

Survival Outcomes Scores (SOFT, BAR and Pedi-SOFT) are Accurate in Predicting Post-Liver Transplant Survival in Adolescents

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Background

- MELD/ PELD scores are accurate predictors of 3-month mortality of candidates wait-listed for liver transplantation (LT).
- However, MELD/ PELD are shown to be poor predictors of mortality following transplantation.
- Scoring systems that predict survival outcome after LT can improve graft allocation and risk stratification among recipients.
- Scoring systems combining donor, recipient and graft factors were developed to overcome the disadvantage of MELD to predict survival after LT in adults.

Survival Outcomes Following Liver Transplant (SOFT) score (Age ≥ 18)

Preallocation score to predict survival outcomes following liver transplantation (P-SOFT)

| Risk factor | Points allotted |
|------------------------------------|-----------------|
| Age > 60 | 4 |
| BMI > 35 | 2 |
| One previous transplant | 9 |
| Two previous transplants | 14 |
| Previous abdominal surgery | 2 |
| Albumin < 2 g/dL | 2 |
| Dialysis prior to transplantation | 3 |
| Intensive care unit pretransplant | 6 |
| Admitted to hospital pretransplant | 3 |
| MELD score > 30 | 4 |
| Life support pretransplant | 9 |
| Encephalopathy | 2 |
| Portal vein thrombosis | 5 |
| Ascites pretransplant | 3 |

Score to predict survival following liver transplantation (SOFT)

| Risk factor | Points allotted |
|--|-------------------|
| P-SOFT score | Total from before |
| Portal bleed 48 h pretransplant | 6 |
| Donor age 10-20 years | -2 |
| Donor age > 60 years | 3 |
| Donor cause of death from cerebral vascular accident | 2 |
| Donor Creatinine >1.5 mg/dL | 2 |
| National allocation | 2 |
| Cold ischemia 0-6 h | -3 |

| SOFT score risk groups | |
|------------------------|-------------|
| Risk group | Point range |
| Low | 0-5 |
| Low-moderate | 6-15 |
| High-moderate | 16-35 |
| High | 36-40 |
| Futile | >40 |

Rana et al. American Journal of Transplantation 2009

Balance of Risk (BAR) score (Age ≥ 18)

| Predictors | Category | Risk score |
|----------------------------|----------|------------|
| Recipient age (years) | ≤ 40 | 0 |
| | > 40-60 | 1 |
| | > 60 | 3 |
| MELD at transplantation | 6-15 | 0 |
| | >15-25 | 5 |
| | >25-35 | 10 |
| | >35 | 14 |
| Retransplantation | No | 0 |
| | Yes | 4 |
| Life support pretransplant | No | 0 |
| | Yes | 3 |
| Cold ischemia (hours) | 0-6 | 0 |
| | > 6-12 | 1 |
| | > 12 | 2 |
| Donor age (years) | ≤ 40 | 0 |
| | > 40-60 | 1 |
| | > 60 | 1 |
| | | 1 |

Dufkowski et al, Annals of Surgery 2011

Pedi-SOFT score (Age ≤ 12)

| Risk factor | Risk points |
|---|-------------|
| Cadaveric technical variant | 4 |
| Recipient weight under 6 kg | 6 |
| Dialysis or Creatinine clearance under 30 | 17 |
| Life support | 27 |
| One previous transplant | 15 |
| Two previous transplants | 49 |

Rana et al, American Journal of Transplantation 2015

Aim of the study

To evaluate the accuracy of SOFT, BAR and Pedi-SOFT scoring systems in predicting the 3-month post-liver transplant survival in patients aged **13-17 years**.

Materials and Methods

- Retrospective analysis of patients aged 13-17 years from UNOS/OPTN database who received liver transplantation between 02/27/2002 (MELD implementation date) and 12/31/2012.
- Follow-up time was defined as time from liver transplantation to either death or end of follow-up.
- **Exclusion criteria:**
 - Recipients of combined organ transplants
 - Donation after cardiac death
 - Living donor graft
 - Patients with missing details for BAR and Pedi-SOFT scores
- Since many patients were missing details on the large number of variables needed to calculate SOFT score, they were not excluded from the study.

