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# Meld Criteria in the Transplant Waiting List: Impact on Mortality Overall and by Diagnostic Groups

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**Abstract: Introduction:** The modification of liver graft allocation for selection by severity criteria based on the Model for End-Stage Liver Disease (Meld) has not yet been properly analyzed in Brazil regarding the distribution of indications for transplant and mortality among enrolled patients. In a context of low organ donation and procurement, this assessment is relevant. **Objective:** To compare mortality on the liver transplant waiting list in Brazil before and after the adoption of Meld score as a criterion for allocation on the waiting list: overall, by diagnostic group, and by Meld range at enrollment. **Methods:** We retrospectively studied 899 patients (median age = 52.8 years, body mass index, BMI = 25.2 and Meld = 18) divided into the pre- (n = 320, 35.6%) and post-Meld (n = 579, 64.4%) periods and into groups: 1 (n = 480, 53.4%): ethanolic, cryptogenic and autoimmune cirrhosis; 2 (n = 80, 8.9%): biliary diseases; 3 (n = 93, 10.3%): metabolic and other diseases; and 4 (n = 246, 27.4%): post-viral B and C cirrhosis. Special scoring was assigned to 19.5% of patients, according to legislation criteria. The sample was also divided by Meld ranges at enrollment (< 18; 18–24; and > 24). Waitlist mortalities of the pre- and post-Meld groups were compared in the total sample, in each diagnostic group, and in each Meld range. **Results:** The incidence of referrals to transplantation was different in the pre- and post-Meld eras (p = 0.049), increasing in group 3 (from 8.1 to 11.6%) and decreasing in group 4 (from 32.5 to 24.5%). Of the enrollees, 32.9% died before transplantation. Mean Meld increased from 16 to 20 (p < 0.001), and mean time between enrollment and outcome (transplant or death) decreased from 102 days to 58 (p = 0.028). Waiting list mortality dropped from 105.7% (patient-years) to 54.9% in the post-Meld group (p = 0.001). There was a reduction from 104.2% (patient-years) to 51.1% (p = 0.034) in group 1, and the proportion fell from 160.3% (patient-years) to 52% (p = 0.019) in group 2. On the other hand, there was no statistically significant variation in the groups 3 and 4. In Meld range 1 (< 18), mortality ranged from 87.2% per patient-year to 24.1% per patient-year (p = 0.005). In Meld range 2 (18–24), it ranged from 109.8 to 72.4% per patient-year (p = 0.019). In the Meld > 24 range, there was no significant change in waitlist mortality. Finally, survival at 1, 3 and 12 months after transplantation did not vary significantly between the pre-Meld and post-Meld era. **Conclusion:** Comparing the pre- and post-Meld groups, patients were enrolled when they were most severely ill, and there was a reduction in mean time on the list for the outcome and a decrease in waiting list mortality with no change in post-transplant survival. Diagnosis groups 1 and 2 have benefited. In addition, the decrease in waiting list mortality was observed among patients with Meld < 24 at the time of enrollment. This reduction was not observed in the group of patients with Meld > 24.

**Keywords:** Organ Transplantation; Liver Transplantation; Liver.

## INTRODUCTION

Liver transplantation has provided treatment for countless patients with terminal liver disease, with no expectation of other less invasive therapeutic methods. To achieve the present success, major advances in immunosuppression, graft preservation and surgical technique were obtained in the 1980s and continue to be improved until today.[1–13] However, virtually no country has achieved full sufficiency in the number of available organs to meet the list of transplant candidates. Efforts to obtain an unlimited number of donors have been made with xenotransplantation research, but this too has not resulted in a practical solution to the problem.[14,15] On the other hand, the use of living donor grafts, grafts from donors with extended criteria, and, more recently, cardiac death donors, has increased the donor pool by about 30%.[5,16–24] Such measures have not been sufficient to eliminate transplant waiting lists. In the early days of transplant activity in the last century, patients were transplanted according to their arrival on the waiting list, a type of organization known as the chronological list. However, as confidence in liver transplantation grew, the waiting lists became longer. Patients who presented more severely and those who became severe during the waiting period succumbed before transplantation, making the waiting list mortality rate increasing. Organ allocation became a matter of debate.

