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ORIGINAL ARTICLE

Liver transplantation in Jehovah's witnesses

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Summary

For religious reasons, Jehovah's witnesses refuse transfusion of blood products (red cells, platelets, plasma), but may accept organ transplantation. The authors developed a multidisciplinary protocol for liver transplantation in Jehovah's witnesses. In a 6-year period, nine Jehovah's witness patients were listed for liver transplantation. They received preoperative erythropoietin therapy, with iron and folic acid that allowed significant haematocrit increase. Two patients underwent partial spleen embolization to increase platelet count. Seven patients underwent cadaveric whole liver transplantation, and two right lobe living-related liver transplantation, using continuous circuit cell saving system and high dose aprotinin. No patient received any blood product during the surgical procedure. One patient suffering from deep anaemia after living-related liver transplantation was transfused as required by his family, but died from aspergillus infection. One 6-year-old child was transfused against her parent's will. The authors demonstrated that it is possible to increase haematocrit and platelet levels in cirrhotic patients awaiting liver transplantation. They were able to reduce intraoperative need for blood products, allowing liver transplantation in prepared Jehovah's witness patients. This experience may be beneficial for non-Jehovah's witness liver transplant recipients.

Introduction

For religious reasons, Jehovah's witnesses (JW) refuse transfusion of any blood product (red cells, platelets, fresh frozen plasma) that has been removed from continuity with the body, but they may accept solid organ transplantation [1]. Kidney [2], pancreas-kidney [3,4], heart [5], lung [6,7] and liver [8–16] transplants were reported in JW patients. Liver transplantation (LT) may be particularly challenging in JW patients. LT requires large surgical dissections and sutures of major vascular vessels. Moreover most LT patients are at high risk of bleeding because of multiple coagulation disturbances because of cirrhosis and portal hypertension [17]. In addition LT may require the use of veno-venous bypass that consumes platelets and coagulation factors. Diffuse fibrinolysis and disseminated intravascular coagulation may occur during the anhepatic phase and after liver graft reperfusion, especially if early graft dysfunction occurs [17].

Working in a University Hospital offering medical care to JW with respect of their beliefs, the authors developed a blood product-free LT program in JW patients and report their experience in this paper. This approach might be beneficial for non-JW patients undergoing LT, as it may help to reduce the perioperative use of blood products.

Materials and methods

The policy of the authors' departments and institution concerning JW patients was approved by the institution ethical committee, and was also in accord with the official advice given by the Belgian National Bioethical Council

[18]. Adult JW patients are managed in respect of their beliefs, after signing a written informed consent. For patients under the age of 18, blood products are avoided except in case of life threatening conditions in which blood products may be used, even against parents' will. The problems and risk of death linked to the avoidance of blood products are openly discussed with the JW patients in a private interview. For LT, it is clearly stated that there is some remnant blood in the transplanted graft. Each component of blood is discussed. The JW patients always refused the cellular parts of blood (red cells and/or platelets) as well as human coagulation factors, cryoprecipitates or fresh frozen plasma. Some proteins purified from blood, as albumin or some immunoglobulins, might be accepted. The authors refuse to offer LT to JW patients if their regular postoperative protocols of immunosuppression, or of disease recurrence prophylaxis may not be used. Particularly, the use of anti HBs immunoglobulins is required in hepatitis B virus (HBV) patients.

Between 1998 and 2003, nine JW patients (four males, five females) were listed for LT and transplanted (Table 1). Their mean age was 41 years (range: 6–60 years). The patients underwent regular pre LT work-up, including abdominal computed tomography, abdominal doppler ultrasonography and cardiac echography. Moreover all of the adult candidates underwent cardiac stress test, even in the absence of cardiovascular risk factors. A haematocrit of 35% and a platelet level of 50 000 mm^3 were considered as the minimal acceptable levels for LT in JW patients. A medical preparation aiming at increasing haematocrit was undergone preoperatively in all patients, consisting of high dose erythropoietin (Neorecormon, Roche, Basel, Switzerland; 800 U/kg load, 200 U/kg s.c. every other day), iron supplementation (oral, 500 mg/day, Fero-Grad, Abbot, Abbot Park, IL, USA, and IV, Venofer, Vifor, Switzerland, 100 mg/day three times per week), and folic acid (4 mg/day, Folavit, Wolfs, Belgium) administration. Percutaneous partial spleen embolization was performed if necessary in order to increase platelet level, as described [19].

