Original Article

Decline in Organ Donation in Germany

A Nationwide Secondary Analysis of All Inpatient Cases

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Summary

Background: The annual number of post-mortem organ donations in Germany has declined by more than 30% since 2010. The causes of this development have not yet been adequately determined.

Methods: All patients hospitalized in Germany between 2010 and 2015 (112 172 869 hospitalizations in total) were included in this nationwide secondary analysis. Among the deceased patients we identified those who had died in the presence of a brain damage and for whom organ donation was not excluded either by a medical contraindication or by the patient's not having been artificially ventilated. The analysis was also conducted separately for six German university hospitals.

Results: Over the period 2010–2015, the number of potential organ donors per year in Germany rose by 13.9%, from 23 937 to 27 258. This development was due to an increase in the number of deaths with severe brain damage as well as an increase in the percentage of patients who were treated with invasive ventilation before death. The contact quotient, i.e., the percentage of potential donors for whom contact was made with the German Foundation for Organ Transplantation (Deutsche Stiftung Organtransplantation, DSO) fell over this period from 11.4% to 8.2%. At the same time, the realization quotient (the percentage of potential donors who became actual donors) fell from 5.4% to 3.2%, and the conversion quotient (the percentage of potential donors for whom contact was made who became actual donors) fell from 47% to 39.1%. From 2010 to 2012, the falling realization quotient was accounted for mainly by the falling conversion quotient; from 2012 to 2015, it was accounted for mainly by the falling contact quotient. The contact and realization quotients among the six university hospitals studied differed markedly (by factors of 17.5 and 23.3, respectively), while the conversion quotients differed only minimally (by a factor of 1.3).

Conclusion: The decline in post-mortem organ donation is due to a deficiency in the recognition and reporting of potential organ donors in hospital. If this process were better supported on the organizational and political level, far more organs could be transplanted.

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The number of organ donors per year in Germany fell by more than one-third over the period 2010–2017 (from 1296 donors in 2010 to only 797 in 2017) (1). Because of this, there were over 1500 fewer recipients of a life-saving organ transplant in 2017 than in 2010 (2). As each organ transplantation prolongs life by an estimated average of 4.3 years, this implies a loss of more than 6000 years of patients' lives for the year 2017 alone (3).

This development has been widely and publicly discussed, but its cause has not yet been clearly determined. It is often attributed solely to a supposed loss of public trust after the organ allocation scandal that became known in 2012. The number of organ donations was, however, already falling before this happened (4), and no lessening in the acceptance of organ transplantation by the general public was seen in the annual surveys spanning the years in question. The percentage of

respondents stating that they had an organ donor card actually rose from 17% in 2008 to 36% in 2018 (*eFigure 1*) (5). The legal framework of organ donation cannot be blamed for the decline, either, as a major improvement came about in this area in 2012 with the introduction of a declaration-based decision model: every person in Germany aged 16 and older is now regularly asked by his or her health-insurance carrier to decide on and document an organ-donation status (“yes,” “no,” “yes with reservations,” or transfer of decision-making competence to another person). Nonetheless, the number of potential organ donors reported to the DSO by the hospitals fell markedly over the period in question. It has been unclear to date whether this is due to a general decline in the number of potential organ donors or, rather, to a deficiency in the recognition and reporting of potential organ donors by hospitals.

TABLE 1

Nationwide analysis of all hospitalizations, 2010–2015*

	2010	2011	2012	2013	2014	2015	DSO In-House Coordination Project 2010–2012 (Categories A and B)
Hospitalizations	18 032 903	18 344 156	18 620 442	18 787 168	19 148 626	19 239 574	–
Deaths, total	405 627	400 051	404 146	415 250	401 204	425 128	–
Deaths with primary or secondary brain damage	65 080	63 652	63 618	65 010	64 544	68 024	22 946
Deaths with an absolute contra- indication to organ donation	6456	6566	6485	6688	7045	7281	3011
Deaths without invasive respiratory therapy	34 687	33 007	33 433	33 221	32 235	33 485	6888
Potential organ donors	23 937	24 079	23 700	25 101	25 264	27 258	13 047
DSO contacts as a percentage of potential donors (contact quotient)	2760 (11.5%)	2778 (11.5%)	2594 (10.9%)	2221 (8.8%)	2170 (8.6%)	2245 (8.2%)	4141 (31.7%)
Actual donations as a percentage of potential donors (realization quotient)	1296 (5.4%)	1200 (5%)	1046 (4.4%)	876 (3.5%)	864 (3.4%)	877 (3.2%)	1327 (10.2%)
Actual donations as a percentage of DSO contacts (conversion quotient)	47.0%	43.2%	40.3%	39.4%	39.8%	39.1%	32.0%

* The results of the DSO In-House Coordination Project are given in the rightmost column for comparison. Category A hospitals are university hospitals; category B hospitals are defined by the presence of a neurosurgical service.