At first, the urgency of patients with fulminant hepatitis and other situations of imminent risk of death without transplantation was recognized, and priority was given to these cases. In the United States, the other nonurgent patients were divided into groups that required hospital support or that could wait at home. In each group, the waiting order was chronological.[13,25] In Brazil, liver transplant activity was incipient in the 1980s and 1990s and concentrated in the state of São Paulo. The level of regulation was low, and the allocation of grafts was done by teams, which took turns. At that time, the emergence of new teams across the country made necessary a more rigid regulation, represented by the chronological list, which exceptions were only the urgency for fulminant hepatitis or retransplants.[26]

The liver transplant activity in Brazil has been growing, following the increase in the number of donors; however, the rate of available donors per million of population has remained low compared to other countries more developed in this activity.[16] Thus, the combination of low organ harvesting and the increase in the number of patients on waiting lists has further exposed the problem of mortality on the list.

Discussion about graft allocation by severity started in several countries. In 2001, the United States changed its liver graft allocation system, organizing the waiting list by the severity of candidate patients.[13,25] The measure of severity was obtained by the Model for End-Stage Liver Disease (Meld), or model for end-stage liver disease, plus exception situations. The Meld is obtained by mathematical calculation that includes creatinine, bilirubin, and the International Normalized Ratio (INR) of prothrombin. This score was developed to evaluate patients hospitalized for decompensated liver disease, outpatients with noncholestatic cirrhosis, patients with primary biliary cirrhosis, and a group of unselected patients with cirrhosis (various etiologies and stages of disease). In all groups, the score was found to be a good predictor of mortality within 3 months of evaluation.[27]

The change in the allocation model, in the United States and in other countries, was followed by a drop in waiting list mortality, without compromising post-transplant survival.[28,29] In 2006, Brazil adopted the Meld-based severity ordering system for the waiting list. The impact of this change has not yet been extensively analyzed in Brazil, where theoretical simulations of the waiting list indicate that at critically low levels of donation, the change in allocation criteria would have no effect on preventing on-list mortality.[27]

The present study questions whether the intervention performed with the sorting of the waiting list by Meld score had an impact on the distribution of patients by etiological diagnosis, as well as on the mortality among patients on the list. The study, already performed in other countries, is justified by the low organ procurement environment found in Brazil.

## METHODS

We retrospectively studied 1,168 patients, aged 12 to 74 years, enrolled on the list of candidates for liver transplantation at the Hospital das Clínicas, Universidade Federal de Minas Gerais (UFMG), between 2002 and 2016. Data were collected from physical medical records and the Zeus electronic system, as approved by the UFMG Research Ethics Committee (no. 19333913.6.0000.5149). A total of 471 physical and 657 electronic medical records were accessed. Two hundred and twenty-nine patients were excluded for the reasons specified in Fig. 1. A total of 899 patients were included in the analysis.

