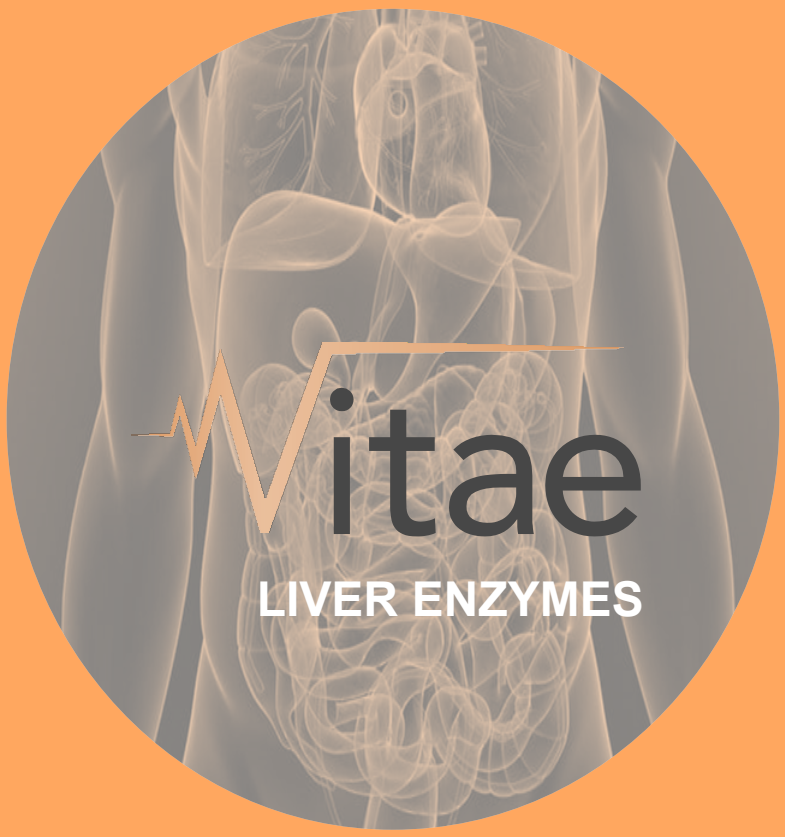

A NEW UNDERWRITING SOLUTION

developed to provide insurance coverage
for people with a liver disease

Antoine MOLL
Valentine SARRAZIN
Odile KOEHREN
Sonal BAGUL
Dominique LANNES
Gabriel MANOLACHE

Authors:

Antoine MOLL
Head of Bio Risks Calculators

Valentine SARRAZIN
Junior Data Analyst

Odile KOEHREN
R&D Risk Selection Manager

Sonal BAGUL
R&D Medical advisor

Dominique LANNES
R&D Medical advisor

Gabriel MANOLACHE
Head of Data Engineering

Introduction and context

The liver is the largest solid organ in the body. 80 billion cells with high enzymatic activity, the hepatocytes, capture molecules from the food, transform them chemically and then synthesise more than 300 essentials to life (e.g., some coagulation factors, transport proteins, etc). They also produce bile, inactivate and eliminate toxic molecules, and store excess sugars and fats. This last storage function allows the release of fats and sugars into the bloodstream according to the body's energy needs.

Whether the reason is alcohol, a virus or fat, the result for the liver is the same: over the years it becomes damaged and in reaction produces fibrous tissue which slowly infiltrates without symptoms until the liver is completely disorganised anatomically and functionally: this is cirrhosis. Cirrhosis can develop slowly and then become decompensated with the appearance of digestive bleeding, ascites, oedema of the lower limbs, jaundice, or coma in its final stage. Moreover, the more fibrosis there is in the liver, the greater the risk of liver cancer.

Hence to assess this heterogenous risk efficiently and accurately, we have developed Vitae Liver Enzymes. Combining state of the art technologies, actuarial techniques, and medical knowledge, this underwriting solution aims to assess the risk of many liver diseases, allowing improve accuracy in estimating individualised risk assessment and underwriting.

