

Split Versus Whole Liver Transplantation

OPTN/UNOS Ethics Committee

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Split Versus Whole Liver Transplantation

Affected Policies: N/A
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Executive Summary

Beginning in 1993, the Ethics Committee (the Committee) developed a series of white papers that are available through the OPTN website. In 2014, the Committee began a systematic review of these white papers to evaluate if each of the white papers were accurate and relevant, and therefore valuable resources for the transplant community. The white paper addressing split versus whole liver transplantation (2004) was determined to require revision.

Over the past year, the Committee completed a substantive revision of the white paper addressing split liver allocation which includes recommendations for changes to the liver allocation, an extensive set of citations, new appendices, and new illustrations.

What problem will this resource solve?

The resource provides an ethical analysis and recommendations regarding split liver transplantation that should be beneficial to transplant hospitals or OPOs considering split liver transplantation. The resource could be helpful to transplant candidates who may be evaluating split liver transplantation versus whole liver transplantation.

Why should you support this resource?

The proposed revisions to this white paper demonstrate that the Committee continues to consider and provide guidance on important issues faced by the transplant community. This white paper will be a resource that members could consult if considering split liver allocation especially in light of the new strategic focus to increase the number of transplants.

How was this resource developed?

Beginning in 1993, the Committee developed a series of white papers that are available through the OPTN website. In spring 2014, the Policy Oversight Committee and OPTN/UNOS Board of Directors (the Board) approved a proposed project to review all existing white papers to determine the accuracy and relevancy of each resource. The Committee began a systematic review of all of the white papers to determine if the papers remained accurate and relevant. Some of the more recently developed white papers were accurate and relevant while other papers were determined to need minor revision or substantive revision. The white paper addressing split versus whole liver transplantation was determined to require substantive revision.

Over the past year, Committee members performed a line by line review of the split liver white paper and determined that some of the language was outdated, it did not reflect current practice, and not all of the recommendations were supported by current literature.

Committee members identified numerous questions or issues that should be reconsidered while revising the white paper:

- Most split liver transplants involving an adult and pediatric recipients have good outcomes.
- Based on limited data, split liver transplants involving two adult recipients have worse outcomes and higher rates of re-transplant. What is the increased risk in a split liver transplant involving two adult recipients?
- Are organs allocated to a transplant candidates or to transplant hospitals?
- What precipitates a plan or decision for a split liver transplant?
- Who decides which livers are split?
- Who decides which segment of the liver goes to each candidate?
- What are the incentives and disincentives for splitting a liver? What are the financial implications?
- If a segment (of adult) liver is used for a child, what happens with the remaining organ segment?
- Do pediatric candidates get priority for liver transplants?
- Could an adult liver candidate need to decide between taking a segment of liver versus continuing to wait for a potential whole liver transplant.

Several drafts of this revised white paper were developed and provided to Committee members for review and feedback. Some members of the Liver and Pediatric Committees were asked to review this resource and to provide feedback prior to the start of the public comment period. The Committee considered all feedback before finalizing the white paper.

This project was completed before the OPTN/UNOS Board determined that all types of guidance documents would require public comment (June 2016). The Committee elected to follow the new process even though the requirement was not in effect at the time work on the project was completed.

How well does this resource address the problem statement?

1. Of 113,394 deceased donor livers recovered and ultimately transplanted from 1/1/1995 - 12/31/2015, 1546 (1.36%) were recovered with the intention of being used in split liver transplants.
2. Of 1546 donor livers split from 1/1/1995 - 12/31/2015, 1439 (93%) provided a liver allograft to a pediatric recipient. 6.8% of whole liver transplants were done in pediatric recipients.
3. From 6/1/2001 - 12/31/2015, there were 151,250 adult registrations for liver transplantation; at listing, 129,276 (85%) noted a willingness to accept a split liver. In 2015, 10,100 (90%) of 11,256 registrants noted a willingness to accept a split liver.

Which populations are impacted by this resource?

The resource could be helpful to transplant candidates who may be evaluating split liver transplantation versus whole liver transplantation.

How does this resource impact the OPTN Strategic Plan?