DSO, German Foundation for Organ Transplantation (*Deutsche Stiftung Organtransplantation*)

In 2010, the DSO and the North Rhine–Westphalia Hospital Association (*Krankenhausgesellschaft Nordrhein-Westfalen*) jointly developed a software program called DSO-Transplantcheck (6) that can use a hospital's billing data to identify the patients who died there who would, in all probability, have been potential organ donors. For the purposes of this article, we refer to this group simply as “potential organ donors.” In what was called the DSO In-House Coordination Project, an analysis with the DSO-Transplantcheck was regularly carried out for two years in more than 100 hospitals, and every potential organ donor identified was then studied in a structured evaluation of his or her actual suitability as an organ donor. This project revealed that, in the participating hospitals, nearly all “potential organ donors” were identified and reported to the DSO (7).

In the study presented in this article, we used the DSO-Transplantcheck analytical algorithm to investigate the following:

- changes in the number of potential organ donors in Germany from 2010 to 2015, and
- the variability across DSO regions and university hospitals in the contact quotient and the realization quotient. The former is defined as the percentage of potential donors for whom contact was made with the DSO, the latter as the percentage of potential donors who became actual donors.

Methods

Hospital billing data compiled as specified by relevant German law (§21 KHEntgG) were analyzed in a four-step process to identify potential organ donors:

- Step 1: selection of all hospitalizations in the year in question for which the documented reason for discharge was death (code 079).
- Step 2: selection of patients who died with a main or subsidiary diagnosis that can be presumed to have led to severe, irreversible brain damage.
- Step 3: exclusion of patients for whom a coded diagnosis or diagnoses contraindicated organ donation.
- Step 4: exclusion of patients for whom invasive ventilation was not billed.

To analyze the process of organ donation further, the realization quotient and the contact quotient (defined above) were calculated for each year of the period in question. The quotient of these two quotients is the conversion quotient, i.e., the percentage of potential donors for whom contact was made who then became actual donors. Further aspects of the methods used are described in the *eMethods* section and in *eFigure 2*.

Results

Nationwide analysis of all hospitalizations from 2010 to 2015

The findings of the analysis of all hospitalizations from 2010 to 2015 are shown in *Table 1* and *Figure 1*. Over this period, the number of hospitalizations per year rose by 6.7%, the number of in-hospital deaths by 4.8%, and the number of in-hospital deaths with primary or secondary brain damage by 4.5%. The number of patients who died with brain damage, but had an absolute contraindication for organ donation, rose by 12.7%. The percentage of patients who died with brain damage, had

no contraindication for organ donation, and were treated with invasive ventilation rose by 3.5%. Overall, the number of potential organ donors rose by 13.9% over the six-year period (Figure 1), yet the number of contacts with the DSO concerning organ donation fell by 18.7% over this period, and the number of actual organ donations fell by 32.3%. The conversion quotient fell from 47% to 39.1% (relative change, -17%). The latter development occurred mainly in the years 2010 to 2012 (Table 1).

A comparative analysis of the contact, realization, and conversion quotients across DSO regions is shown in eTable 1. The eTable reveals that the drop in the contact quotient over the period of the study was less marked in the federal states that had been part of East Germany before reunification.

Nationwide analysis of all hospitalizations in university hospitals from 2010 to 2015

The results of the analysis are summarized in eTable 2. Over the period of the study, a constant percentage (9.6%) of all hospitalizations—between 1.7 and 1.8 million hospitalizations in absolute numbers—were in university hospitals. The percentage of hospitalizations in university hospitals that ended in death was slightly below the nationwide average (2% vs. 2.2%). Among all patients who died in the hospital, the percentage that had primary or secondary brain damage was 24.1% in university hospitals, which was markedly above the nationwide average of 15.9%. Moreover, among all patients who died and had primary or secondary brain damage, the percentage with an absolute contraindication for organ donation was higher in university hospitals than the national average (13.5% vs. 10.4%), and the percentage who were treated with invasive ventilation in an intensive care unit was likewise higher than the national average (74% vs. 49.7%). The number of potential organ donors in university hospitals rose by 19.2% over the period of the study, a much greater increase than the nationwide average. Contacts with the DSO regarding organ donation fell by 21.4% over the same period, while the number of actual organ donations fell by 30.5%. The conversion quotient fell over the period of the study from 48.1% to 42.5% (relative change, -11.6%).

