damage caused by oxidative stress is linked to both the *grade* of liver *fibrosis* and the overall level of liver damage.^{1,2}

The level of *glutathione* (an antioxidant) can be significantly depressed in many people with hepatitis C.¹ Insufficient amounts of glutathione can reduce the liver's ability to break down drugs, chemicals, and other *toxins*. This can result in liver damage.

Antioxidant Supplements

A study of people chronically infected with the *hepatitis C virus (HCV)* found their blood levels of the antioxidants glutathione, *vitamin A*, *vitamin C*, *vitamin E*, and selenium were much lower than those of people the same age and sex who did not have HCV.³ Low levels of antioxidants were accompanied by high levels of blood markers that indicate oxidative stress (damage from free radicals). The levels of these markers were closely correlated to the amount of liver fibrosis. The higher the level of oxidative stress, the more advanced the fibrosis. Fibrosis was also related to low blood levels of the same antioxidants.

These findings applied not only to people with significant fibrosis and *cirrhosis on liver biopsy*, but also to those with minimal fibrosis and no cirrhosis (Ishak scores of 0-2, please see *Chapter 4.1, Liver Disease Progression*). Higher levels of oxidative stress were associated with lower levels of antioxidants and more severe liver damage. The most important information this research reveals is that even in the beginning *stages* of hepatitis C, antioxidants are important. Although this information does not prove antioxidants prevent liver damage, the authors of this research suggested that antioxidants might play an important role in slowing the progression of HCV and delaying the onset of cirrhosis.

Nutritional antioxidants can counteract the damage caused by oxidative stress and low glutathione levels. Many different antioxidants work in many different ways in the body. These include vitamins A, E, and C, the family of carotenoids (including beta-carotene), the minerals zinc and selenium, alfa-lipoic acid, N-acetyl cysteine, and SAME.

The antioxidants vitamin E, N-acetyl cysteine, SAME, and selenium have been studied in people with hepatitis C to determine their effect on liver inflammation. The process of inflammation involves the accumulation of fat in the liver. Fatty cells are susceptible to damage, which can cause fibrosis and, ultimately, cirrhosis.^{4,5}

Vitamin E, selenium, zinc, and N-acetyl cysteine (NAC) have also been studied for their potential to inhibit fibrosis in chronic hepatitis. Of particular importance are the antioxidants and nutrients that work together to increase glutathione. The use

of supplements to normalize glutathione levels may be very important for preventing liver damage. The nutrients that contribute to glutathione production are alfa-lipoic acid, vitamin C, vitamin E, NAC, and glutamine. The *B vitamins* and the mineral selenium also contribute to the antioxidant defense system.

Following are descriptions of several nutritional supplements, their effects in the body, and their roles in maintaining or improving liver health.

Alfa-Lipoic Acid

Alfa-lipoic acid (ALA) is a fatty acid and an antioxidant. It is very important in liver cell *metabolism*. ALA is rapidly depleted when the liver is under stress. ALA has a long history of use in Europe where it is used to treat liver disorders because of its apparent ability to help the liver repair itself.⁶ ALA's effectiveness in raising cellular glutathione levels is thought to be very important for liver repair with diseases like hepatitis C and *HIV* since both can cause glutathione deficiency.

Unlike most other antioxidant nutrients that work in either the fatty parts of the body (including the outer layers of cells) or the watery parts (including the blood), ALA works in both. This allows ALA to provide protection to cells throughout the body. ALA also helps recycle and regenerate other antioxidants including vitamins E and C. This helps maintain optimal levels of these nutrients in the body. ALA has been given in doses up to 1,200 mg intravenously without *toxicity*. The only side effect reported was nausea and vomiting, and this was reported infrequently. No side effects have been reported with oral doses up to 1,000 mg daily.^{7,8} Oral ALA doses of 500 mg to 1,000 mg have been well tolerated in *placebo*-controlled studies.⁹

Glutamine

Glutamine is an amino acid normally found in greater abundance in the body than any other free amino acid. It is crucial to many body functions including maintenance of optimal antioxidant status, intestinal health, and immune function. Glutamine powers immune cells and is therefore in high demand in the bodies of people living with chronic viral infections.