Increase the number of transplants: Increased utilization of split liver transplantation could increase the number of transplants.

Improve equity in access to transplants: Increased utilization of split liver transplantation could increase access to transplants.

Improve waitlisted patient, living donor, and transplant recipient outcomes: There is no impact to this goal.

Promote living donor and transplant recipient safety: There is no impact to this goal.

Promote the efficient management of the OPTN: There is no impact to this goal.

How will the OPTN implement this resource?

If this resource is supported during public comment and subsequently approved by the Executive Committee of the Board, it will be available through the OPTN website.

The resource will not require programming in UNetSM.

How will members implement this resource?

Members will be able to access this resource through the OPTN website.

Will this resource require members to submit additional data?

This resource does not require additional data collection.

How will members be evaluated for compliance with this resource?

This resource does not affect member compliance. Members could consult this resource on a voluntary basis.

SPLIT LIVER TRANSPLANTATION

CAVEAT: The purpose of this White Paper is to outline potential ethical issues and other considerations relevant to split liver transplantation. The document should not be construed as a recommendation to require that all centers adopt split liver transplantation. Throughout this document, surrogate decision-makers can speak on behalf of patients when those patients lack decision-making capacity.

A disparity exists between the number of donor livers available for transplant and the number of persons on the waiting list for a liver transplant. The practice of splitting deceased donor liver allografts to provide liver transplants for two recipients from one deceased donor could ease this disparity by increasing the number of organs available for transplant.

Since November 2007, an OPTN match run has identified a donor liver as one with the potential to be split if all these criteria are met:

1. Donor is less than 40 years old;
2. Donor is on a single vasopressor or less;
3. Donor transaminases are no greater than three times the normal level;
4. Donor body mass index (BMI) is 28 or less.

More than 10% of all deceased donors, and more than 20% of donors less than 35 years old, meet these criteria, yet only <1.5% of all donor livers have been split since criteria adoption (Appendix-1). The Ethics Committee (the Committee) supports efforts to increase liver allograft splitting when these (and other) criteria are met, including development of an allocation scheme to optimize use of these donor livers. As described below, the Committee acknowledges that substantial barriers must be overcome before the practice could become more common.

The ethics of optimal allocation

The Committee affirms that optimal allocation policies involving whole liver or split liver allografts should reflect a balance between the principles of equity and utility. Additionally, the Committee notes that the moral principle of respect for autonomy is generally important in organ allocation to the extent that a competent transplant candidate or surrogate retains the right to refuse an organ offer including a split liver organ. The autonomy of transplant candidates (or their surrogates) should not be compromised by situations in which they may feel coerced to make a decision about accepting a particular organ or allowing splitting of a liver to take place. The Committee also recognizes the value of transparency during the process of revising allocation policies so that stakeholders and the public may have adequate opportunity to respond to proposals.

Current liver allocation of deceased donor liver allografts

In current practice, liver allografts are allocated such that priority is generally given to candidates with the highest risk of death on the waiting list. This priority is predicted by the Model for End-stage Liver Disease (MELD), or Pediatric End-stage Liver Disease (PELD) score, and most patients are critically ill before receiving priority for a liver transplant. In addition, liver allocation often prioritizes patients with standardized "exception points" due to hepatocellular carcinoma, hepatopulmonary syndrome, and portopulmonary hypertension, and there is published evidence that non-standardized exception points are not awarded consistently region to region or by race^{1,2}.

¹ Goldberg DS, Makar G, Bittermann T, French B. Center variation in the use of nonstandardized model for end-stage liver disease exception points. *Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society*. 2013;19(12):1330-1342

² Hsu EK, Shaffer M, Bradford M, Mayer-Hamblett N, Horslen S. Heterogeneity and disparities in the use of exception scores in pediatric liver allocation. *Am J Transplant*. 2015;15(2):436-444.

47 The Committee does not believe that current liver allocation is optimal, because it neither takes into
48 account post-transplant outcomes (an important metric of efficiency), nor does it maximize equitable
49 distribution. Proposals to revise the current liver allocation system are under consideration by the OPTN.
50 In the text below, we consider split liver transplantation in the context of the current allocation system, but
51 also consider how the practice might be implemented under different allocation systems.