Statistical Analysis

- Kaplan-Meier product-limit estimates were used to assess 3-month post-liver transplant survival.
- Area under the ROC curve was used to assess the accuracy of BAR, PEDI-SOFT and SOFT scores in predicting 3-month liver transplant free survival.
- A $p < 0.05$ was considered statistically significant.

Patient Selection

| | N |
|--|-----|
| Adolescent LT recipients ‡ (2002-2012) | 988 |
| Exclusions | |
| Living donor | -52 |
| Donation after cardiac death | -17 |
| Combined transplant* | -94 |
| Missing PEDI-SOFT | -43 |
| Missing BAR | -71 |
| Total Included | 711 |

‡ Adolescent: Aged 13-17 years at time of LT

*Liver combined with either heart, lung, kidney, intestine or pancreas transplant

Patient Demographics and Clinical Characteristics

| Total (N=711) | | |
|---|--------------|--------------------|
| Factor | Summary | Data available (n) |
| Age (mean ± SD) | 15.2 ± 1.4 | 711 |
| Male N (%) | 325(45.7) | 711 |
| Race | | 711 |
| White (%) | 55.6 | |
| Black/ Hispanic/ Other (%) | 22 / 17/ 5.6 | |
| Body Mass Index (kg/m ²) (mean ± SD) | 22.8±5.5 | 709 |
| Dialysis N (%) | 59(8.3) | 711 |
| Ascites N (%) | 323(46.9) | 689 |
| Encephalopathy N (%) | 270(39.1) | 690 |
| Life support N (%) | 115(16.2) | 711 |
| Ventilator use N (%) | 119(16.7) | 711 |
| Portal vein thrombosis N (%) | 21(3.0) | 694 |
| Hepatocellular Carcinoma N (%) | 6(0.84) | 711 |
| Portal hypertensive bleed N (%) | 12(5.9) | 205 |

Laboratory, Liver transplant and Donor Information

| Total (N=711) | |
|---|---------------|
| Factor | Summary |
| Days on waiting list (mean ± SD) | 207.1 ± 439.6 |
| MELD at LT (mean ± SD) | 19.7± 12.7 |
| GFR (ml/min/1.73 m ²) (mean ± SD) | 139.0 ± 68.7 |
| Albumin at LT (g/dl) (mean ± SD) | 3.1 ± 0.77 |
| Re-Transplantation (mean ± SD) | 98 (13.6) |
| Num. previous transplants N (%) | |
| 0 | 613 (86.2) |
| 1 | 81(11.4) |
| 2 | 11(1.5) |
| >2 | 6(0.84) |
| Pre-LT Medical condition N (%) | |
| In ICU | 230 (32.3) |
| Hospitalized, not in ICU | 91(12.8) |
| Not hospitalized | 390 (54.9) |
| Partial/Split transplant N (%) | 53 (7.5) |
| Total cold ischemic time (hours) (mean ± SD) | 7.3 ± 3.4 |
| Donor Age (years) (mean ± SD) | 23.7 ± 14.1 |
| Donor Risk Index | 1.6 ± 0.34 |

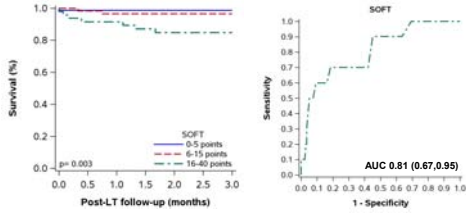
Post-LT Mortality

| Total (N=711) | |
|--------------------------------|-----------|
| Factor | Summary |
| Deceased | 100(14.1) |
| Deceased within 3 months | 33(4.6) |
| Patient survival time (months) | 45.4±34.7 |

Values presented as Mean ± SD or N (%).

