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MELD and PELD Scores: Predict Models for the Survival in Patients with End-Stage Liver Disease

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Abstract

The liver is the largest essential internal organ of the body. At present, liver disease has become a major cause of morbidity and mortality worldwide, and patients with advanced liver disease may die within months to years. The model of end-stage liver disease (MELD) is an objective measure incorporating three quantitative values, such as serum creatinine, international normalized ratio (INR), and serum bilirubin that is used to prioritize and allocate adult patients of minimum age 12 years, with liver cirrhosis waiting for a liver transplantation (LT). The five factors are used in the pediatric end-stage liver disease (PELD) score, such as serum albumin, patient's age at listing, international normalization ratio (INR), total bilirubin, and growth failure, whose age is less than 12 years. At present the PELD score is successfully applied as a strong predictor of death on the waiting list in pediatric LT hospitals. The PELD score and the MELD score have been used as predictors of mortality among the listed liver failure patients that have only option of LT for survival. Both models provide more accurate measures of liver disease severity and predict that the patients are at risk of dying on the waiting list of LT.

Keywords: PELD score, MELD score, cirrhosis, liver transplantation

1. Introduction

The liver is an essential organ in the human body that performs up to 5,000 different vital functions in combination with other organs and systems, such as supporting digestion, immunity, proteins synthesis, amino acid metabolism, blood coagulation, detoxification, vitamin storage, etc. (Hettiaratchi, 2022). More than 844 million people worldwide suffer from chronic liver disease (CLD), among them about 29 million are in the European region and about 30 million are in the USA (Blachier et al., 2013). The most common liver diseases are chronic hepatitis B and C, alcoholic liver disease, non-alcoholic steatohepatitis, autoimmune disease, sclerosing cholangitis, hepatocellular carcinoma (HCC), primary biliary cirrhosis, autoimmune hepatitis, hemochromatosis, Wilson's disease, and drug reactions (Mincis & Mincis, 2006, Mohajan, 2024a).

The MELD was originally developed at the Mayo Clinic of the USA around 2000 through the effort of a group of researchers lead by Dr. Patrick Kamath, professor of gastroenterology and hepatology (Malinchoc et al., 2000). The PELD score is developed in June 2000 using a cohort of 779 patients from the Studies in Pediatric Liver Transplantation (SPLIT) registry that has included in North American pediatric LT programs (Hsu et al., 2021).

The PELD and MELD scores are derived from distinctly different equations. The factors in MELD score are bilirubin, international normalization ratio (INR), and serum creatinine (Freeman, 2005). The PELD score is similar to MELD score but uses some different factors to recognize the specific growth and development needs of children (Mohajan, 2024b,c). The factors in PELD score are serum albumin, patient's age at listing, international normalization ratio (INR), total bilirubin, and growth failure (Chang et al., 2018). Both models are simple, objective and verifiable, and yield consistent results. Usually, the group with a PELD score greater than or equal

to 25 needs an immediate liver transplant (Leonis & Balistreri, 2008).

2. Literature Review

In any type of research, literature review is an introductory section, where works of previous researchers are included (Polit & Hungler, 2013). Hamidreza Kianifar and his coauthors studied 106 patients with chronic liver disease using PELD and MELD scores, and concluded that these scores are beneficial for cirrhotic patients. (Kianifar et al., 2014). Joseph Kaplan and his coauthors have found that the MELD/PELD system transformed the rules for liver allocation and based them on objective laboratory criteria deemed to best approximate the risk of death from liver disease. They have studied on United Network for Organ Sharing (UNOS) allocation policy that changes the waiting list mortality for pediatric and adult transplant candidates listed for liver-intestine in comparison to patients listed for liver-only (Kaplan et al., 2011).