52

53 Clinical background: The practice of splitting a deceased donor liver allograft

54 Historically, split liver transplantation has primarily benefited pediatric recipients who are too small to be
55 transplanted with a full-sized liver (Appendix-2). This scenario usually arises when a child is offered a liver
56 that is too large, but the ability to split that liver and transplant the child with the left lateral section
57 (segments II and III; see Figure 1) results in transplantation sooner than if the child had to wait for an age-
58 or size-matched deceased donor liver. Since pediatric donors are less common than adult donors, split
59 liver transplantation has significantly reduced time and mortality for patients on the pediatric waitlist^{3,4}.
60 The “extended right lobe” remnant graft (segments IV, V, VI, VII and VIII; see Figure 1) can then be
61 transplanted into an adult, thus transplanting two candidates from one deceased donor. For pediatric and
62 adult recipients, graft and patient survival after this type of split liver transplantation are similar to those for
63 recipients of whole organs, though complications are more frequent^{5,6,7,8,9,10,11,12}.

64

65 Splitting a single liver allograft for two large (e.g., adult sized) recipients is also possible. The two grafts
66 resulting from this type of liver splitting are: “right lobe” (segments V through VIII; see Figure 2), and “left
67 lobe” (segments II, III and IV; see Figure 2). Both recipients in this scenario are usually adults. There is
68 less experience with this type of split transplant and the recipient outcomes are not as consistently
69 favorable^{13,14,15}, though at least one recent report indicates good results may be achieved in low-MELD
70 recipients¹⁶.

³Gridelli B, Spada M, Petz W, et al. Split-liver transplantation eliminates the need for living-donor liver transplantation in children with end-stage cholestatic liver disease. *Transplantation*. 2003;75(8):1197-1203.

⁴Cintorino D, Spada M, Gruttaduria S, et al. In situ split liver transplantation for adult and pediatric recipients: an answer to organ shortage. *Transplant Proc*. 2006;38(4):1096-1098.

⁵Hong JC, Yersiz H, Farmer DG, et al. Longterm outcomes for whole and segmental liver grafts in adult and pediatric liver transplant recipients: a 10-year comparative analysis of 2,988 cases. *J Am Coll Surg*. 2009;208(5):682-689; discussion 689-691.

⁶Spada M, Cescon M, Aluffi A, et al. Use of extended right grafts from in situ split livers in adult liver transplantation: a comparison with whole-liver transplants. *Transplantation proceedings*. 2005;37(2):1164-1166.

⁷Broering DC, Topp S, Schaefer U, et al. Split liver transplantation and risk to the adult recipient: analysis using matched pairs. *Journal of the American College of Surgeons*. 2002;195(5):648-657.

⁸Renz JF, Yersiz H, Reichert PR, et al. Split-liver transplantation: a review. *Am J Transplant*. 2003;3(11):1323-1335.

⁹Takebe A, Schrem H, Ringe B, et al. Extended right liver grafts obtained by an ex situ split can be used safely for primary and secondary transplantation with acceptable biliary morbidity. *Liver Transplantation*. 2009;15(7):730-737.

¹⁰Mabrouk Mourad M, Lioussis C, Kumar S, et al. Vasculobiliary complications following adult right lobe split liver transplantation from the perspective of reconstruction techniques. *Liver Transplantation*. 2015;21(1):63-71.

¹¹Cauley RP, Vakili K, Fullington N, et al. Deceased-donor split-liver transplantation in adult recipients: is the learning curve over? *J Am Coll Surg*. 2013;217(4):672-684 e671.

¹²Cauley RP, Vakili K, Potanos K, et al. Deceased donor liver transplantation in infants and small children: are partial grafts riskier than whole organs? *Liver Transpl*. 2013;19(7):721-729.

¹³Aseni P, De Feo TM, De Carlis L, et al. A prospective policy development to increase split-liver transplantation for 2 adult recipients: results of a 12-year multicenter collaborative study. *Annals of surgery*. 2014;259(1):157-165.

¹⁴Giacomoni A, Lauterio A, Donadon M, et al. Should we still offer split-liver transplantation for two adult recipients? A retrospective study of our experience. *Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society*. 2008;14(7):999-1006.