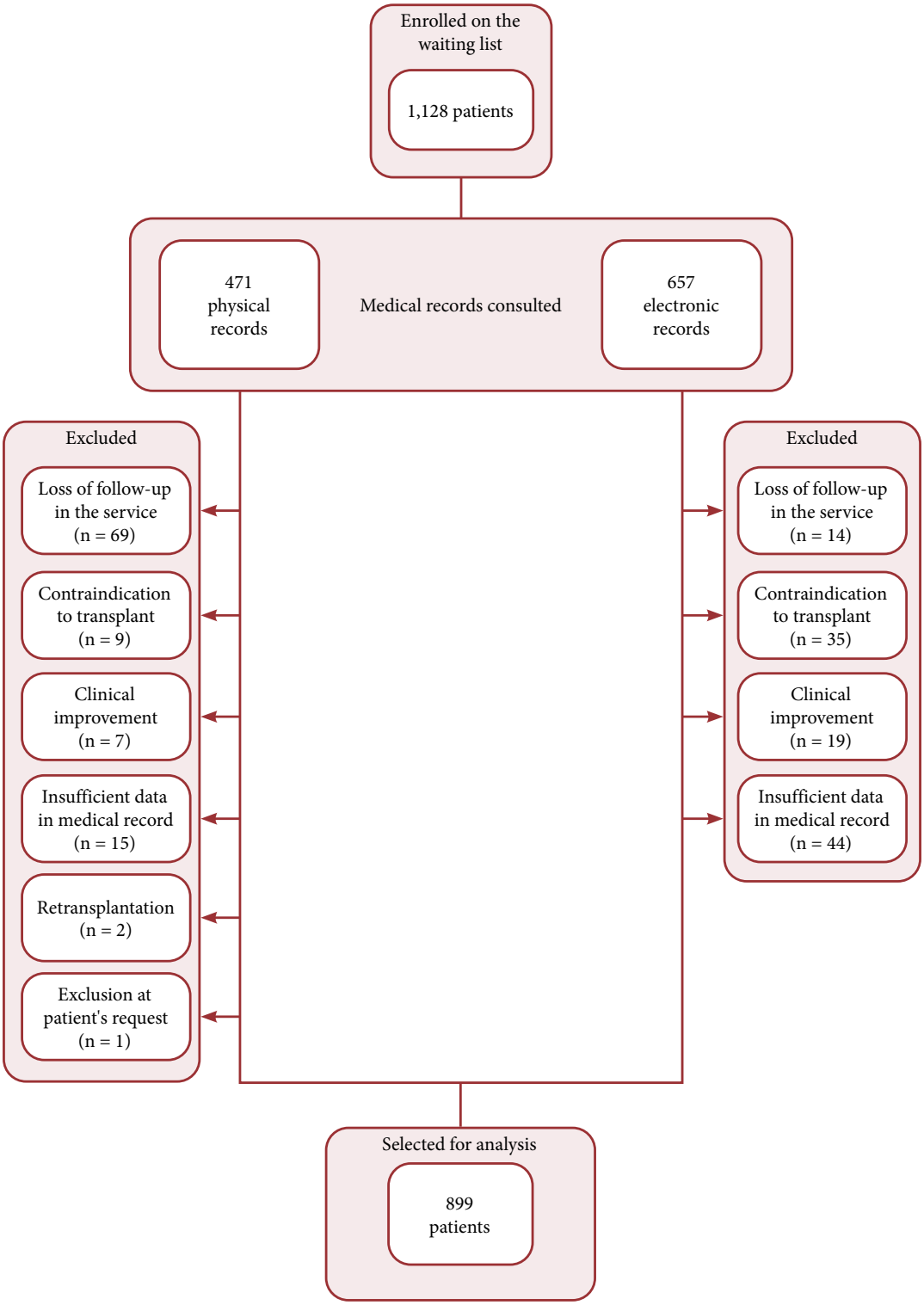



**Figure 1.** Organizational chart of obtaining cases for analysis and cases excluded from the study.

For each patient in the sample, the following data were recorded: waiting list enrollment date, age, height, weight, BMI, ABO blood group, Rh factor, clinical outcome (death or transplantation), Meld score at enrollment, and indication for transplantation. The time from evolution (days) to outcome was calculated. For patients enrolled before the Meld criteria were in effect, the score was calculated based on laboratory test records (serum creatinine, total bilirubin, and prothrombin IRN) collected up to 90 days from the date of enrollment (Table 1). Those who did not have laboratory data for calculation that fit this criterion were excluded due to absence of the required data in medical records.

**Table 1.** Variables documented in 899 patients enrolled on the liver transplant candidate list and respective units used.

| | Unit/nominal variables |
|---|---|
| Age | years |
| Sex | M / F |
| BMI | kg/m$^2$ |
| Enrollment date and end date | date |
| Outcome | death/transplant |
| Meld score for the waiting list | value |
| Diagnosis group | 1 / 2 / 3 / 4 |
| Special Scoring Situation | Yes / no |
| Blood group | A / B / O / AB |
| Rh factor | Positive / negative |
| Progress time on the waiting list | days |

BMI: body mass index. MELD: model for end-stage liver disease.

The cases were divided into the pre-Meld periods, when enrolled between May 17, 2002 and July 10, 2006; and post-Meld, for those enrolled between July 20, 2006 and April 7, 2016.