A comparative analysis of hospitals in category A

The contact, realization, and conversion quotients of the participating German university hospitals in 2015 are shown in Figure 2 to enable comparison across hospitals. Two of them are in the first quartile of German hospitals in terms of size (number of hospitalizations per year), one is in the second quartile, and three are in the third quartile. The percentage of in-hospital deaths associated with primary or secondary brain damage for which there was a coded contraindication for organ donation varied across hospitals, from 8.6% to 13.4%. The percentage of patients who received complex intensive care treatment with invasive

Comparative representation of potential organ donors and actual organ donations, 2010–2015

ventilation before their death was between 63.1% and 84.7%. The number of hospitalizations in each hospital did not correlate with the number of patients who had a coded contraindication ($r = 0.31$; $p > 0.05$) or with the number who underwent invasive ventilation ($r = -0.42$; $p > 0.05$). Nor was there any correlation between the percentage of patients that underwent invasive ventilation and the percentage of actual organ donations ($r = 0.43$, $p > 0.05$).

Estimation of the theoretically realizable number of organ donations in Germany

The analysis of all hospitalizations in Germany in 2015 implies that 2780 organ donations could have taken place, rather than the 877 that actually did take place, if the realization quotient in 2015 had equaled the one previously achieved in the DSO In-House Coordination Project (10.2%). This would have corresponded to 33.8 organ donations per million people per year.

If, in 2015, all university hospitals had had the same realization quotient as the hospital with the highest realization quotient in this study (i.e., a realization quotient of 16.3%), then the category A hospitals alone would have achieved 928 organ donations in 2015, or more than actually took place in that year in the entire Federal Republic of Germany.

Discussion

Before any organ donation can take place in Germany, the following must happen:

- A patient must have severe, irreversible brain damage and be considered a potential organ donor.
- The treating physician must recognize this situation in timely fashion and report it to the DSO.
- The patient's irreversible loss of brain function must be ascertained and documented.
- The patient must truly be suitable for organ donation.
- Consent to organ donation must be present.

The reason for the drop in organ donations in Germany is to be sought in one or more of these steps in the process.

FIGURE 2

Comparative analysis of the contact, realization, and conversion quotients of six university hospitals in the year 2015. The red dotted line represents the quotient achieved by the reference hospitals in the DSO In-House Coordination Project. The blue dotted line represents the average quotient of all German category A hospitals in 2015.

DSO, German Foundation for Organ Transplantation (*Deutsche Stiftung für Organtransplantation*); UH, university hospital

An analogous development can be seen in the annual analyses of the potential for organ donation (National Potential Donor Audit, PDA) conducted by the National Health Service (NHS) in the United Kingdom. The clinical data of all patients who died in intensive care were analyzed to identify potential organ donors (13, 14); the number of potential organ donations from brain-dead donors rose by 4.5% from 2010 to 2015 (15, 16). Similarly, according to an analysis by the Organ Procurement and Transplantation Network in the USA, the number of potential organ donors in the USA is expected to rise by ca. 5% from 2010 to 2020 (17). It should be noted that the term “potential organ donor” is used internationally mainly for patients who would have been considered suitable for organ donation on the basis of their clinical data (medical records, imaging studies). Our study design, in contrast, does not permit a distinction between patients who died because of severe brain damage and those who had severe brain damage but died of other causes. This might account for the higher rise in potential organ donors in our analysis compared to the studies conducted abroad. One may, however, safely conclude that the increasing deficiency of organ donations in Germany cannot be explained by a lack of potential organ donors.

The number of contacts with the DSO regarding organ donation in Germany declined by 18.7% from 2010 to 2015 (18, 19). The number of potential organ donors increased over the same period, so the contact quotient actually declined by a greater amount (28.7%). This development was even more pronounced in the university hospitals, in which the contact quotient declined by 34.1% from 2010 to 2015.