Russell H. Wiesner and his coworkers have realized that compared to the CTP score, the MELD and PELD models provide the means to more accurately measure liver disease severity and to better predict which patients are at risk of dying on the waiting list. They have shown that the MELD score is an extremely powerful predictor of the probability of death in patients with chronic liver disease (Wiesner et al., 2001). Alireza Salehi and his coworkers have shown that the high morbidity and mortality rates of decompensated cirrhosis have put the treatment and prognosis of this disease in top priority. Although the PELD and MELD scores are difficult to calculate, these are commonly used to anticipate the survival chance of children with liver cirrhosis (Salehi et al., 2021). Jinsoo Rhu and his coauthors have tried to evaluate the validity of the PELD score as a prognostic index of native liver survival in biliary atresia before Kasai portoenterostomy. Since failure rate is higher for patients with high PELD score, cautious monitoring and consultation should be made whether the liver fails and requires transplantation for the high-risk patients (Rhu et al., 2012).

Rabab Farhan Thejeal and his coworkers have noticed that liver disease is one of the major causes of hospitalization and mortality in children. They have stressed that LT is a life-saving procedure for patients with chronic end-stage liver disease and selected patients with acute liver failure when there are no available medical and surgical treatment options (Thejeal et al., 2021). Sonja M. Swenson and her coauthors have shown that the PELD score for children age 0–11 years old and the MELD scores for adults of 12 years and older are derived to predict the risk of short-term waitlist mortality using objective, and quantitative measures (Swenson et al., 2019). Evelyn Hsu and her coworkers have stated that allocation of organs to children on LT waiting list in the USA is determined by the PELD score for children aged younger than 12 years and the MELD score for children aged 12-17 years (Hsu et al., 2021).

3. Research Methodology of the Study

Research is a systematic inquiry where researchers collect data and information; later analyze and interpret them efficiently to give a rational and sensible conclusion (Groh, 2018). It is a creative work that needs systematic investigations. To perform good research, a researcher should be a devotee in the collection, interpretation, and refinement of data (Pandey & Pandey, 2015). Methodology is a system of explicit rules and procedures in which research is based, and against which claims of knowledge are evaluated (Ojo, 2003). Research methodology refers to the specific procedures used to identify, select, process, and analyze materials related to the research matter (Schwandt, 2014).

In this study, I have stressed the use of secondary data that are gathered from published and unpublished sources (Mohajan, 2017, 2018, 2020, 2024d-q,y,z). I have consulted books of famous authors, national and international journals, e-journals, handbooks, theses, etc. to enrich the article (Mohajan & Mohajan, 2023a-e, 2024d).

4. Objective of the Study

Liver is the powerhouse of the body for metabolism and a center for numerous physiological processes. Liver damage is one of the major causes of morbidity and mortality (Mohajan, 2024b,c). When the entire liver is scarred, it shrinks and gets hard. In this situation, it is called cirrhosis, and usually this damage cannot be reversed and happens very slowly. Gradually, the whole liver becomes hardened and shrunken, which makes it very hard for blood to flow through the liver (Bansal & Friedman, 2018). The MELD is a numerical scale, ranging from 6 (less ill) to 40 (gravely ill) that is used for LT candidates age 12 and older. The number is calculated by a formula using three routine lab test results: serum bilirubin, the international normalized ratio (INR) for prothrombin time, and serum creatinine (Montgomery et al., 2005). The PELD score is similar to the MELD score but is used for children aged less than 12 years (Mohajan, 2024x). It may be measured by a formula using: serum bilirubin, growth failure, the international normalized ratio (INR) for prothrombin time, and whether the child is less than one year old (Bourdeaux et al., 2005). Main objective of this article is to discuss the basic properties of the MELD and the PELD scoring systems. Other minor objectives of the study are as follows:

- to highlight on liver and its functions

- to focus on liver transplantation (LT), and
- to discuss PELD and MELD scores.

5. An Overview of Liver and Its Functions

The liver is the largest internal organ of the body that weighs about 1500 to 2000g (Mohajan, 2024r,t,u). It is a dark pinkish-brown peritoneal organ and is divided mainly into two lobes by the falciform ligament, which connects the liver to the diaphragm and the anterior abdominal wall (Sumadewi, 2023). It consists of two major types of cells: hepatocytes and Kupffer cells. It is located in the upper right-hand portion of the abdominal cavity, below the diaphragm, on top of the stomach, right kidney, and intestines; and extends into the left hypochondrium (Juza & Pauli, 2014). It is an accessory organ in digestion, and also undertakes several metabolic processes, such as bile production, bilirubin synthesis, and protein, lipid, and carbohydrate metabolism. It has a remarkable capacity to regenerate its injured tissues (Mohajan, 2024v).