The patients in the sample were grouped according to diagnosis:

- Group 1: ethanolic, cryptogenic and autoimmune cirrhosis;
- Group 2: biliary diseases (biliary tract atresia, primary biliary cholangitis, secondary biliary cirrhosis, primary sclerosing cholangitis, and Caroli disease);
- Group 3: metabolic and other diseases (fulminant hepatitis, hepatic adenomatosis, amyloidosis, drug cirrhosis, alpha-1-antitrypsin deficiency, Wilson's disease, polycystic disease, nonalcoholic steatohepatitis, liver metastases, oxalosis, porphyria, Budd–Chiari syndrome, hepatic artery thrombosis);
- Group 4: post-viral cirrhosis B and C.

The cases were also divided by range from Meld to enrollment, with the following ranges:

- Track 1: Meld to enrollment <18;
- Track 2: Meld to enrollment between 18 and 24; Track 3: Meld to enrollment > 24.

Cases from the post-Meld era were designated as with special scoring and without special scoring, according to the current Brazilian legislation. The situations provided for special scoring are: metastatic neuroendocrine tumor, hepatocellular carcinoma, familial amyloidotic polyneuropathy (scores I, II, and III), hepatopulmonary syndrome, giant unresectable hemangioma, hemangiomatosis or polycystic disease with compartment syndrome, unresectable fibrolamellar carcinoma without extrahepatic disease, and extensive unresectable multiple bilobar adenomatosis.[30]

For descriptive analysis of the sample, nominal variables were analyzed by frequency. Continuous variables were classified as normal or non-normal by the Kolmogorov–Smirnov test and presented, respectively, as mean and standard deviation or median and interquartile range (IQR). The pre- and post-Meld groups were compared using statistical tests appropriate for the distribution type (Mann–Whitney U-test for independent samples, z-test for comparison of proportion).

Pre- and post-Meld mortalities were compared in the total sample and subsequently in each diagnostic group and in each established Meld range. To analyze the variation in mortality between the pre- and post-Meld period, the following steps were performed:

- The mortality rate on the transplant waiting list was calculated for each year of the study by Eq. 1:

$$\text{Mortatlity rate} = \text{Deaths per year}/\text{Patients per year} \times 100 \quad (1)$$

as directed by the Organ Procurement and Transplantation Network of the US Department of Health. The patient-year parameter is calculated by adding the days in line for all patients in that year divided by the total number of days in the period (365 days). Subsequently, the number of deaths on the waiting list for that period is divided by the patient-year value and multiplied by 100;[31]

- In each group analyzed, the normal or non-normal distribution of mortality values was verified by the Shapiro–Wilk test, and the means or medians were calculated according to the distribution;
- The pre- and post-Meld means of mortality were compared by Welch's two- tailed t-test when the distribution was normal. Medians, on the other hand, were compared by Wilcoxon's test when the distribution was non-normal.

Finally, it was ascertained whether there was a difference in post-transplant survival at one month, three months and one year in the pre- and post-Meld samples by means of the $\chi^2$ test.

The analyses were performed using the Statistical Package for the Social Sciences (SPSS 20) and RStudio software. Differences were considered significant when the p value was $\leq 0.05$.

## RESULTS

The 899 patients enrolled on the transplant waiting list had median age of 52.8 years, BMI of 25.2, and Meld at enrollment on the waiting list of 18 (Table 2). Patients were divided into the pre-Meld period (n = 320, 35.6%)—enrolled between May 17, 2002 and July 10, 2006—and post-Meld period (n = 579, 64.4%)—enrolled between July 20, 2006 and April 7, 2016. Special scores were assigned to 19.5% of patients in the post-Meld era.

**Table 2.** Medians of age, Meld and BMI, subdivided into pre- and post-Meld* groups.

| | All cases (IQR) | Pre-Meld (IQR) | Post-Meld (IQR) | p-value |
|---|---|---|---|---|
| Age (years) | 52.8 (16.7) | 51.1 (16.4) | 53 (17) | 0.036 |
| Meld at registration | 18 (6) | 16 (7) | 20 (7) | < 0.001 |
| BMI (kg/m$^2$) | 25,2 (6) | 24,7 (5,4) | 25,3 (6,4) | 0.013 |
| Time of evolution on the waiting list (days) | 72 (88) | 102 (233) | 58 (150) | 0.028 |
| Rh factor | 781 positive (86.9%) | 283 positive (88%) | 498 positive (86%) | > 0.05 |
| | 117 negative (13.1%) | 37 negative (12%) | 81 negative (14%) | |
| Blood group | A: 371 (41.3%) | A: 135 (42.0%) | A: 236 (40.7%) | > 0.05 |
| | B: 94 (10.5%) | B: 34 (10.6%) | B: 60 (10.3%) | |
| | AB: 34 (3.8%) | AB: 10 (3.1%) | AB: 24 (4.2%) | |
| | O: 400 (44.5%) | O: 141 (44.0%) | O: 259 (44.7%) | |