At least two surgeons experienced in LT were in the operative room during all procedures. Meticulous haemostasis was achieved using surgical ligatures, uni- and/or bipolar coagulation, and argon beam coagulation. Cold and warm ischaemia and operative time were kept minimal. High dose aprotinin (Trasylol, Bayer, Germany) (2 000 000 kallikrein inhibiting unit (KIU) as a loading dose at induction, followed by continuous infusion of 500 000 KIU/h) was given during LT to limit fibrinolysis. Continuous circuit cell salvage and reinfusion whereby scavenged blood was maintained in continuity with the patient's circulation, was used in all procedures. Hypothermia was limited by the forced use of an air warmer blanket and blood drawing was kept as minimal as possible.

In cadaveric adult LT, the Belghiti's technique was used [20]. Briefly, it is a piggy-back LT with a systematic surgical, end-to-side, temporary, porto-caval shunt, without the use of a veno-venous bypass. The caval reconstruction consists in a large (>5 cm), side-to-side, cavo-caval anastomosis. This technique is the authors' standard LT procedure in adults. The 6-year-old child underwent standard orthotopic LT procedure, with triple (supra hepatic vena cava, infra hepatic vena cava, portal vein) clamping and without bypass, according to the paediatric surgeon preferences. Marginal cadaveric liver grafts were not accepted. Two patients underwent a living related liver transplantation (LRLT) using a right lobe, as described [21]. During right lobe harvesting, liver cut surface haemostasis was achieved by contact radiofrequency (TissueLink Floating Ball, Tissuelink, Dover, NH). In the LRLT recipient procedures, 20 μg/kg recombinant activated factor VII (Novoseven, Novo Nordisk, Denmark) was injected at the beginning of dissection, and at reperfusion.

During the postoperative period, erythropoietin therapy was continued, as long as the haematocrit was lower than

Table 1. Characteristics of the patients listed for liver transplantation.

Patient no.	Gender	Age (years)	Liver disease	CHILD	Status	Outcome
1	Male	60	HCV + HCC	B	LT	Alive
2	Male	45	HBV	C	LT	Alive
3	Female	34	PSC	A	LT	Alive
4	Female	50	PBC	B	LT	Alive
5	Female	6	Antitrypsin	B	LT	Alive
6	Female	16	Autoimmune	B	LRLT	Alive
7	Male	60	HBV + HCC	C	LRLT	Deceased
8	Male	53	Idiopathic	B	LT	Alive
9	Female	49	PBC	B	LT	Alive

HBV, hepatitis B virus; HCC, hepatocarcinoma; HCV, hepatitis C virus; PSC, primary sclerosing cholangitis; PBC, primary biliary cirrhosis; LT, liver transplantation; LRLT, living related liver transplantation.

35%. Invasive postoperative procedures were avoided if possible. Postoperative immunosuppression consisted in a combination of calcineurin inhibitors (cyclosporin, Neoral, Novartis, or tacrolimus, Prograft; ProGraft, Astellas, Tokyo, Japan), antimetabolites (azathioprine, Imuran, or mycophenolate mofetil, Cellcept; Roche) and low-dose steroids (rapidly tapered to be stopped at month 3–6). Acute rejection was suspected on biological grounds and/or on liver graft biopsy. First line treatment of acute rejection consisted in calcineurin inhibitors dosing increase and in three i.v. administrations of daily 500 mg of methylprednisolone (Solumedrol; Pfizer, New York, NY, USA). The patients were all regularly seen at the outpatient clinic. None was lost to follow-up.

Statistical analysis

All results are expressed as mean and standard error of the mean. One-way ANOVA was used for statistical analysis. A *P*-value <0.05 was considered as statistically significant.

Results

Preoperative period

During the preparation and the waiting time period, all patients received erythropoietin and iron therapy. This treatment allowed a significant increase of haematocrit, from 35.5 ± 2.0% to 40.0 ± 2.7% ($p < 0.05$) at LT. The platelet level was in the acceptable range for LT, according to the critical minimal levels, in all patients but two whose platelet count was lower than 20 000/mm^3. These two patients underwent partial spleen embolization that allowed platelet count increase with a maximum level after 1–2 weeks (Fig. 1). These two patients were subsequently successfully transplanted 2 and 12 weeks after procedure, without complication linked to the spleen embolization. All but one patient (patient 4) accepted the use of purified human albumin, and the HBV patients accepted the use of anti HBs immunoglobulins.