Some researchers believe that among people with chronic hepatitis C, the body's demand for glutamine can exceed the amount that can be supplied in the diet.¹⁰ Lack of glutamine can result in inadequate production of glutathione, which is needed to counteract the oxidative stress of chronic hepatitis C. The reason is somewhat complex, but simply stated, glutamine is the factor that determines how much glutathione the body can produce if a sufficient amount of cysteine is available (see the discussion of NAC and cysteine production for additional information). If glutamine stores are depleted by ongoing immune system demands, glutathione production will be inadequate. This situation is particularly important for people coinfecting with HCV and HIV because their immune systems are fighting two chronic infections instead of one.

Glutamine is an important nutritional supplement. It is given to support the liver and its glutathione production. Research suggests doses of at least 10 grams of powdered glutamine daily for people coinfecting with HCV and HIV (J. Shabert, personal communication).

N-Acetyl Cysteine

N-acetyl cysteine (NAC) is a form of the amino acid cysteine found in plants and animals. Like all amino acids, cysteine is a building block of proteins. NAC has been used to treat lung diseases and *acetaminophen* poisoning. It is used in *acetaminophen* poisoning to increase glutathione in the liver. NAC has been shown to increase blood glutathione in HIV-infected patients.¹¹ One study of 24 hepatitis C patients who had low glutathione showed that 600 mg of NAC taken three times daily along with *interferon* led to a normalization of *ALT* in 41% of patients.¹² The *viral loads* of patients who were on NAC were significantly lowered. NAC appeared to have the important effect of bringing glutathione levels back to normal inside *white blood cells* after six months of the combined therapy. NAC alone had no effect.

However, the results of studies using NAC in hepatitis C are conflicting. A study of NAC (1,200 mg daily) along with 600 IU per day of vitamin E and interferon found no effect on *liver enzymes*.¹³ Similar studies using 1,800 mg daily doses of NAC and interferon also found no effect on liver enzymes. Researchers found no changes in glutathione levels in the blood or white blood cells.¹⁴ A separate study that included NAC at 1,800 mg per day had no effect when it was given along with selenium and interferon.¹⁵

It is unclear whether NAC has no influence on the effectiveness of interferon or if larger doses are needed to have an effect. In one study, the doses necessary to raise glutathione levels in HIV-infected people appeared to be 3,200 mg to 8,000 mg daily.¹¹ Unfortunately, doses that high often cause nausea. The authors of this research have speculated that doses of approximately 2,000 mg may be capable of achieving the same effect. However, the dose of 1,800 mg used in some studies with hepatitis C patients was very close to that amount and still had no effect.

Studies of HIV-infected people who improved on a combined antioxidant *protocol* of NAC, glutamine, vitamin C, vitamin E, selenium, and beta-carotene indicate that antioxidants may need to be given together to have an effect.¹⁰ Antioxidants work in different ways in different places in the body, and interact with each other in many positive ways. It is not surprising that better results are seen in people given a broad spectrum of antioxidant nutrients rather than one alone. In the case of NAC, people with hepatitis C may be deficient in glutamine. Those who are coinfecting with HIV have an even higher risk of glutamine deficiency. Although the cysteine in NAC is initially the limiting factor in how much glutathione can be produced, when enough cysteine is present, glutamine becomes the limiting factor. Thus, if people are deficient in glutamine, all the NAC in the world will not raise glutathione levels and, therefore, will not provide liver protection.

Another important factor that can influence the results of NAC supplementation is its form. To maintain its antioxidant capacity, NAC must be manufactured with care and packaged in a way that prevents oxidation. Products that are not manufactured and packaged carefully can oxidize over time, losing their antioxidant capacity. It is best to choose products made from pharmaceutical grade NAC and packaged in vacuum-sealed containers known as blister packs, which protect against oxidation. NAC should always be taken with meals. It should be avoided if you have active stomach ulcers.