*One-sample Kolmogorov-Smirnov test; IQR: interquartile range; Meld: model for end- stage liver disease; BMI: body mass index.

Considering all the patients analyzed, 32.9% of those enrolled on the waiting list died before transplantation. The following results are presented in order to highlight the behavior of the analyzed data before and after the change on the waiting list allocation criteria (pre- versus post-Meld).

Median Meld to enrollment increased from 16 in the pre-Meld era to 20 in the post-Meld era ($p < 0.001$). The median elapsed time from patient enrollment on the waiting list to outcome (death or transplant) reduced from 102 to 58 days ($p = 0.028$).

The distribution of the sample in the diagnostic groups was as follows:

- Group 1: n = 480, 53.4%;
- Group 2: n = 80, 8.9%;
- Group 3: n = 93, 10.3%;
- Group 4: n = 246, 27.4%.

The change in the proportion of diagnostic groups in the composition of the waiting list ($p = 0.049$) is shown in Table 3. Group 4 was the only one that showed statistically significant variation ($p = 0.001$), reducing from 32.5 to 24.5% of the sample.

**Table 3.** Proportions of diagnostic groups in the pre- and post-Meld* periods.

| | Pre-Meld (n, %) | Post-Meld (n, %) | p-value |
|---|---|---|---|
| Group 1 | 162 (50.6) | 318 (54.9) | 0.220 |
| Group 2 | 28 (8.8) | 52 (9.0) | 0.910 |
| Group 3 | 26 (8.1) | 67 (11.6) | 0.100 |
| Group 4 | 104 (32.5) | 142 (24.5) | 0.001 |
| Total | 320 | 579 | |

* $\chi^2$ test; Meld: model for end-stage liver disease.

Comparison of waitlist mortality in the pre- and post-Meld eras showed a reduction from 105.7% (± 14.0%) to 54.9% patient-year (± 14.1%) ($p = 0.001$) (Table 4).

**Table 4.** Variation in mean annual mortality rates on the waiting list pre- and post-Meld*.

| | Pre-Meld (% patient-year) ± SD | Post-Meld (% patient-year) ± SD | p-value |
|---|---|---|---|
| Average mortality rates | 105.7 (±14.0) | 54.9 (±14.1) | 0.001 |

*Welch's t-test; Meld: model for end-stage liver disease; SD: standard deviation.

There was also variation in the mortality rate in each diagnostic group between the two eras (Table 5). The change was significant in group 1, in which the rate, which was 104.2% patient-year, decreased to 51.1% ($p = 0.034$). It was also significantly reduced in

group 2, from 160.3% to 52% patient-year (p = 0.019). There was no significant change in mortality between the pre- and post-Meld eras in groups 3 and 4.

**Table 5.** Variation of mortality rate on the waiting list by diagnostic group*.

| | Pre-Meld (%patient-year) | Post-Meld (%patient-year) | Measure | p-value |
|---|---|---|---|---|
| Group 1 | 104.2 (17.8) | 51.1 (32.8) | Median (IQR) | 0.034 |
| Group 2 | 160.3 (± 55.8) | 52 (± 50,1) | Mean ± SD | 0.019 |
| Group 3 | 197 (± 183.7) | 85,6 (± 65.3) | Mean ± SD | 0.315 |
| Group 4 | 91.6 (± 91.6) | 55,8 (± 55.8) | Mean ± SD | 0.148 |

*Welch's t-test for means and Wilcoxon's test for medians; Meld: model for end-stage liver disease; SD: standard deviation; IQR: interquartile range.