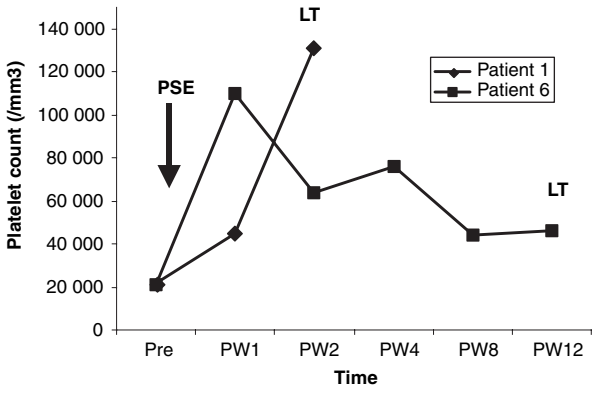

Figure 1 Evolution of platelet count before and after partial spleen embolization in patients 1 and 6 (LT, liver transplantation; PSE, partial spleen embolization; PW, post embolization week).

Transplant procedures

Six adult patients and the 6-year-old child underwent cadaveric whole LT, and two patients LRLT using a right lobe. During all procedures, a continuous red cell saving system was used to scavenge blood from the operative field. As the liquid aspirated by the cell saving system is a mixture of blood, ascitis and heparinized fluid from the system itself, it is difficult to precisely determined the operative bleeding (mean total aspirated fluid: 1472 ± 361 ml). The volume of red cell concentrate readministrated to the patient during the operation, may be a more objective estimation of the operative bleeding, expressed as the amount of lost red cells (488 ± 115 ml with 60% haematocrit). Mean graft ischaemia was 355 ± 47 min for cadaveric LT, and 42 min for LRLT. Graft function was immediate in all cases, with intraoperative bile production. No patient received any blood product (except purified albumin when accepted) during the surgical procedures.

Postoperative period

Postoperative day 1 mean haematocrit level was 30.8 ± 2.8% significantly lower than the pre transplant level ($P < 0.05$), and further decreased during the post transplant period (mean lowest haematocrit: 25.6 ± 3.1%, $P < 0.05$). Mean haematocrit at discharge was 33.0 ± 2.3%.

Seven patients (patients no. 1–4, 6, 8 and 9) had no severe complication during the whole hospitalization period. Their mean intensive care unit (ICU) stay was 4.0 days (range: 1–7 days), and they left the ward after a mean postoperative stay of 21 days (range: 12–45 days). Patient 3 denied the use of purified albumin. Her perioperative haemoglobin and albumin levels are presented in Fig. 2. When she was suffering from deep hypoalbuminemia and hypoproteinemia she developed mild pleural effusion. She did not need respiratory support and spontaneously recovered. She left ICU on postoperative day 7.

Two patients experienced severe complications. Patient 5, a 6-year-old girl, developed peritonitis secondary to perforated gastric ulcer on day 6 and had to be reoperated. Afterwards she developed inflammatory anaemia that did not respond to erythropoietin and iron therapy. She developed clinical symptoms of deep anaemia with severe asthenia and tachypnea, and received one unit of red cells against her parents' will when her haematocrit reached

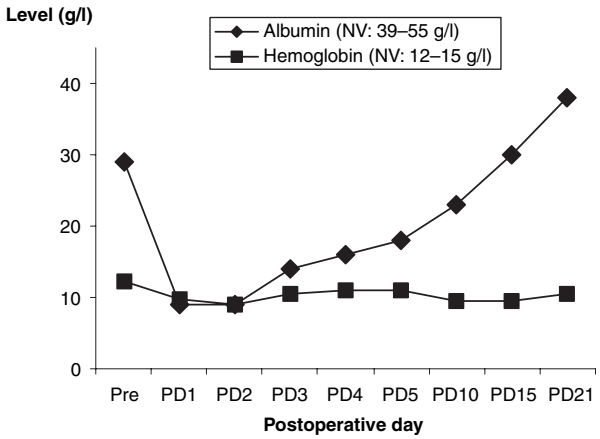

Figure 2 Evolution of albumin and haemoglobin levels in patient 3 (NV, normal values; PD, postoperative day).