¹⁵Wan P, Li Q, Zhang J, Xia Q. Right lobe split liver transplantation versus whole liver transplantation in adult recipients: A systematic review and meta-analysis. *Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society*. 2015;21(7):928-943.

¹⁶Hashimoto K, Quintini C, Aucejo FN, et al. Split liver transplantation using Hemiliver graft in the MELD era: a single center

71
72 However, there are a number of clinical limitations to the practice of splitting liver allografts. First, some
73 adult recipients are not well suited to receive a partial liver. Critically ill patients are not optimal candidates
74 for a partial liver because they are less able to tolerate the more-frequent complication(s). A second
75 limitation (noted earlier, Appendix-1) is the limited number of donated livers (more than 10% of all
76 donated livers) that meet OPTN-specified criteria for splitting. A third limitation is center expertise,
77 because split liver transplantation requires substantial clinical experience on the part of both the procuring
78 surgeons and the recipients' clinical teams. This lack of experience may be one reason why only about
79 1% of livers are split. In practice, very few centers have consistently performed split liver transplantation
80 over the past decade.

81
82 To ground these limitations in concrete examples, we suggest that split liver transplantation may be
83 considered in the following clinical scenarios. These scenarios all assume appropriate center expertise
84 and candidate readiness. Donor "suitability" refers to clinical criteria listed above:

85

experience in the United States. *Am J Transplant.* 2014;14(9):2072-2080.

86 *Scenario 1*

87 A suitable donor is identified, a suitable pediatric candidate in whom the left-lateral section is size-
88 appropriate has allocation priority, and a suitable larger (adult or pediatric) candidate is identified to
89 receive the extended right lobe graft remnant (Figure 1).

90 *Scenario 2*

91
92 A suitable donor is identified, a suitable large pediatric or adult candidate has allocation priority, and a
93 suitable pediatric candidate in whom the left-lateral section is size-appropriate is identified (Figure 1).
94

95 *Scenario 3*

96
97 A suitable donor is identified, a suitable candidate (adult or pediatric) too small for the whole liver or
98 extended right lobe graft (but requiring more than the left-lateral section) has allocation priority, and a
99 second suitable adult or pediatric candidate is also identified. In this scenario, the liver is split more evenly
100 (Figure 2).
101

102 The ethics of modifying allocation and practice to promote split liver transplantation

103 The main ethical justification for split liver transplantation is that the practice may increase efficiency when
104 two liver segments can provide greater net survival to two appropriately selected recipients instead of a
105 single recipient. Split liver transplantation could also increase transplant access for pediatric candidates.
106 As discussed in another white paper from the Committee¹⁷, children may be considered among the ‘worst
107 off’ transplant candidates, and affording this group some allocation preference is reasonable.

108 When the index candidate (the candidate at the top of the allocation match run) is a child who requires
109 only the left-lateral section of a suitable donor, we feel it is fair and efficient for this candidate’s center to
110 split the liver for the child and a larger (adult or pediatric) candidate in whom the extended right lobe graft
111 is size-appropriate (Scenario 1; see also Figure 1). Necessary elements of splitting the liver include, but
112 are not limited to, medical suitability of the candidates and donor, as well as current center-specific
113 experience with split liver transplantation. The ethical rationales for this practice are that survival gains
114 from transplantation are provided to two individuals and that the index pediatric candidate is not
115 disadvantaged.

116 If splitting the donor liver is planned, the transplant center should notify the organ procurement
117 organization (OPO) managing the donor as early as possible, to allow the OPO to offer the remnant graft
118 to other candidates on the match run. According to OPTN policy, if the remnant graft has not been
119 allocated by the start of organ retrieval, the index candidate’s transplant center should offer it to medically
120 appropriate candidates on its list according to their waitlist priority. The goal of these efforts is to ensure
121 fair and efficient remnant graft allocation and minimize remnant graft discard. Ideally, the initial match run
122 for a suitable donor would identify two recipients for consideration before offering the liver as a whole
123 graft: the index pediatric recipient to receive the left-lateral section and a larger (adult or pediatric)
124 recipient for the extended right lobe graft. Notably, since 2001 approximately 85% of candidates have
125 been listed as agreeing to receive a partial liver (Appendix-3). The Committee supports consideration of a
126 change in allocation policy to facilitate this scenario.