Mortality by Meld range varied with statistical significance in Meld ranges 1 and 2 at enrollment on the waiting list (Meld < 18 and between 18 and 24, respectively). In range 1, mortality varied from 87.2% to 24.1% patient-years (p = 0.005). In range 2, it varied from 109.8% to 72.4% patient-years (p = 0.019). In the Meld > 24 range, on the other hand, there was no significant change in mortality on the waiting list (Table 6).

**Table 6.** Variation of mortality rate on the waiting list by Meld range at enrollment*.

| | Pre-Meld (% patient-year) | Post-Meld (% patient-year) | Measure | p-value (two-tailed) |
|---|---|---|---|---|
| Range 1 | 87.2 (36.7) | 24.1 (12.9) | Median (IQR) | 0.006 |
| Range 2 | 109.8 (42.4) | 72.4 (37.8) | Median (IQR) | 0.019 |
| Range 3 | 238 (130.4) | 352.3 (229.3) | Mean (± SD) | 0.282 |

*Welch's t-test for means and Wilcoxon's test for medians; Meld: model for end-stage liver disease; range 1: Meld at enrollment < 18; range 2: Meld at enrollment between 18 and 24; range 3: Meld at enrollment > 24; SD: standard deviation; IQR: interquartile range.

Finally, post-transplant survival at one month, three months and one year did not vary significantly between pre- and post-Meld samples (Table 7).

**Table 7.** Post-transplant survival before and after institution of Meld*.

| Post-transplant time | Pre-Meld survival (%) | Post-Meld survival (%) | p-value |
|---|---|---|---|
| 1 month | 84.93 | 82.71 | 0.619 |
| 3 months | 80.82 | 78.12 | 0.562 |
| 1 year | 78.08 | 73.52 | 0.321 |

* $\chi^2$ test; Meld: model for end-stage liver disease.

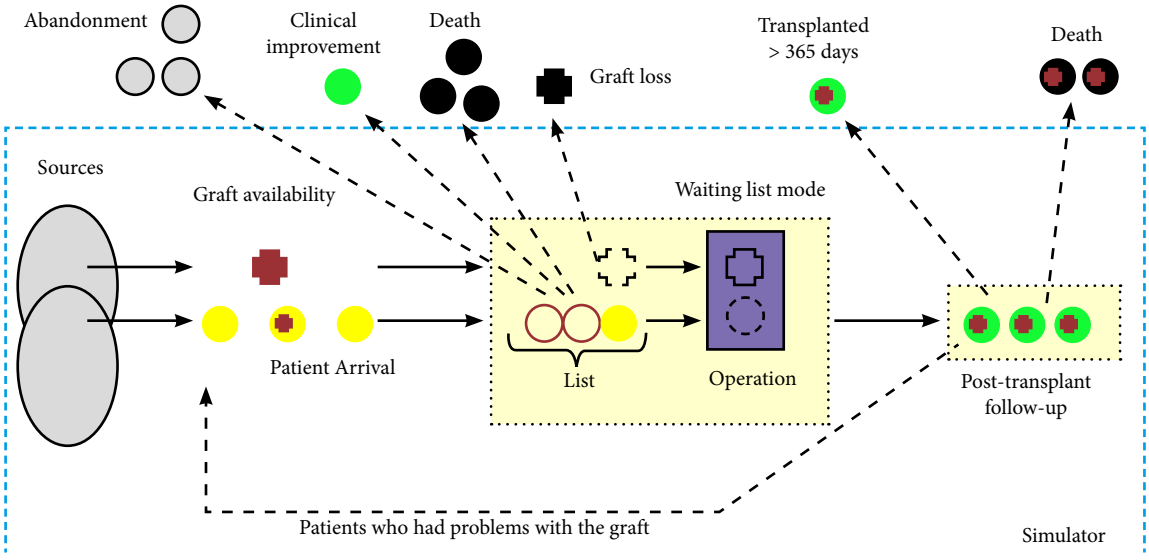
## DISCUSSION

In most waiting lists for liver transplantation there is a clear disproportion between the number of candidates and the number of organs offered. Such disparity requires regulations to control the distribution of grafts. In Brazil, until 2006, the order by waiting time prevailed. If an advantage could be expected from this policy, it could be summarized in the clear transparency determined by the date of entry on the waiting list; however, severely ill patients succumbed to waiting in long lists, while early referred patients were transplanted with incipient severity.