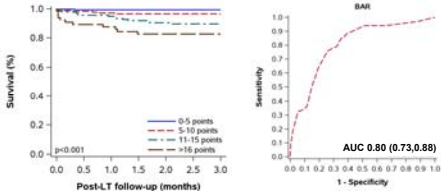
Prediction of 3-Month Post-LT Survival: SOFT

| Factor | N | Summary | Hazard ratio | p-value |
|-----------------------------------|----------|----------|-------------------|---------|
| SOFT (mean ± SD) | 190 | 10.2±9.6 | | |
| SOFT risk group N (%) | | | | |
| Low risk (0-5 points) | 80(42.1) | | Reference | --- |
| Low-moderate risk (6-15 points) | 62(32.6) | | 2.7 (0.24, 29.7) | 0.42 |
| High-moderate risk (16-35 points) | 45(23.7) | | 11.5 (1.4, 97.2) | 0.025 |
| High risk (36-40 points) | 3(1.6) | | 36.9 (2.7, 503.4) | 0.007 |



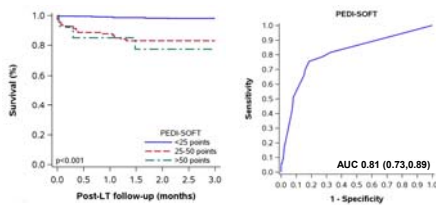
Prediction of 3-Month Post-LT Survival: BAR score

| Factor | N | Summary | Hazard ratio | p-value |
|-----------------------------|-----------|---------|---------------------|---------|
| BAR (mean ± SD) | 711 | 6.9±5.8 | | |
| BAR risk group N (%) | | | | |
| 0-5 points | 333(46.8) | | Reference | --- |
| 5-10 points | 174(24.5) | | 5.7 (1.2, 28.5) | 0.033 |
| 11-15 points | 139(19.5) | | 17.3 (3.9, 76.2) | <0.001 |
| 16-20 points | 61(8.6) | | 26.7 (5.7, 124.5) | <0.001 |
| >20 points | 4(0.56) | | 106.8 (15.7, 726.3) | <0.001 |



Prediction of 3-Month Post-LT Survival: Pedi-SOFT

| Factor | N | Summary | Hazard ratio | p-value |
|-----------------------------------|-----------|----------|------------------|---------|
| PEDI-SOFT (mean ± SD) | 711 | 9.3±16.1 | | |
| PEDI-SOFT risk group N (%) | | | | |
| <25 points | 581(81.7) | | Reference | --- |
| 25-50 points | 116(16.3) | | 9.6 (4.6, 20.0) | <0.001 |
| >50 points | 14(2.0) | | 13.0 (3.7, 45.9) | <0.001 |



Cut off values to predict 25% three-month Mortality Post-LT

| Score | Cut off value |
|-----------|---------------|
| SOFT | 32 |
| BAR | 20 |
| Pedi-SOFT | 53 |

Is there a need for a Post-LT Survival Scoring ?

| VARIABLES | PATIENT 1 | PATIENT 2 |
|---|------------|-----------------------------|
| Age | 17 years | 17 years |
| MELD | 30 | 30 |
| 3-month waitlist mortality | 53 % | 53 % |
| Re-transplantation | No | Yes (1 previous transplant) |
| Life support | No | Yes |
| Dialysis or Creatinine clearance under 30 | No | Yes |
| Recipient age | < 40 years | < 40 years |
| Cold ischemia time | 0-6 hours | 7-12 hours |
| Cadaveric technical variant | No | Yes |
| Donor age | 35 years | 50 years |
| BAR score | 10 | 19 |
| 3-month post LT survival | 95 % | 76 % |
| Pedi-SOFT score | 0 | 63 |
| 3-month post LT survival | 98 % | 63 % |

Limitations

- Retrospective study.
- Scores could not be calculated for all the included patients because of missing details.
- Small sample size of the highest risk category and those who died within 3 months limited our ability to determine cutoff values that will be predictive of futile LT.

Conclusions

- BAR, SOFT and Pedi-SOFT scores proved to be good post-transplant survival models in adolescent population.
- These scoring systems will help in recipient-donor matching, risk stratification in recipients, resource allocation and informing adolescent patients and their families about the survival outcome post-LT.