16%. She improved rapidly and left the ward at postoperative day 32. Patient 7, a CHILD C patient suffering from HBV cirrhosis and hepatocarcinoma, underwent LRLT with a right lobe harvested from his JW son, despite preoperative haematocrit level at 22.4%. During the procedure total operative aspirated fluid was 3700 ml (1195 ml reinjected). Postoperative haematocrit was 12.7%. Liver graft function was immediate. However haematocrit fell to 8.2% at postoperative day 3. The patient's family requested transfusion after cardiac arythmia episodes. The patient developed invasive aspergillosis and died from multiple organ failure at postoperative day 11. No right lobe donor developed any complication or received any blood product.

Follow-up

Four patients developed moderate rejection during hospitalization that was easily managed by increase of calcineurin inhibitor levels and/or pulse of corticosteroids. Mean follow-up was 41 months (ranges: 1–72 months). All patients who survived the procedure were alive and well at follow-up, with perfect liver graft function. Patient 1 developed HCV recurrence that was treated with interferon and ribavirine with sustained viral response (normal transaminases and negative PCR 6 months after end of therapy). No other patients developed recurrence of the preoperative disease. Patient 3 gave birth to a healthy child 16 months after OLT.

Discussion

The JW population refuses transfusions of homologous and autologous blood products that have been removed from continuity with the body. This refusal is based on their interpretation of the bible [1]. According to their beliefs, acceptance of blood or blood products will forfeit their chance for resurrection and eternal salvation. Most JW accept crystalloid solutions, synthetic colloid solutions, haemoglobin substitutes as perfluorocarbons or artificial haemoglobin solutions, and recombinant proteins as erythropoietin or activated factor VII, while whole blood, red blood cells, platelets and plasma are unacceptable. Individual decisions need to be made regarding administration of purified fractions of plasma, as immunoglobulins and albumin, or solid organ transplants. Additionally, patients need to make personal decisions regarding (heart or veno-venous) bypasses, haemodilution and intraoperative red cell salvage. This request may be challenging for physicians, as blood products may be life saving in some severe medical conditions. On the contrary, the medical community has learned that blood products may submit patients to some risk of life threatening incidents [22], of allergic reactions, and of various known (or unknown) blood-borne infections [23]. It is also considered that multiple transfusions may decrease immunity, and they have been linked to increased postoperative morbidity and mortality rates [24,25] and cancer recurrence [26]. These reasons, added to the costs and the scarcity of some blood components, have forced the development of blood product-free medical strategies [27].

During the past decade, LT blood product requirements have significantly decreased in most centres, coincidentally with better patient and graft survival rates. This improvement may be related to the better experience of the medical teams with peri- operative liver recipient management, to the better surgical techniques, to better LT indication and to better liver graft use and preservation. The use of the antifibrinolytic agent aprotinin [28], of the lysin analogues tranexamic acid and ε-aminocaproic acid [29,30] was also associated with decreased transfusion requirements in LT. In a preliminay report, the use of recombinant activated factor VII was also proposed to reduce bleeding during LT [31]. The piggy-back technique and the avoidance of veno-venous bypass, may allow less transfusion requirements [32]. The use of autologous (cell saver) transfusion in LT may increase the overall blood transfusion requirement [33] but decreases the need of allogeneic red blood cells from the blood bank [34]. In their usual adult LT practice, the authors routinely use high dose aprotinin, autologous transfusion, and use the LT technique described by Belghiti *et al.* [20]. This piggy-back technique avoids the use of a veno-venous bypass. The first steps of the procedure include the ligature of the liver hilum elements but the portal vein. Then, the completion of a systematic, large, temporary, surgical, end-to-side, porto-caval shunt allows to

efficiently decompress the portal hypertension, and to decrease the associated bleeding from the splanchnic bed. To the authors' view, the early devascularization of the diseased liver reduces the bleeding associated with its mobilization and dissection from the retrohepatic vena cava, especially the bleeding from the accessory retrohepatic veins. The devascularized liver is also smaller, mobile, and therefore easier to dissect. The piggy-back technique also allows to limit bleeding and oozing from the retro-caval space.