6. An Overview of LT

A healthy liver is necessary for survival that can regenerate most of its own cells when these are damaged. A LT is a life-saving treatment option of a diseased liver through the replacement with a healthy liver from a deceased donor or a portion of a healthy liver from a living donor. It has been accepted as a sure treatment for acute liver failure and end-stage liver disease (Lucas, 2021). A LT is a complex process that requires hundreds of steps before, during and after LT. The LT person needs a long-time follow up treatment with medications to prevent the body from rejecting of the new liver (Mohajan, 2024r). A healthy adult living-donor can donate a portion of his/her liver to someone with end-stage liver disease. Most LT patients are able to return to a normal and healthy lifestyle and can enjoy an improved quality of life (Lewis & Howdle, 2003).

7. MELD Score

The model for end-stage liver disease (MELD) is the scoring system that is used to measure illness severity in the allocation of livers to adult transplant candidates at least 12 years old (Mohajan, 2024s,w). It is developed in 2001 and incorporated into United Network for Organ Sharing (OPTN) policy in 2002 (Kamath et al., 2001). It is introduced to provide a method that expressed the risk of death in patients awaiting LT and to allow better prioritization of patients for LT that is used combinations of waiting time, liver dysfunction, and hospitalization status (Wiesner et al., 2003).

It is calculated from three laboratory parameters, such as serum bilirubin, serum creatinine, and international normalized ratio (INR) of prothrombin time. It is defined by American hepatologist Michael Malinchoc through the following formula (Malinchoc, et al., 2000):

$$\text{MELD} = 3.78 \times ln\big(\text{serum bilirubin (mg/dL)}\big) + 11.2 \times ln(\text{INR}) + 9.57 \times ln\big(\text{serum creatinine (mg/dL)}\big) + 6.43 \quad (1)$$

The MELD score uses a continuous scale from 6 to 40, based on serum bilirubin, international normalized ratio (INR) of prothrombin time, and serum creatinine (Kamath et al., 2001). After the introduction of MELD score for organ allocation in the USA in the very first year have reduced about 12% in waitlist mortality (Wiesner et al., 2006).

8. PELD Score

The PELD score is calculated to all cases depending on the age; gender; growth parameter, such as height and weight; and laboratory investigations results, such as total serum bilirubin level, serum albumin, and international normalized ratio (INR) (Thejeal et al., 2021). The score is an important prognostic marker for survival and is a useful tool where individual assessment of the severity of liver disease and prioritization on the waiting list cannot be made in other ways (Swenson et al., 2019).

The patients with PELD score less than 11 must be followed up every one year, those in between 11 and 18 need to be evaluated every six months, those in between 19 and 24 need follow up every one month, and more than or equal to 25 need immediate LT (Kerkar & Lakhole, 2016). Liver disease severity is assessed by the PELD formula as (Shinkai et al., 2003),

$$\text{PELD} = 4.80 \times ln\big(\text{serum bilirubin (mg/dL)}\big) + 18.57 \times ln(\text{INR}) - 6.87 \times ln\big(\text{serum albumin (g/dL)}\big) + 4.36\ (< 1 \text{ year old}) + 6.67\ (\text{growth failure}) \quad (2)$$

The PELD score is calculated by equation (2) using the laboratory results of a patient provide the time when the patient will die within a certain time period (Mohajan, 2024x).

9. Conclusions

The liver plays an essential role in metabolism through the preservation and regulation of the levels of lipid, and glucose in the body as well as energy metabolism. The cost of advanced liver disease in terms of human suffering,

hospital costs, and the loss of productivity is very high. The PELD score for children and the MELD score for adults are developed simultaneously to predict the severity of the chronic liver disease and to prioritize children awaiting liver transplantation (LT). Everybody should take proper care of liver through the maintenance healthy lifestyle, such as taking healthy balanced diet, taking moderate physical exercise, and avoiding fast foods and alcohol to avoid many liver diseases.

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