127 Scenario 2 differs only in that the index candidate is not the proposed recipient of the left-lateral section.
128 This results when a larger (pediatric or adult) recipient is the index candidate for a liver from which the
129 extended right lobe graft would suffice, leaving the left-lateral section for a medically suitable smaller
130 pediatric candidate (Figure 1). Again, when a suitable donor is identified, it would be appropriate for the
131 match run to identify two potential recipients: the index adult or large pediatric candidate for the extended

¹⁷ OPTN/UNOS. Pediatric Transplantation and Ethics Committees. Ethical principles of pediatric organ allocation; Ethical Principles of Pediatric Organ Allocation

132 right lobe graft and a smaller pediatric candidate for the left-lateral section. This would encourage centers
133 with an opportunity to split a liver to allow an additional child to receive a transplant to do so – again,
134 transplanting two recipients from a single donor. Among other considerations, the index candidate's
135 individual situation and current center-specific experience, practice, and outcomes are all important in the
136 decision to perform split liver transplantation in this scenario. It is again recognized that critically ill
137 patients may not be optimal candidates for a partial liver allograft and could, therefore, be disadvantaged
138 if all donor livers meeting split criteria were primarily offered only as a split. This disadvantage could be
139 mitigated by allowing candidates with a certain MELD threshold (e.g., >35) to receive priority for the whole
140 liver over candidates who appear on the split liver match run.

141
142 Alternatively, and less commonly, the index candidate is an adult or pediatric recipient in whom a right
143 lobe graft (segments V, VI, VII, VIII) or left lobe graft (segments II, III, and IV) would be size-appropriate.
144 As previously mentioned, reported results¹³⁻¹⁵ from this type of split (Scenario 3) are less consistently
145 favorable than Scenario 1 or 2. Thus, in this case, providing a partial liver to the index candidate and
146 offering the other liver segment to another suitable candidate on the waiting list may not promote
147 efficiency versus whole liver allocation. Given this problem and graft weight/body weight ratio
148 requirements, particularly for high-MELD patients, we do not currently advocate a change in policy to
149 facilitate this scenario.

150

151 Informed consent

152 The principle of autonomy requires that transplant candidates (or their surrogates) have transparent
153 discussion and disclosure of information about allograft quality, expected outcomes with the transplant
154 versus remaining wait-listed, and center experience. These requirements of informed consent should
155 encompass discussion about split liver transplantation where clinically appropriate. These processes of
156 informed consent should first be addressed while the patient is on the waiting list (ideally at the time of
157 listing) and when organs are offered. Patients (or surrogates) may change their decisions about
158 willingness to accept certain types of organs because of changes in clinical status or other reasons. If a
159 center and/or patient decline a split liver offer, they should retain their position on the list; in this scenario,
160 the split liver can be offered to the next candidate on the match run willing to receive a partial liver graft.

161

162 The specific clinical circumstances of liver transplantation include challenges to informed consent that the
163 Committee acknowledges. First, liver transplant candidates often become critically ill on the waiting list,
164 impairing their capacity and requiring consent from surrogates. Ideally, informed consent would involve
165 discussions when candidates are capable of understanding the risks and benefits, although candidates
166 are sometimes added to the waiting list when hepatic encephalopathy precludes such discussions.
167 Second, because a patient's or their center's circumstances might change while the patient is on the
168 waiting list, recurring informed consent discussions regarding this issue, along with potential updating of
169 their willingness with the OPTN, are appropriate. Third, transplant candidates or their surrogates should
170 not be put in a position of undue pressure, in which the transplant staff may be perceived as coercing
171 them to accept a split liver transplant at the time of organ offer. Instead, allocation procedures should be
172 developed such that when two patients are identified on the match run that are likely to have favorable
173 outcomes with a split liver, then split liver transplantation should be offered to the candidates as the only
174 transplantation option with that organ, rather than asking the candidates whether they want the entire liver
175 or a split liver. This approach avoids candidate (or surrogate) coercion and recognizes that deceased
176 donor livers – whether transplanted as whole or split organs – are a community resource that should be
177 allocated according to the principles articulated earlier in this document.