The German law concerning an amendment to the Transplantation Law took effect on 1 August 2012, with the aim of strengthening the role of the hospitals in the process of organ donation. As of that date, all hospitals are required to designate a person responsible for transplantation and to report potential organ donors to the DSO (20). Remarkably, the contact quotient declined more steeply after this law went into effect (–24.8% from 2012 to 2015) than it had done before (–5.2% from 2010 to 2012). It bears mentioning in this context that the manner in which the law was formulated led to uncertainty by not precisely specifying when potential organ donors are supposed to be reported.

Before the organ allocation scandal became public, the decline in organ donation was largely accounted for by a decline in the conversion quotient. Furthermore, surveys revealed no general decline in the public acceptance of organ donation in the wake of the scandal (21). The

The age-adjusted mortality rates due to ischemic and hemorrhagic stroke have markedly declined in recent decades in Western industrialized countries (8), as have the mortality rates due to subarachnoid hemorrhage (9, 10). The number of people killed in traffic accidents in Germany each year has also been declining for many years (11). Meanwhile, diseases that contraindicate organ donation, such as metastatic cancer, have become markedly more prevalent in our society (12). It would seem plausible that the decline in organ donations might be accounted for, at least in part, by these developments. Our analysis shows, however, that the number of potential organ donors per year actually increased by 13.9% from 2010 to 2015. This can be explained as mainly due to an increase in deaths of patients with brain damage and an increasing percentage of patients who undergo complex intensive care treatment, including invasive respiratory therapy, before they die.

scandal thus seems to have caused uncertainty mainly among doctors, rather than among the general public, and to have negatively affected their reporting behavior. The university hospitals that voluntarily participated in the DSO In-House Coordination Project from 2010 to 2012 had relatively high contact quotients, presumably because of their high motivation. A comparison with these hospitals shows that the general rate of DSO contacts about potential organ donors should have been about three times as high as it actually was in 2015 (22).

Notably, the contact quotient fell to a lesser extent in the northeastern and eastern DSO regions than it did in the rest of Germany; these regions comprise the “new federal states,” i.e., what used to be East German territory before reunification. But the contact quotient was found to vary not only regionally, but also to a marked extent among hospitals in the same region—sometimes with a more than tenfold difference between two hospitals with a similar number of potential organ donors. This finding rules out the notions that

- there exists a blanket *a priori* rejection of organ donation, or that
- the current legal and financial framework inevitably leads to a decline in the number of organ donation.

The falling number of organ donations is occasionally linked to the German Law on Patients’ Rights, which was passed in 2013 (23). It is conceivable that earlier termination of treatment in gravely ill patients, in accordance with their advance directives, might have led to an overall decline in the situations in which patients suffer irreversible loss of brain function in the presence of conditions that make them in principal suitable for organ donation. The temporal course of the decline in organ donation does not accord well with this explanatory approach. Some of the observed variation across hospitals might conceivably be due to differing interpretations of the patients’ wishes. However, hospitals with high and low contact quotients do not differ to any major extent in the percentage of patients that are in intensive care, or that are treated with invasive ventilation, so this explanatory approach cannot account for the major differences among hospitals. Instead, the findings reported here show that these hospitals suffer from major deficiencies in the identification and reporting of potential organ donors. It is also clear, however, that this trend could be reversed without any necessary changes in the legal framework.

The falling conversion quotient from 2010 to 2015 implies that the decline in organ donations must also be due, in part, to factors acting after the potential donor has been identified and reported. Most of the decline in the conversion quotient took place from 2010 to 2012, before the organ allocation scandal became known. The major cause of this decline was a rise in refusals of organ donation (as expressed either in advance directives or by their families) by patients who had received the diagnosis of an irreversible loss of brain function, from 37.2% in 2010 to 41.5% in 2012 (24, 25). Such figures enable us, in theory, to quantify the effect of the changed attitude of the public to organ transplantation: if the conversion quotient had been the same in 2015 as in 2010, there would have been

178 more organ donations in 2015 (a 17% increase). Yet, when one considers in comparison the number of organ donations that would have occurred if all potential donors had been reported, it becomes clear that an increase in organ donations can be achieved mainly by the improved identification and reporting of potential donors.

The number of donated organs continued to decline in 2016 and 2017. These years were not included in the present analysis, because the relevant billing data are not yet available. The legal framework has not changed over this time, and so there is no reason to postulate any other reason for the continuing decline beyond the ones discussed above.