LRLT in adult recipients has been recently developed to overcome the organ donor shortage [21]. LRLT may be particularly interesting in JW patients, as it may allow careful planning of the procedure at the best time for both donors and recipients, and this is particularly crucial in JW patients [13,15]. Moreover the quality of the graft is perfect and ischaemic time is short, allowing immediate graft function if the graft volume is sufficient. The most experienced surgeons and anaesthesiologists may be all present in the operative rooms. LRLT in JW patients may be challenging if the donor is JW himself, as in one of our cases (patient 7). It was recently demonstrated that in right lobe donors, blood product transfusion is exceptional, especially as a cell saving system is systematically used during surgical procedure [35]. So the authors, as others, consider that LRLT may be proposed to JW patients with a JW donor [16,36].

The authors considered the different means to prepare JW patients for LT. Recombinant erythropoietin with oral or intravenous iron supplementation, is an established, efficient but relatively expensive therapy to increase haematocrit levels and reduce allogeneic red blood cell transfusion [37]. The use of recombinant human erythropoietin was also shown to raise the haematocrit concentration in critically ill patients hospitalized in ICU, and to reduce the number of units of red blood cells they require [38]. In this study, the authors showed that it is possible to significantly increase the haematocrit level in cirrhotic patients waiting liver transplantation. Liver transplant candidates also very often suffer from thrombocytopenia induced by portal hypertension and hypersplenism. In two cases of this series, the authors chose to perform partial spleen embolization that allowed platelet count increase [9]. Partial spleen embolization may present severe complications, mainly sepsis by infection of the necrotic splenic tissue, but may be efficient to increase platelets in thrombocytopenia [19] that may last a few weeks after the procedure. This temporary effect could be a problem in case of long waiting time, but partial spleen embolization could be helpful in preparation for LRLT. Splenectomy may also be proposed [39], but this procedure is more aggressive, may induce abdominal adhesions and may be complicated by severe post transplant sepsis [40]. Transjugular intrahepatic portosystemic shunt (TIPS) may allow correction of portal hypertension in cirrhotic patients, and may be associated with reduction of intraoperative LT bleeding [41]. However, this finding is largely disputed by other reports [42,43], and TIPS does not increase the platelet level [44]. The authors would not recommend systematic TIPS insertion in preparation of JW for LT as it may decompensate liver function. They might discuss TIPS use in cirrhotic JW transplant candidate with preserved liver function and past history of major abdominal surgery (hepatobiliary, gastric or colonic) in which vascularized adhesions may render liver dissection haemorrhagic. However, the University of Southern California group reported successful LRLT in JW patients who were prepared with TIPS [14].

Red cell saving by the mean of a device aspirating blood from the surgical field, filtrating it and concentrating the red cells for immediate autotransfusion, is generally accepted by JW if there is no interruption of the lines between the device reservoir and the patient. Intraoperative cell saving autotransfusion has been associated with an increase in the overall blood loss in LT and an increased need for overall blood transfusion [33], but the need for allogeneic red cells is significantly decreased [34]. The authors use intraoperative cell saving autotransfusion in all LT cases. However, if autotransfusion allows recovering of red cells and preserving haematocrit level, platelets and coagulation factors are lost and that may be a problem in case of significant acute intraoperative bleeding. For coagulation cascade disturbances, the only possible correction has to come from the liver graft itself, as JW do not accept coagulation factors from human origin. This emphasizes the necessity of a perfect liver donor and of short ischaemia for immediate graft function in the setting of LT in JW. The recently developed recombinant activated factor VII may help to correct coagulation in cirrhotic patients [45]. A preliminary study showed some reduction in LT transfusion requirements when recombinant activated factor VII is used at LT induction [31]. The authors successfully used recombinant activated factor VII during the adult-to-adult LRLT. The main inconveniences of recombinant activated factor VII are the high price and the potential hazards of hypercoagulation on fresh vascular sutures if used during LT. However it may be the only way to partly correct the coagulation disturbances in JW during or after LT. Regarding other blood proteins, most JW accept the use of purified human albumin. One of our patients did not and suffered from severe hypoalbuminemia and hypoproteinemia that was well tolerated and corrected in a few days.