178

179 Center expertise

180 With the preceding discussion, the Committee acknowledges that the risk-benefit ratio of split liver
181 transplantation will vary between transplant programs and the acuity of illness of their listed candidates.
182 Our intent is not to require a change in practice if liver splitting is not appropriate for a center; rather,
183 centers with appropriate experience and/or expertise are encouraged to consider split liver transplantation
184 in order to safely increase the number of liver transplants performed. Because of similar outcomes with
185 Scenarios 1 and 2 when compared with whole liver transplantation, changes in allocation and practice
186 (e.g., offering the liver to two recipients as a split) may be appropriate at this time to encourage this type

187 of split liver transplantation, as net survival would be expected to increase. If good outcomes become
188 consistently documented with Scenario 3, changes to encourage this practice should also be considered.
189

190 In addition to the individual medical suitability of donors and recipients, the Committee recognizes other
191 stakeholders and/or factors, some with competing interests. If *in situ* splitting is planned, for example, the
192 donor hospital's capabilities and resources (personnel, operating room time and equipment) need to be
193 considered. Increased intraoperative time would impact the extrahepatic organ retrieval team(s); the
194 donor may become hemodynamically compromised, impacting *all* organs and those targeted candidates;
195 if split liver candidates are at different centers, both centers might want their surgeon(s) involved in the
196 splitting, further complicating case coordination. If *ex vivo* splitting is planned and the candidates are at
197 different centers, additional challenges may emerge. Lastly, intraoperative findings (e.g., anomalous
198 vascular anatomy) may preclude safe splitting. For logistical reasons, therefore, it is likely unfeasible to
199 split every donor liver that meets split liver transplantation criteria. It is worth noting again, however, that
200 split liver transplantation is probably underutilized in contemporary practice.
201

202 Each liver transplant program should develop a written protocol that addresses their policies related to
203 split liver transplantation, including information about processes of informed consent. This informed
204 consent should incorporate information about the national and the center's experience and outcomes with
205 liver splitting.
206

207 Additional Challenges

208 Expansion of the practice of liver splitting poses other challenges. One challenge in the context of current
209 allocation is that MELD-driven allocation usually directs liver allografts toward individuals with the highest
210 level of illness and probability of death on the waiting list, yet split liver allografts may not be well suited to
211 those individuals. Potential solutions might address this challenge. First, under current allocation, many
212 transplant candidates receive exception points and have MELD-exception points despite not being
213 critically ill. Split liver grafts could be directed to these individuals, and/or, as previously mentioned, a
214 minimum MELD/PELD score could be set (e.g., 35) beyond which a liver meeting split criteria is offered to
215 those candidates as a whole graft before allowing consideration of splitting. Second, future revisions to
216 liver allocation processes that take into account post-transplant survival (in addition to waiting list survival)
217 might result in highest priority for individuals who are not necessarily critically ill and might also benefit
218 from split liver transplantation.
219

220 A change in allocation policy to identify two individuals on a match run would also have to indicate which
221 candidate's center would have priority in deciding splitting technique and how the blood supply and bile
222 duct would be shared. It would also need to address whole graft allocation when plans for split liver
223 transplantation are aborted late in the process.
224

225 We also acknowledge the possibility that gains in efficiency from liver splitting might come at the cost of a
226 small reduction in access to liver transplantation for persons who are not well suited for receiving a split
227 liver allograft. For instance, individuals with a very large body mass index might not have good outcomes
228 with a split allograft because of organ/recipient size mismatch and might decline these splits. However,
229 the reduction in access to transplantation for obese individuals should be modest. First, the percentage of
230 livers eligible for splitting is low. Second, most obese candidates could accept split livers procured as part
231 of Scenario 1 or Scenario 2 because these split livers are relatively substantial in size. Third, these split
232 allografts are high quality because of the donor characteristics, which counterbalance or may outweigh
233 perceived size disadvantages of the split allograft. As noted earlier, split liver transplantation might also
234 disadvantage high MELD individuals, a problem that could be mitigated if allocation policy discouraged
235 splitting when a high MELD candidate (e.g., MELD >35) had allocation priority.
236