Now that the process of organ transplantation has become much more transparent to the general public in the wake of the organ allocation scandal, the emphasis should now be on improving the routine identification of potential organ donors and their reporting to the DSO.

Limitations

The main strength of this study is the large number of hospitalizations that were analyzed. It has some weaknesses as well:

- The reliance on billing data enables us to make no more than a retrospective estimate, from reference information, of the percentage of “potential organ donors.” This may well differ from the number of patients for whom organ donation would really have been feasible.
- In many countries, the term “potential organ donors” is used only for patients who have been so judged on the basis of pertinent clinical information (medical records and imaging studies). This should be recalled in any comparison of the present study with other studies from abroad.
- The conversion quotient accounts solely for cases in which organ donation was refused after the reporting of a potential organ donor to the DSO.
- The quality of billing data depends on the quality of coding, which may differ from one hospital to another. Nonetheless, we consider the data analyzed in this study to be highly valid, in view of their high economic importance and the fact that they are checked for plausibility by the Health Insurance Medical Service (*Medizinischer Dienst der Krankenversicherung*, MDK).

Conflict of interest statement

Dr. Rahmel is the medical head of the German Foundation for Organ Transplantation.

Dr. Fränkel is a member of the liver transplantation conference of the Uniklinik RWTH Aachen.

Prof. Feldkamp has served as a paid consultant for Bristol-Myers Squibb (BMS), Roche, Novartis, Fresenius, Chiesi, Teva, Novartis, Neovii, Hexal, and Sanofi. He has been paid by Novartis for co-authorship in a publication relating to the topic of this article. He has received reimbursement of meeting participation fees and/or travel and accommodation expenses and/or lecture honoraria from Biotest, BMS, Astellas, Chiesi, Novartis, Neovii, Roche, Hexal, Fresenius, and Sanofi. He has received third-party research funding from Chiesi, BMS, Astellas, Novartis, Hexal, and Teva. He is a member of the renal transplantation conference of the University Hospital Schleswig-Holstein, Campus Kiel.

Key messages

- The number of potential organ donors in Germany increased by 13.9% from 2010 to 2015.
- Nonetheless, the percentage of potential organ donors reported to the DSO has declined markedly in recent years and varies widely across hospitals.
- Only a small part of the decline in organ donations can be accounted for by changing attitudes among the general public.
- Improved reporting behavior in hospitals is the most important factor that can help reverse the decline in organ donations.

The other authors state that they have no conflict of interest.

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► **Supplementary material**
eMethods, eTables, eFigures:
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Supplementary material to:

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A Nationwide Secondary Analysis of All Inpatient Cases

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Attitude of the population to organ donation.

Results of representative surveys conducted by the German Federal Centre for Health Education (Bundeszentrale für gesundheitliche Aufklärung, BZgA) on the topic of organ and tissue transplantation (5). The term "active acceptance" refers to the readiness of the respondents to agree to organ transplantation in case the relevant situation should arise

The analytical algorithm

eMETHODS

Data set and data source

The hospital billing data collected in accordance with the relevant German law (§21 KHEntgG) include the following information (and other information) about the patients treated in each hospital:

- Basic personal data (e.g., age, sex)
- Reasons for admission and discharge
- Main and subsidiary diagnoses (ICD codes)
- Operation and procedure key codes (OPS codes)
- Duration of invasive ventilation, in hours.

A dataset of this type must be generated by every approved hospital in Germany each year and submitted to the Institute for the Hospital Compensation System (*Institut für das Entgeltsystem im Krankenhaus*, InEK) from where it is forwarded to the Federal Statistical Office (*Statistisches Bundesamt*) in the following year. The participating university hospitals conducted the analyses of their billing data with the DSO-Transplantcheck independently, on the institutional level (DSO = German Foundation for Organ Transplantation [*Deutsche Stiftung Organtransplantation*]). The results of these analyses were then made available in anonymous form. Six of the 22 university hospitals that were initially contacted by telephone took part in the analysis.

The data from all German university hospitals (category A hospitals), like the data from all German hospitals in general, were made available to us by the Federal Statistical Office. In order to analyze cumulative billing data, multiple evaluation syntaxes were created in IBM SPSS Statistics for Windows (version 22.0.0.2, IBM, 2013) to mirror the described selection algorithm. The university hospitals were retrieved from the overall data set by means of the corresponding institutional identifiers; to preserve data confidentiality as required by law, all university hospitals were analyzed together. A total of 112 172 869 hospitalizations were analyzed. The analysis of billing data was carried out by the Data Warehouse of the Federal Statistical Office. The ICD codes used in the second and third stages of the analysis are listed in *eTables 3a* and *3b*.