Vitae Liver Enzymes – Assessment of many liver diseases

The objective of Vitae Liver Enzymes biometric calculator is to assess the risks related to six common liver diseases and the elevated liver enzymes when the cause of this alteration in biological constants is unknown:

- **Hepatic steatosis:** accumulation of fat without causing any deleterious effects on the liver, which causes swelling of the liver and alteration in some biological constants (e.g., increase in liver enzymes, hypercholesterolemia, hyperglycemia).
- **NASH (Non-Alcoholic Steato Hepatitis) or the new term, Metabolic dysfunction-Associated Steato Hepatitis (MASH):** severe form of steatosis that can lead to fibrosis, cirrhosis, and hepatocarcinoma.
- **Hepatic fibrosis:** characterized by the presence of fibrous tissue in the liver following a chronic aggression of the liver, whatever the cause. The last stage of fibrosis is cirrhosis.
- **Chronic Hepatitis B:** viral liver infection caused by the hepatitis B virus (HBV) and responsible of fibrosis in the liver.
- **Chronic Hepatitis C:** viral liver infection caused by the hepatitis C virus (HCV) and responsible of fibrosis in the liver.
- **Cirrhosis:** consequence of a chronic aggression of the liver characterised by the presence of fibrous tissue in the liver and the development of a mass of hepatic cells known as regenerative nodules. The main complication is hepatocarcinoma.
- **Elevated liver enzymes (cause of the alteration in biological constants unknown):** transaminases (ALT and AST) and Gamma Glutamyl Transferase (GGT) are specific enzymes located mainly in the liver cells which participate in the metabolic activity of the liver. Abnormally high levels may represent a significant risk of death.

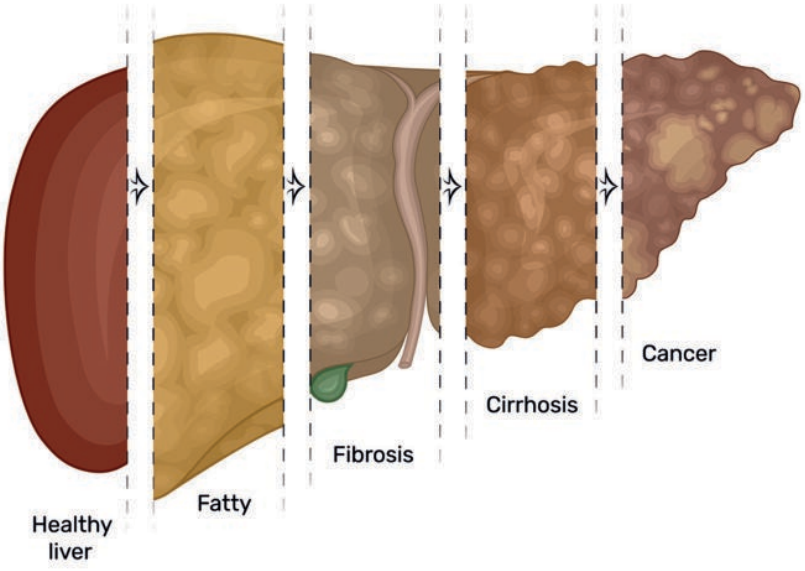

Figure: Fatty liver disease[1]

The choice of pathologies or biological anomalies covered by this new underwriting solution is based on:

- the frequency of these pathologies in the underwriter's day-to-day work
- the use of biological constants in medical practice (monitoring the patient and the progress of the pathology)
- the use of these same biological constants for risk assessment by the underwriter in the current rating pages

[1] Washington University School of Medicine in St. Louis

Use of Metavir, FIB-4 scores and blood test results to assess the risks related to liver diseases

Metavir

The Metavir scoring system is used to assess the extent of inflammation and fibrosis by histopathological evaluation in a liver biopsy. There are five stages of Metavir score[2]:

- F0: No fibrosis
- F1: Portal fibrosis without septa (thin wall that separates two parts of an organ)
- F2: Portal fibrosis with few septa
- F3: Numerous septa without cirrhosis
- F4: Cirrhosis

The higher the stage, the greater the all-cause death probability[3].