237 We also acknowledge that the transplant field has only general information about appropriate recipient
238 candidacy for split liver transplantation. The field would benefit from greater research in this area.
239

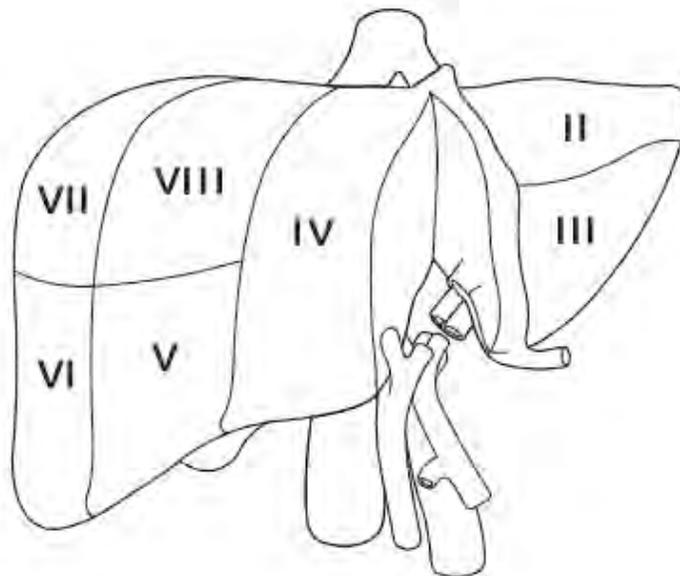
240 Summary

241 There are many ethical and logistical issues to be considered in splitting a donor liver. The following
242 points deserve emphasis:

- 243 1. The transplant community has an ethical obligation to maximize the outcomes from donated organs,
244 while also promoting equity. Split liver transplantation might improve net survival of liver transplant
245 candidates, while also increasing the number of individuals who benefit from transplantation,
246 especially children. Splitting suitable livers for suitable patients is appropriate in centers with
247 adequate experience and outcomes.
- 248 2. An overriding responsibility of transplant professionals is to properly inform candidates of national and
249 center-specific practices and outcomes of split versus whole liver transplantation. Patients have the
250 right to decide which risks to accept and the right to refuse an organ, including a split liver.
- 251 3. Informed consent discussions regarding split liver transplantation should take place early: when
252 candidates are initially listed, or, for those patients already listed, when a split liver program is
253 initiated. Recurring discussions will often be necessary, as candidates' and programs' circumstances
254 may change.
- 255 4. The decision to split a donor liver must be made and communicated as early as possible to allow
256 efficient and fair allocation of the remnant graft. Allocation of both resulting grafts on the initial match
257 run for a suitable donor would be optimal. Contingency whole graft allocation is also important, if
258 plans to split a liver are aborted.
- 259 5. Split liver transplantation involves many stakeholders and complicated logistics. Each stakeholder
260 bears an inherent responsibility to promote appropriate stewardship of donor livers to optimize
261 transplant outcomes and should collaboratively work through logistical issues on behalf of all
262 transplant candidates.