As LT transfusion requirements have significantly decreased and are no longer a problem for most blood

banks, one may wonder if there is any interest and/or need to further reduce allogeneic LT blood product requirements in non JW patients. However, it is clear that blood product transfusions submit patients to an added risk of specific complications [24,27] and may have an immunosuppressive effect [46,47] that may in part explain the increased incidence of infectious complications in LT with important intraoperative loss [48], and the lower patient and graft survival rates in patients who require more than 10 units of packed red blood cells [49]. On the contrary, LT recipients who receive low quantity of blood products may be at higher risk of rejection of the liver graft, because of the decreased transfusion-induced immunosuppression [48]. However, with the improvement of the immunosuppressive protocols, acute and/or chronic rejection is no longer a significant source of patient and graft loss after LT. In this series, the authors did not specifically study the effects of their protocol of allogeneic blood product avoidance in LT and did not perform protocol liver graft biopsies because of the risk of bleeding complications of liver biopsy. Four patients had clinical and/or biopsy proven moderate acute liver rejection that was treated with increased doses of immunosuppressive drugs. Moreover, one may hypothesize that the reduction of transfusion-induced immunosuppression may lead to a decreased risk of disease recurrence after LT.

The main concern about offering LT to JW patients is ethical. The acceptance of solid organ transplantation and the refusal of transfusion are impossible to understand for non-JW. It is clear that fully informed adult patients have the right to refuse some therapy, as the use of blood products. At the other hand health care personnel may not accept this patient's transfusion refusal. JW should therefore be referred to teams experienced with bloodless medical care that requires most often a multidisciplinary approach. Every JW patient should be interviewed individually, and the use of every blood fraction should be discussed. External pressure has to be excluded. In our experience one patient sent as JW for LT accepted transfusion after private interview, pretending that her JW husband pressured her to deny the use of blood product.

In the actual organ shortage era, cadaveric LT in JW raises another issue. The use of cadaveric liver grafts in JW patients may only be justified if long-term results are equal (or even better) than in the general LT population. The loss of a JW patient because of bleeding during or after cadaveric LT would not only lose a human being, but a liver graft that otherwise would have saved another patient who would accept blood products. In this study, the authors showed that prepared and selected JW might be transplanted with equal results than the general population. No JW patient receiving a cadaveric graft died. The authors believe that long-term results of LT in JW patients might be excellent, as these patients easily accept regular medical long-term follow-ups. As a matter of fact, their high level of beliefs might be a key to good results. It was reported that in renal transplantation, recipients who use religious coping after transplantation appear to have a better outcome than those who do not, may be by better postoperative compliance [50]. In our series two JW patients underwent living related LT, one with a JW donor. Living related LT in JW has the advantage of not putting a cadaveric liver at risk of bleeding. However living related LT with a JW donor put a healthy donor at higher risk because of the denial of use of blood products. This has to be considered when such a procedure is planned [16].

In conclusion, the authors presented the results of a LT program in JW patients. They demonstrated that it is possible to increase haematocrit and platelet levels in cirrhotic patients waiting LT. With a multidisciplinary protocol, they were able to reduce the need of blood product during LT procedures. This experience may be beneficial for the general LT candidate population, as the use of large amount of large amount of blood products during LT have been linked to increased morbidity and mortality.

References

1. Sarteschi LM. Jehovah's witnesses, blood transfusions and transplantations. *Transplant Proc* 2004; **36**: 499.
2. Kaufman DB, Sutherland DE, Fryd DS, Ascher NL, Simmons RL, Najarian JS. A single-center experience of renal transplantation in thirteen Jehovah's Witnesses. *Transplantation* 1988; **45**: 1045.
3. Figuero J, Vaidya A, Ciancio G, Olson L, Miller J, Burke GW. Simultaneous pancreas-kidney transplantation in Jehovah's Witness patients. *Clin Transplant* 2003; **17**: 140.
4. Boggi U, Vistoli F, Del Chiaro M, *et al.* Kidney and pancreas transplants in Jehovah's witnesses: ethical and practical implications. *Transplant Proc* 2004; **36**: 601.
5. Burnett CM, Duncan JM, Vega JD, Lonquist JL, Sweeney MS, Frazier OH. Heart transplantation in Jehovah's witnesses. *Arch Surg* 1990; **125**: 1430.
6. Conte J, Orens J. Lung transplantation in a Jehovah's witness. *J Heart Lung Transplant* 1999; **18**: 796.
7. Grande AM, Rinaldi M, D'Armini AM, Pellegrini C, Vigano M. Lung transplantation in a Jehovah's witness. Case report in a twinning procedure. *J Cardiovasc Surg (Torino)* 2003; **44**: 131.
8. Ramos HC, Todo S, Kang Y, Felekouras E, Doyle HR, Starzl TE. Liver transplantation without the use of blood products. *Arch Surg* 1994; **129**: 528.
9. Detry O, Honoré P, Delwaide J, Dondelinger RF, Meurisse M, Jacquet N. Liver transplantation in a Jehovah's witness. *Lancet* 1999; **356**: 1680.