Selenium

Selenium is a mineral that has been investigated for its potential to improve immune function and decrease cancer risk. Selenium provides powerful antioxidant protection to the body via the selenium-containing *enzyme* glutathione peroxidase. This enzyme helps the body maintain sufficient levels of glutathione in the liver and all other glutathione-containing cells of the body. Selenium is one of the most crucial of all nutrients for maintaining effective immune responses. Many cancer researchers believe it is one of the most important nutrients in preventing cancer.¹⁶

Selenium is one of the antioxidant nutrients that can be significantly reduced among people with HCV.³ One study found people with hepatitis C who did not have cirrhosis had selenium levels 20% below normal, and those with cirrhosis had levels 40% below normal.

Selenium is very important both as an antioxidant and as a cancer prevention agent. Therefore, low selenium levels in people with hepatitis C could contribute to progressive liver damage and the development of *liver cancer*. One study looked at selenium levels in 7,342 men with chronic *hepatitis B* and C and their risk of developing liver cancer (*hepatocellular carcinoma*).¹⁷ For analysis, the participants were divided into four groups based on their selenium levels. The study found selenium levels were lowest in the men with chronic hepatitis C. Participants in the group with the highest selenium levels were 38% less likely to get liver cancer than those in the group with the lowest selenium levels. This decreased risk of liver cancer was greatest in the men with chronic hepatitis C who smoked and had low levels of vitamin A or carotenoids. Carotenoids are vitamin A-like compounds including beta-carotene. Although this study does not prove that selenium is the reason people developed less liver cancer, other studies have shown that selenium does play a protective role against liver cancer in people with chronic hepatitis.

Another selenium study conducted in China, an area with high rates of chronic hepatitis B and liver cancer, involved 130,471 people. Participants were given table salt that had been supplemented with selenium and were followed for eight years.¹⁸ The rate of liver cancer in people taking supplemental selenium was found to be one third lower than the usual liver cancer rate observed in that area. The same study included 226 people with chronic hepatitis B. Participants were given either 200 mcg of selenium daily or a placebo (an inactive substance), and were followed for four years. No one in the group that took selenium (113 people) developed liver cancer. Of the 113 who took placebo, seven developed liver cancer. The selenium was then taken away, and both groups were followed for another four years. The incidence of liver cancer in people no longer taking selenium rose to a rate similar to those who never took selenium. This indicates the supplemental selenium may have had a preventive effect on the development of liver cancer in this group of chronic hepatitis B patients.

A study that examined selenium levels in HIV-positive people showed people coinfecting with HCV and HIV had lower levels of selenium than those who had only HIV.¹⁹ HIV infection is more likely to be fatal in a person who is selenium deficient.²⁰ Clearly, having HCV, HIV, and low selenium is not a good combination.

Studies on selenium supplementation have used 50 mcg to 400 mcg (micrograms) daily of different forms of selenium. Selenomethionine appears to be one of the safest and most absorbable forms of selenium. Other forms of selenium can be *toxic* at high doses.¹

Selenium provides general antioxidant protection and immune defense. Selenium in doses of 200 mcg to 400 mcg daily may also provide protection against the development of potentially life-threatening liver cancer.

S-Adenosyl-L-Methionine

S-adenosyl-L-methionine (SAME) is another compound that aids glutathione production in the liver. SAME is an amino acid that can be made in the liver. It helps cell membranes (the outside layer of a cell) function normally. It also assists in detoxifying drugs and other compounds the liver processes.²¹

SAME is used as a medication to treat liver disease in Europe. SAME is usually called AdoMet in Europe. It has been shown to delay the need for liver transplantation in people with alcoholic cirrhosis.²² Recent research revealed that SAME has the ability to protect normal liver cells while causing liver cancer cells to die.²³ Although this research does not mean that SAME alone can prevent or treat liver cancer, it does suggest that SAME may provide some protection against developing liver cancer.

Other research involving liver disease and SAME centers around its ability to normalize *bile* secretion by the liver, a process commonly affected by chronic liver diseases. SAME has been used in multiple studies to treat the chronic skin irritation and resulting itching (*pruritus*) that is a common *symptom* of hepatitis C and many other chronic liver diseases. Studies in hepatitis B and C, and other chronic liver conditions found that SAME helps reduce the symptoms of itching, *jaundice*, and *fatigue*, and lowers liver enzymes and *bilirubin* levels in as little as 16 days.^{24, 25} Doses of SAME in these studies were either 800 mg intravenously, or 800 mg to 1,600 mg by mouth. No side effects were reported in any of the studies with SAME in chronic liver disease. More studies with SAME are needed in the United States since all of the current studies were done in Europe or Russia.