FIB-4 score

The FIB-4 score is used in medical practice to assess the presence of fibrosis. It is a well acknowledged non-invasive method to assess liver fibrosis used for monitoring risk of liver fibrosis in patients with underlying liver disease. It may be available directly in the medical report or calculated using the value of AST, ALT, platelets, and age.

According to studies[4]:

- A value of FIB-4 below 1.30 is considered as low risk for advanced fibrosis.
- FIB-4 values between 1.30 and 2.67 are considered as intermediate risk of advanced fibrosis.
- A value of FIB-4 over 2.67 is considered as high risk for advanced fibrosis.

By considering platelets, when the information is available, and consequently FIB-4 Score, VITAE Liver Enzymes estimate a more accurate risk and can propose a more commercial tariff to the client.

Blood test results

The values of Aspartate Aminotransferase (AST, ASAT or SGOT), Alanine transaminase (ALT, ALAT or SGPT), and Gamma GT allow assessment of the severity of many liver diseases. These values must compared with the upper normal limit (which may vary slightly from one laboratory to another).

Studies showed negative impacts of high level of AST, ALT, or Gamma GT on all-cause mortality[5][6].

[2] Verywellhealth. METAVIR Score Uses and Results
[3] P. S. Dulai et al., Increased risk of mortality by fibrosis stage in non-alcoholic fatty liver disease: Systematic Review and Meta-analysis. 2017 May;65(5):1557-1565
[4] https://www.hepatitisc.uw.edu/page/clinical-calculators/fib-4
[5] H. Chang Kim et al., Normal serum aminotransferase concentration and risk of mortality from liver diseases: prospective cohort study. 2004 Apr 24; 328(7446): 983
[6] E. Ju Cho et al., Gamma-glutamyl transferase and risk of all-cause and disease-specific mortality: a nationwide cohort study. 2013

VITAE solutions consider co-morbidities to avoid double penalty

Significant correlation exists between conditions such as fatty liver diseases such as NASH, MASH, or Hepatic Steatosis and obesity, metabolic syndrome, or type 2 diabetes[7][8].

VITAE Solutions – Cardio and Liver Enzymes - communicate to assign a tariff which consider interactions among risk factors and avoid charging excess premium for overlapping risks.

An updated philosophy at the crossroads of statistics, medical expertise, and underwriting

To quantify the impact of elevated liver enzymes on mortality, statistics were made on the NHANES database. NHANES (National Health and Nutrition Examination Survey) is a program of studies to assess the health and nutritional status of adults and children in the United States.

From this database, physicians and actuaries have collaborated to build a model to assess the impact on mortality of anormal values of AST, ALT Gamma GT, platelets or FIB4, by controlling by gender, age, BMI, tobacco status and medical history.

Additional medical studies enriched the philosophy proposed by SCOR to be in line with medical literature. Underwriters from all around the world contributed to make the tool user friendly and accessible for all users.

Building an API accessible in various underwriting programs

The new underwriting solution, Vitae Liver Enzymes, has been realised as an API. An API (Application Programming Interface) is software that links two software programs or services in order to exchange data and functionality. Vitae Liver Enzymes can therefore be implemented in various underwriting programs by adapting the user interface.

It is available through SCOR's traditional Underwriting manual SOLEM, but it can be available through eUW solutions as it is the case for VITAE Cardio.

[7] Sheka AC, et al.. Nonalcoholic Steatohepatitis: A Review. JAMA. 2020 Mar 24;323(12):1175-1183.
[8] Fabbrini E,et al.. Obesity and nonalcoholic fatty liver disease: biochemical, metabolic, and clinical implications. Hepatology. 2010 Feb;51(2):679-89..