10. Seu P, Neelankanta G, Csete M, *et al.* Liver transplantation for fulminant hepatic failure in a Jehovah's witness. *Clin Transplant* 1996; **10**: 404.
11. Snook NJ, O'Beirne HA, Enright S, Young Y, Bellamy MC. Use of recombinant human erythropoietin to facilitate liver transplantation in a Jehovah's witness. *Br J Anaesth* 1996; **76**: 740.
12. Calne R. *Art, Surgery and Transplantation*. London: Williams and Wilkins, 1996.
13. Detry O, De Roover A, Kaba A, *et al.* Right lobe living-related liver transplantation in a Jehovah's witness. *Transpl Int* 2003; **16**: 895.
14. Jabbour N, Genyk Y, Mateo R, *et al.* Live-donor liver transplantation: the USC experience. *Acta Chir Belg* 2001; **101**: 220.
15. Jabbour N, Gagandeep S, Mateo R, *et al.* Live donor liver transplantation without blood products: strategies developed for Jehovah's Witnesses offer broad application. *Ann Surg* 2004; **240**: 350.
16. Jabbour N, Gagandeep S, Bramstedt KA, *et al.* To do or not to do living donor hepatectomy in Jehovah's witnesses: single institution experience of the first 13 resections. *Am J Transplant* 2005; **5**: 1141.
17. Porte RJ, Knot EA, Bontempo FA. Hemostasis in liver transplantation. *Gastroenterology* 1989; **97**: 488.
18. Lamy M. Invited comments concerning the article entitled ''A practical approach to ethical problems in surgical emergencies''. *Acta Chir Belg* 2004; **104**: 129.
19. Dondelinger RF, Kurdziel J. Embolization of the spleen. In: Dondelinger RF, Rossi P, Kurdziel J, Wallace S, eds. *Interventional Radiology*. New York: Thieme Medical Publishers, 1990: 505–512.
20. Belghiti J, Noun R, Sauvanet A. Temporary portocaval anastomosis with preservation of caval flow during orthotopic liver transplantation. *Am J Surg* 1995; **169**: 277.
21. Trotter JF, Wachs M, Everson GT, Kam I. Adult-to-adult transplantation of the right hepatic lobe from a living donor. *N Engl J Med* 2002; **346**: 1074.
22. Williamson LM, Lowe S, Love EM, *et al.* Serious hazards of transfusion (SHOT) initiative: analysis of the first two annual reports. *Br Med J* 1999; **319**: 16.
23. Barbara J, Flanagan P. Blood transfusion risk: protecting against the unknown. *Br Med J* 1998; **316**: 717.
24. Goodnough LT, Brecher ME, Kanter MH, AuBuchon JP. Transfusion medicine. First of two parts–blood transfusion. *N Engl J Med* 1999; **340**: 438.
25. Chang H, Hall GA, Geerts WH, Greenwood C, McLeod RS, Sher GD. Allogeneic red blood cell transfusion is an independent risk factor for the development of postoperative bacterial infection. *Vox Sang* 2000; **78**: 13.
26. Vamvakas EC. Transfusion-associated cancer recurrence and postoperative infection: meta-analysis of randomized, controlled clinical trials. *Transfusion* 1996; **36**: 175.
27. Spahn DR, Casult M. Eliminating blood transfusion. *Anesthesiology* 2000; **93**: 242.
28. Porte RJ, Molenaar I, Begliomini B, *et al.* Aprotinin and transfusion requirements in orthotopic liver transplantation: a multicentre randomised double-blind trial. *Lancet* 2000; **355**: 1303.
29. Boylan JF, Klinck JR, Sandler AN, *et al.* Tranexamic acid reduces blood loss, transfusion requirements, and coagulation factor use in primary orthotopic liver transplantation. *Anesthesiology* 1996; **85**: 1043.
30. Dalmau A, Sabate A, Acosta F, *et al.* Tranexamic acid reduces red cell transfusion better than epsilon-aminocaproic acid or placebo in liver transplantation. *Anesth Analg* 2000; **91**: 29.
31. Hendriks H, Meijer K, De Wolf J, *et al.* Reduced transfusion requirements by recombinant factor VIIa in orthotopic liver transplantation. *Transplantation* 2001; **71**: 402.
32. Cacciarelli T, Keefe E, Moore D, *et al.* Primary liver transplantation without transfusion of red blood cells. *Surgery* 1996; **120**: 698.
33. Hendriks H, Van der Meer J, Klompmaker IJ, *et al.* Blood loss in orthotopic liver transplantation: a retrospective analysis of transfusion requirements and the effects of autotransfusion of cell saver blood in 164 consecutive patients. *Blood Coagul Fibrinolysis* 2000; **11**(Suppl. 1): S87.
34. Williamson K, Taswell H, Rettke SR, Krom RA. Intraoperative autologous transfusion: its role in orthotopic liver transplantation. *Mayo Clin Proc* 1989; **64**: 340.
35. Liu CL, Fan ST, Lo CM, *et al.* Living donor liver transplantation without the use of blood products. *Hong Kong Med J* 2002; **8**: 192.
36. Detry O, De Roover A, Delwaide J, *et al.* Living related liver transplantation in adults: first year experience at the University of Liège. *Acta Chir Belg* 2004; **104**: 166.
37. Goodnough LT, Monk TG, Andriole GL. Erythropoietin therapy. *N Engl J Med* 1997; **336**: 933.
38. Corwin H, Gettinger A, Rodriguez R, *et al.* Efficacy of recombinant human erythropoietin in the critically ill patient: a randomized, double-blind, placebo-controlled trial. *Crit Care Med* 1999; **27**: 2346.
39. Pivalizza EG, Tjia IM, Juneja HS, Cohen AM, Duke JH. Elective splenectomy in an anemic Jehovah's witness patient with cirrhosis. *Anesth Analg* 1998; **87**: 529.
40. Troisi R, Colle I, Van Vlierberghe H, Hesse UJ, Cuomo O, de Hemptinne B. Splenectomy and liver transplantation. *Transplant Proc* 2001; **33**: 1500.
41. Menegaux F, Baker E, Keefe E, Monge H, Esquivel C. Impact of transjugular intrahepatic portosystemic shunt on orthotopic liver transplantation. *World J Surg* 1994; **18**: 866.
42. Millis J, Martin P, Gomes A, *et al.* Transjugular intrahepatic portosystemic shunts: impact on liver transplantation. *Liver Transpl Surg* 1995; **1**: 229.
43. Lerut J, Laterre PF, Goffette P, *et al.* Transjugular intrahepatic portosystemic shunt and liver transplantation. *Transpl Int* 1996; **9**: 370.