SAME is sold without a prescription. It is usually packaged in bottles or vacuum-sealed containers known as blister packs because it oxidizes (loses its potency) easily. SAME is expensive, so some people take a combination of the amino acid methionine, tri-methyl glycine (betaine), vitamin B12, and folic acid to help the body make its own SAME. The dosages for this combination are 500 mg methionine, 500 mg betaine, 800 mcg folic acid, and 500 mcg to 3,000 mcg of vitamin B₁₂ daily. Whether this combination results in the same effect as taking supplemental SAME is unknown. However, betaine, folic acid, and vitamin B₁₂ are nontoxic and do not have any harmful side effects at these doses.

Vitamin C

Vitamin C (ascorbic acid) is a powerful antioxidant and natural anti-inflammatory agent. Both characteristics are crucial for people with hepatitis C since much of the damage caused by HCV comes from a combination of oxidative stress and

inflammation in the liver. One recent study examined the relationship of blood levels of vitamin C to ALT levels in people living with hepatitis C. The researchers found that higher ALT levels were associated with lower levels of circulating vitamin C. They concluded this relationship may indicate greater consumption of vitamin C with increasingly severe oxidative stress in the liver.²⁶

Vitamin C is also very important for immune function. The white blood cells that perform many of your immune functions are dependent on vitamin C. Therefore, vitamin C is a crucial nutrient for control of any viral infection. Individual needs for vitamin C vary. For this reason, recommended dosages can range from 1,000 mg to 6,000 mg or more per day. Amounts in excess of individual tolerance of vitamin C can result in gas and/or diarrhea.

Vitamin E

Vitamin E is an antioxidant that works in the fatty parts of the body, including the outer layers of cells called cell membranes. Vitamin E is important for the protection of liver cell membranes.

In one study, 24 people with hepatitis C undergoing *interferon-based therapy* were divided into three treatment groups. Group 1 took interferon alone. Group 2 took interferon plus 1,800 mg of NAC and 400 mcg of selenium per day. Group 3 took 544 IU of vitamin E per day in addition to interferon, NAC, and selenium.¹⁵ Liver enzyme levels, HCV viral load, and response to interferon were similar in the first two groups. Those who received the complete combination that included vitamin E had a significantly greater response to treatment and achieved significantly greater drops in viral load. Although the study was small and the *relapse* rate was equal in all groups, the effect of the combination that included vitamin E was significant. It is unclear whether the vitamin E alone should be credited with the improved results or, perhaps more likely, the improvement was the result of using an effective combination of nutrients. It is always important to remember that nutrients interact in many ways and places in the body. Thus, combinations often work better than an individual nutrient.

Another study of 23 hepatitis C patients on 800 IU of vitamin E found almost half the participants experienced improvement of liver enzyme levels.²⁷ Liver enzymes went back up almost immediately after stopping the vitamin E. This suggests that vitamin E was neither combating the viral infection nor permanently stopping the process of inflammation in the liver, but was directly affecting inflammation in the liver while it was being taken. In other words, vitamin E only works while you take it. Other studies looking at the use of vitamin E and other antioxidants along with interferon have found similar results. It appears that vitamin E taken with interferon does not reduce viral levels long term and therefore does not make interferon more effective.¹³ However, it may slow the process of fibrosis.¹

Vitamin E appears to work by interrupting the biochemical pathway that leads to fibrosis in the liver. Fibrosis can lead to cirrhosis. A study of six patients on 1,200 IU of d-alfa tocopherol (a form of vitamin E) per day for eight weeks resulted in a complete interruption of this pathway, but had no effect on viral loads.²⁸ Animal studies have shown d-alfa tocopherol inhibits the genetic mechanisms that lead to cirrhosis.²⁹

Vitamin E and vitamin C supplementation was recently examined in a study of people with *NASH* but without HCV. *NASH* stands for non-alcoholic *steatohepatitis*. *NASH* is a disease in which increased liver fat can lead to fibrosis and cirrhosis. It occurs in people with and without HCV who do not drink large amounts of alcohol. The study participants took 1,000 IU of vitamin E and 1,000 mg of vitamin C daily along with a low-fat diet and weight loss plan. After six months, participants' liver biopsy results improved significantly.³⁰ It is unclear whether the same results would occur in someone with *NASH* and chronic hepatitis C. But these vitamin dosages are safe, and we know vitamin E has a measurable effect in chronic hepatitis C. Therefore, it seems reasonable that this combination may be helpful in someone with both conditions. However, a larger *clinical trial* is needed to determine this with certainty.