In 2001, the Meld score was introduced in the liver allocation process in the United States. This organ allocation process, based on the severity of liver disease, aims to minimize the effects of such a mismatch between demand and supply, based on the premise that the most severely ill patient is more likely to die before reaching transplantation.[13,25,26] The result of this policy has been the reduction of mortality on the waiting list in some European countries and in the United States.[27–29]

The change to severity-based allocation in Brazil in 2006 raised the question about the validation of this method in a reality different from the North American and European contexts.[30] In a continental developing country such as Brazil, there are several factors that lead to questioning the outcome of this change. Among them are the low donation rates in most states. Low donation rates generate such an imbalance between the demand and availability of viable organs that the outcome could be different than expected due to the change in criteria.

Oliveira et al.,[32] using a digital simulation of transplants on the waiting list in Brazil (Fig. 2), concluded that there would be no difference in mortality or abandonment of the waiting list using the Meld system or the first-come, first-served system. The result could be explained by the several factors that make it difficult to meet the demand for organs for transplantation, such as the great disproportion between the number of donors and the number of patients on the waiting list, the difficulty of transportation and preservation of organs, among others. Thus, it is hypothesized that the Meld score allocation system, which favors more severely ill patients in the allocation on the waiting list, could only change the patients who die on the waiting list without changing the mortality rate. This hypothesis would be supported by the theory that in this new system, the initially less severe patients, who would wait longer on the waiting list, would not be treated in time and would die in the same proportion as those more severe died previously in the enrollment system by chronological order. . Oliveira et al.[33] tested another simulation model of transplant list in a real sample of patients enrolled for liver transplantation in São Paulo (2007/2008) and agreed with the ineffectiveness of the model change when the organ supply factor is very limiting.




Source: adapted from Oliveira et al.[33]

**Figure 2.** Dynamics of the simulation model.

In contrast, Salvalaggio et al.,[34] in 2012, conducted a study using census data from the liver transplant waiting list in São Paulo from 2003 to 2009. In that study, the unadjusted waiting list death rate decreased after the implementation of the Meld system (from 91.2 to 33.5/1,000 patients per year, $p < 0.0001$). The authors then concluded that the Meld score could be used as a prioritization criterion in successful liver graft allocation in developing countries.

Later, in 2014, Mattos coordinated a study in the southern region that retrospectively analyzed 162 patients from the pre-Meld era and 184 from the post-Meld era. In that research, the survival curve on the waiting list showed statistically significant improvement. The authors then concluded that the use of the Meld criterion in the transplant on the waiting list would be beneficial in relation to short- and long-term survival on waiting list when compared to the criterion applied before (chronological).[35]

As can be seen, the outcome of the cited studies was similar to those found in other countries. In Switzerland, in 2011, Dutkowski et al.[29] retrospectively analyzed 200 patients (100 pre-Meld × 100 post-Meld) and denoted a reduction in mortality from 386/1,000 to 242/1,000 patients-year on the waiting list ($p < 0.0001$), with no impairment in survival after one year of transplantation. In Argentina, Cejas et al.,[36] in 2013, analyzed outcomes of 3,272 patients on the waiting list from 2000 to 2010 and observed a reduction in on-list mortality from 28.5% patients-year to 21.9% patients-year ($p < 0.001$) from the pre- to the post-Meld era.

The study conducted at the Hospital das Clínicas of UFMG showed similar results to those performed in São Paulo and Porto Alegre, despite the difference in organ supply rate between these capitals. The rate of effective donors per million population varied, in the period from 2004 to 2016, from 5.2 to 12.5 in Minas Gerais; from 9.2 to 21.2 in São Paulo; and from 11.9 to 25.2 in Rio Grande do Sul. It is observed that the average numbers of effective donors increased in the three states from the pre-Meld period (from 2004 to 2006) to the post-Meld period (2006 to 2016). The average number of effective donors per year per million population was 5.9 pre-Meld in Minas Gerais and 9.7 post-Meld. In São Paulo this average jumped from 10.4 to 17.5, and in Rio Grande do Sul it went from 12.7 to 16.9.[37–39]