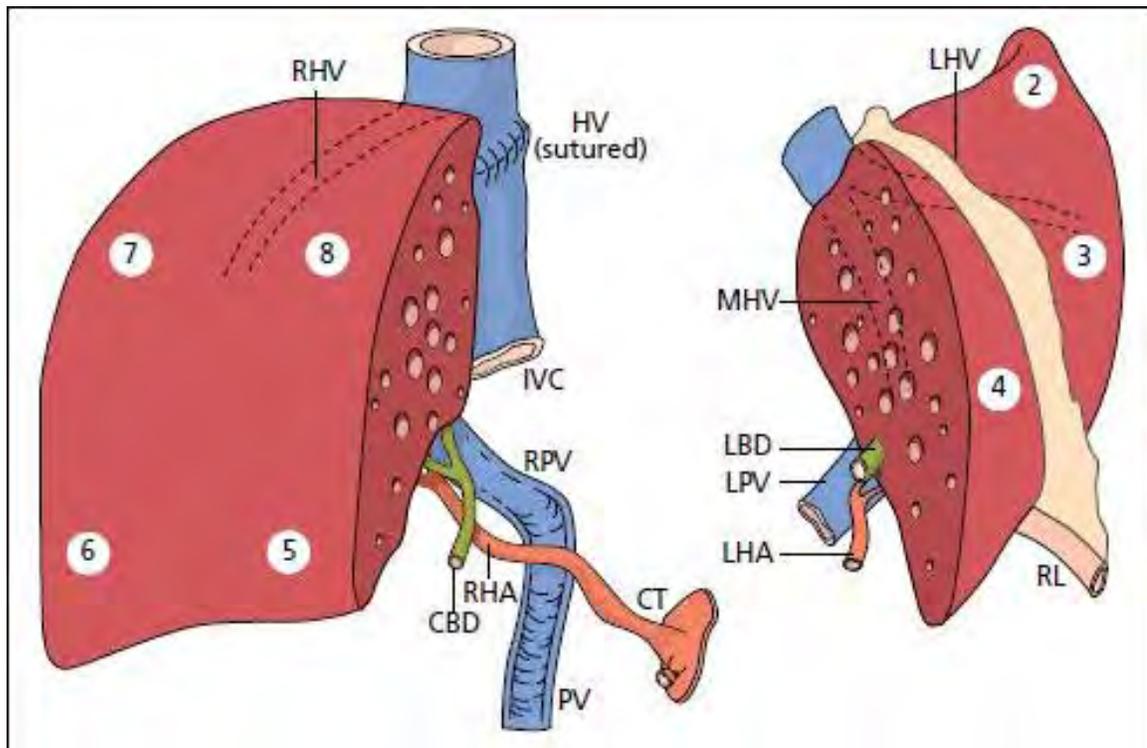
264 The Committee supports all reasonable efforts to increase the number of transplants safely performed.
265 Changes in allocation and practice to encourage split liver transplantation are a potential means to that
266 end.

267
268
269 **Figure 1.** Segmental anatomy of the liver; the liver is being divided along the plane to be split and
270 transplanted into small pediatric recipient and a larger (pediatric or adult) recipient (Scenarios 1 and 2 in
271 the text).
272 "Extended right lobe graft" in the text refers to segments, IV, V, VI, VII and VIII; "left-lateral section" refers
273 to segments II and III. The smaller recipient would receive the left-lateral section, whereas the larger
274 recipient would receive the extended right lobe graft.



276

277 **Figure 2.** Split for 2 “larger” recipients (either adult large pediatric patients); the difference from Figure 1 is
 278 that segment 4 goes with segments 2 and 3 to give similar-sized grafts. This corresponds to Scenario 3 in
 279 the text. In this figure Arabic numerals are used.
 280



281
 282
 283 Fig. 2, Springer Science & Business Media.
 284
 285

286 **Appendices** (Data generated by OPTN analysts)

- 287 1) Of 113,394 deceased donor livers transplanted from 1/1/1995 - 12/31/2015, 1546 (1.36%) were split
 288 liver transplants. The criteria listed were adopted in November 2006; from 19 months pre-adoption
 289 through 19 months post-adoption (April 2006 - June 2009), 2247 (10.3%) of 21,832 deceased donors
 290 met these criteria; during this same period, 218 (1.1%) of 19,644 livers transplanted were split liver
 291 transplants.
 292 2) Of 1546 donor livers split from 1/1/1995 - 12/31/2015, 1439 (93%) provided a liver allograft to a
 293 pediatric recipient. 6.8% of whole liver transplants were done in pediatric recipients. Additionally, from
 294 April 2006 - June 2009, a pediatric recipient was the primary candidate on the match run for 201
 295 (92%) of 218 split liver transplants.
 296 3) From 6/1/2001 - 12/31/2015, there were 151,250 adult registrations for liver transplantation; at listing,
 297 129,276 (85%) noted a willingness to accept a split liver. In 2015, 10,100 (90%) of 11,256 registrants
 298 noted a willingness to accept a split liver.

#