A dose of 800 IU to 1,200 IU of vitamin E daily is safe, unless you are on a blood-thinning drug such as coumadin or suffer from a *vitamin K* deficiency.³¹ Talk with your doctor to be sure the dose you are taking is safe in combination with your other medications.

Zinc

Patients with chronic liver disease can have low levels of several minerals including zinc.³² Zinc deficiency is known to suppress the immune system. A small study of 40 people undergoing interferon plus *ribavirin* therapy for HCV found zinc levels among those with hepatitis C were significantly lower in those with HCV compared to healthy control subjects.³³ These levels were further depressed during interferon-based therapy, but were restored to normal by supplemental zinc. No difference in viral response to the interferon-based therapy was found between those receiving zinc supplementation and those who did not receive supplemental zinc.

Researchers have begun to examine whether supplemental zinc may enhance response to interferon-based therapy for HCV. One small study (34 patients) conducted in 2000 looked at the effect of zinc supplementation in people with HCV *genotype 1b* undergoing standard interferon *monotherapy*.³⁴ Participants were given interferon alone (10 patients), interferon plus daily doses of zinc sulfate (9 patients), or interferon plus a zinc-containing product called polaprezinc (15 patients). Sustained viral response was significantly higher in those receiving interferon + polaprezinc compared to those receiving interferon + zinc sulfate or interferon alone. However, the implications of this study remain unclear. Another small study (75 patients) of polaprezinc added to standard interferon monotherapy among patients with genotype 1b found no advantage in viral response with polaprezinc supplementation among those with high pretreatment viral loads, but improved response rates in those with “moderate” pretreatment viral loads.³⁵

Polaprezinc does not seem to have the same advantage when added to *combination therapy* (interferon plus ribavirin). A study published in 2006 also conducted among patients with HCV genotype 1b (102 participants) found no enhancement in viral response with the addition of polaprezinc to interferon plus ribavirin therapy.³⁶ In another small study (23 participants), the addition of zinc to *pegylated interferon* plus ribavirin treatment was found to provide no advantage in terms of viral response.³⁷

Polaprezinc is an approved drug in Japan, but is not available in the United States. However, both zinc and carnosine are available as supplements. It is not known whether taking zinc and carnosine as separate supplements has the same effects as polaprezinc itself.

Nutritional Supplement Combinations

Antioxidants and other nutrients interact with each other in positive ways. Therefore, it comes as no surprise that positive results occur in trials in which people are given a combination of nutrients rather than any single nutrient.

A combined antioxidant approach has been used in research conducted at the Integrative Medical Center of New Mexico in Las Cruces, New Mexico.³⁸ Three patients with progressive hepatitis C and moderate to severe cirrhosis were treated with a combination of 600 mg of lipoic acid daily, 400 mcg of selenium daily, 900 mg of silymarin daily, 100 mg of vitamin B complex twice per day, 400-800 IU of vitamin E daily, 1,000-6,000 mg of vitamin C daily, 300 mg of coenzyme Q-10 daily, and one multiple vitamin and mineral supplement daily. In addition to the supplements, participants were advised to eliminate *alcohol*, sugar, and caffeine, to decrease their meat intake to a few times weekly, to increase intake of purified water to eight glasses daily, and to begin a modest exercise program. The nutrients in this protocol were chosen because of their ability to protect the liver from free radical damage, to increase the levels of other important antioxidants, and to interfere with the progress of HCV infection. There were reductions in ALT of at least 60% in all three patients, and reported improvements in overall health and well-being.