44. Jabbour N, Zajko A, Orons P, Irish W, Fung JJ, Selby RR. Does transjugular intrahepatic portosystemic shunt (TIPS) resolve thrombocytopenia associated with cirrhosis? *Dig Dis Sci* 1998; **43**: 2459.
45. Bernstein D, Jeffers L, Erhardtsen E, *et al.* Recombinant Factor VIIa corrects prothrombin time in cirrhotic patients: a preliminary study. *Gastroenterology* 1997; **113**: 1930.
46. Blumberg N, Heal JM. Transfusion and recipient immune function. *Arch Pathol Lab Med* 1989; **113**: 246.
47. Triulzi DJ, Vanek K, Ryan DH, Blumberg N. A clinical and immunologic study of blood transfusion and postoperative bacterial infection in spinal surgery. *Transfusion* 1992; **32**: 517.
48. Palomo Sanchez J, Jimenez C, Moreno Gonzalez E, *et al.* Effects of intraoperative blood transfusion on postoperative complications and survival after orthotopic liver transplantation. *Hepatogastroenterology* 1998; **1998**: 1026.
49. Mor E, Jennings L, Gonwa TA, *et al.* The impact of operative bleeding on outcome in transplantation of the liver. *Surg Gynecol Obstet* 1993; **176**: 219.
50. Tix AP, Frazier PA. The use of religious coping during stressful life events: main effects, moderation, and mediation. *J Consult Clin Psychol* 1998; **66**: 411.