There was a reduction in mortality on the waiting list after adoption of the Meld criteria with no impairment in post-transplant survival up to one year. In the present study, however, the impact of the change on the different diagnostic groups was also verified, and a lower frequency of transplants was observed in patients affected by post-viral cirrhosis B and C. This decrease could be related to the epidemiological transition in progress in the country, which denotes a reduction in the proportion of infectious diseases and increase in the proportion of chronic diseases, or to the insidious evolution of the disease in such patients (which could result in lower Meld values), but the present study did not aim to clarify this point. There was a predominance of diagnostic group 1 in the sample analyzed in both eras. The significant reduction in mortality rate occurred only in diagnosis groups 1 and 2. It is noteworthy that group 2 showed the greatest reduction in this rate, which went from 160.3% to 52% patients-year (a value corresponding to 32.4% of the previous rate).

As for mortality by Meld range, it could be expected that mortality on the waiting list would be reduced mainly in enrollment on higher Meld ranges, since these ranges would be prioritized on the waiting list. However, as shown in Table 7, there was a significant reduction in this mortality only in ranges 1 and 2 (Meld < 18 and between 18 and 24, respectively), with the most notable reduction in the group enrolled with Meld < 18 (from 87.2 to 24.1% patients-year). No explanation for this phenomenon has been found. Perhaps the number of donors was not sufficient for the most urgent transplants (in patients with high Meld) to be performed in time. This result invites us to question the magnitude of the influence of factors other than allocation criteria, such as donor proportion, organ transport efficiency, and communication between health services, among others, on the change in mortality on waiting list from the pre- to the post-Meld era.[27]

This study had the analysis of a considerably larger sample than previous studies on the subject in Brazil. Furthermore, a longer period of time was covered than in other studies already done. The analysis of pre- and post-Meld mortality by diagnostic group had also not been done in previous studies on the subject in the country. The study is subject to measurement and recording errors, since the Meld values used were calculated based on medical record data for patients in the pre-Meld era. The maximum period of 90 days between the date of the tests used for calculation and the date of enrollment on the waiting list corresponds to the legislation in force for the Meld range 11 to 18. This range encompasses the median (16) Meld at enrollment of the pre-Meld sample. It would not be possible, in this study, to measure laboratory data at intervals closer to the enrollment date, such as 30 or 7 days without noticeable impairment of the pre-Meld sample size, which could be questioned as a limitation.

As for the patients of the post-Meld era, the values considered were those used for the waiting list, thus respecting the validities determined by the legislation for all Meld ranges.[40] Furthermore, the analysis of mortality by Meld range may be compromised by the absence of the special score in the pre-Meld sample, since there was no establishment of this legislation for this group. For this reason, no analysis by special scoring was performed, as there is no adequate record of special scoring situations for the pre-Meld sample. It is also important to note that because of the peculiarities of each country and region, which directly influence the transplant system, the results of the studies are difficult to transfer to areas with different conditions from those in which they were performed. It is therefore necessary to carefully observe the impact of the system change in each state and region, which may differ.[26,32,41]

## CONCLUSION

After the implementation of liver graft allocation by Meld, there was enrollment of more severely ill patients, a decrease in mean time to evolution and a reduction in list mortality. This reduction in mortality was noted significantly in the groups of patients with ethanolic, cryptogenic and autoimmune cirrhosis and with biliary diseases. Therefore, these patient groups benefited the most from the change in the allocation system, with those with biliary diseases benefiting the most. There was no change in post-transplant survival at one month, three months, and one year between the pre- and post-Meld eras. Finally, there was a significant reduction in mortality on the waiting list for patients enrolled on it with Meld < 24. This decrease was not seen in the group of enrollees with Meld > 24.

## AUTHORS' CONTRIBUTION

**Substantive scientific and intellectual contributions to the study:** Lima AS and Melki CR; **Conception and design: Lima AS**; **Data collection, analysis and interpretation:** Lima AS, Melki CR and Fernandes JLR; **Drafting of the article:** Melki CR and Lima AS; **Critical revision: Lima AS**; **Final approval: Lima AS**, Melki CR and Fernandes JLR.

## AVAILABILITY OF RESEARCH DATA

Data will be made available upon request.

## FINANCING

Not applicable.

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