A *phase I clinical trial* of 47 patients with chronic hepatitis C looked at changes in liver enzymes, viral load, and liver biopsy results while on a protocol of antioxidants. Oral daily doses of glycyrrhizin, schisandra, silymarin, ascorbic acid, lipoic acid, L-glutathione, and alfa-tocopherol were given for 20 weeks along with intravenous preparations of glycyrrhizin, ascorbic acid, L-glutathione, and B-complex given twice weekly for the first 10 weeks.³⁹ The antioxidants used in the study included oral daily doses of glycyrrhizin, schisandra, silymarin, ascorbic acid, lipoic acid, L-glutathione, and alfa-tocopherol, and twice weekly intravenous preparations of glycyrrhizin, ascorbic acid, L-glutathione, and B-complex. At the end of 20 weeks, 44% of the patients (15 out of 34) who started the study with elevated ALT levels

had reductions to normal levels. Thirty-six percent of those in the study had an overall improvement in their liver biopsy results. Interestingly, those patients in the study who had not responded to previous trials with interferon/ribavirin did not show any improvement in liver biopsy results. While there is some indication that antioxidants may slow the progression of liver disease in hepatitis C, this specific antioxidant therapy cannot replace standard treatment as a means of eliminating the hepatitis C virus. However, the researchers suggest that the combination of antioxidants with *antiviral* therapy might improve the overall response rate.

Nutritional Supplements for Patients With Cirrhosis

In chronic hepatitis C infection that has progressed to cirrhosis, one of the concerns is an increased risk for liver cancer. The chances of developing liver cancer are estimated to be about 2% to 7% over the first 20 years of infection.⁴⁰ There are no drugs that specifically prevent liver cancer. However, sustained *viral clearance* as a result of interferon-based therapy has been shown to reduce the risk of future development of liver cancer.⁴¹⁻⁴⁴ Nonetheless, there are still many people who remain chronically infected with HCV with long-term risks for cirrhosis and liver cancer.

Retinol (a form of vitamin A) and vitamin K2 may have a role in reducing the risk for development of liver cancer among those with cirrhosis. A small study of 40 women with viral hepatitis cirrhosis evaluated the long-term risk of developing liver cancer between those taking 45 mg of vitamin K2 daily compared to those not taking supplemental vitamin K. The researchers found those taking vitamin K2 were significantly less likely to develop liver cancer compared to those who did not take supplemental vitamin K.⁴⁵ The authors concluded, "There is a possible role for vitamin K2 in the prevention of hepatocellular carcinoma in women with viral cirrhosis." NOTE: If you are taking coumadin or are on any kind of anticoagulant therapy, you should not take vitamin K in any form.

A large study of men (213 patients and 1,087 controls) examining the level of circulating retinol with the risk of developing liver cancer found that higher levels of retinol (a specific form of vitamin A) were associated with reduced risk for liver cancer. This effect was most pronounced in men who also had hepatitis B.⁴⁶ Although the men in this study were more likely to develop liver cancer as a result of their hepatitis B than are people with hepatitis C, the way that vitamin A prevents liver cancer is the same in both forms of viral hepatitis. Interestingly, serum levels of alfa-carotene, beta-carotene, beta-cryptoxanthin, lutein, lycopene, zeaxanthin, alfa-, gamma-, and delta-tocopherols, and selenium were not found to independently affect the risk of liver cancer in this study.

Hepatic *encephalopathy* (see *Chapter 5*) can occur along with liver failure. When the liver is no longer able to break down *ammonia* or efficiently filter toxins from the intestinal tract, toxins build up that affect brain function. Symptoms of hepatic encephalopathy include sleep problems, confusion, depression, and disorientation. A study of 100 patients with hepatic encephalopathy found that treatment with the amino acid L-carnitine (2 grams twice daily) resulted in decreased levels of circulating ammonia and improved brain function.⁴⁷

Summary

There is strong evidence that nutritional supplements such as antioxidants can play an important role in limiting the chronic inflammatory effects of HCV in the liver. Antioxidant supplements may counteract the damage caused by increased free radical activity in the body.

Other nutrients such as glutamine are important in the production of glutathione, an antioxidant used by the liver to break down toxins, drugs, and chemicals.

Adding appropriate nutritional supplements may have a positive effect on the health of your liver and on slowing the progression of hepatitis C.

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