The analytical algorithm, the DSO-Transplantcheck software program, and the DSO In-House Coordination Project

In 2010, in accordance with Appendix 1 to the German Medical Association's guideline for medical evaluation in transplant medicine, entitled "Richtlinie gemäß §16 Abs. 1 Satz 1 Nr. 3 TPG zur ärztlichen Beurteilung nach §11 Abs. 4 Satz 2 TPG," the DSO and the Hospital Association of North Rhine–Westphalia developed the so-called DSO Transplantcheck software program. The goal was to provide hospitals with the IT support they need to help them retrospectively identify all potential organ donors. This program was then made available to the project hospitals participating in the DSO In-House Coordination Project. Kaiser et al. [26] were able to show that the algorithm reliably identifies all cases in which a diagnosis of irreversible loss of brain function would have been possible. In the DSO In-House Coordination Project, all potential organ donors identified by the DSO-Transplantcheck were studied in a structured dialogue using clinical data to determine whether such a diagnosis could, in fact, have been made in each particular case. Each hospital's participation in the DSO In-House Coordination Project was voluntary; thus, the hospitals that actually took part were particularly interested in the topic and highly motivated to participate. A total of 112 hospitals participated, including 33 university hospitals.

Further statistical analyses

The Spearman correlative analyses were conducted with GraphPadPrism Version 6.0. The significance level was set at $p < 0.05$.

eTABLE 1

Comparative analysis of the contact, realization, and conversion quotients of the different DSO regions

Region	Quotient	2010	2011	2012	2013	2014	2015
North	Contact quotient	11.3%	11.4%	10.8%	7.9%	8.2%	6.2%
	Realization quotient	5.5%	4.8%	4.4%	3.3%	3.7%	2.5%
	Conversion quotient	48.7%	42.1%	40.7%	41.8%	45.1%	40.3%
Northeast	Contact quotient	10.9%	8.9%	8.5%	7.1%	7.4%	9.8%
	Realization quotient	6.4%	5.6%	4.8%	4.2%	4.4%	3.4%
	Conversion quotient	58.7%	62.9%	56.5%	59.2%	59.5%	34.7%
East	Contact quotient	11.2%	12.5%	11.2%	10.4%	9.8%	10.8%
	Realization quotient	5.0%	5.4%	4.1%	3.6%	3.7%	4.2%
	Conversion quotient	44.6%	43.2%	36.6%	34.6%	37.8%	38.9%
Bavaria	Contact quotient	11.3%	12.9%	12.9%	9.1%	8.8%	8.8%
	Realization quotient	5.5%	5.4%	4.6%	3.2%	3.3%	3.5%
	Conversion quotient	48.7%	41.9%	35.7%	35.2%	37.5%	39.8%
Baden-Württemberg	Contact quotient	12.6%	12.1%	12.9%	10.0%	9.6%	8.3%
	Realization quotient	4.7%	4.1%	4.3%	3.2%	3.2%	3.3%
	Conversion quotient	37.3%	33.9%	33.3%	32.2%	33.3%	39.8%
Central	Contact quotient	13.6%	12.0%	10.6%	9.1%	8.8%	7.8%
	Realization quotient	6.7%	5.6%	4.8%	3.9%	3.3%	3.2%
	Conversion quotient	49.3%	46.7%	45.3%	42.9%	37.5%	41.0%
North Rhine-Westphalia	Contact quotient	10.5%	10.8%	9.9%	8.5%	8.0%	7.4%
	Realization quotient	4.8%	4.5%	4.2%	3.4%	2.9%	2.9%
	Conversion quotient	45.7%	41.7%	42.4%	40.0%	36.3%	39.2%
Mean	Contact quotient	11.5%	11.5%	10.9%	8.8%	8.5%	8.2%
	Realization quotient	5.4%	5.0%	4.4%	3.5%	3.4%	3.2%
	Conversion quotient	47.6%	44.6%	41.5%	40.8%	41.0%	39.1%
Standard deviation	Contact quotient	1.1%	1.3%	1.6%	1.2%	0.9%	1.5%
	Realization quotient	0.8%	0.6%	0.3%	0.4%	0.5%	0.5%
	Conversion quotient	6.4%	8.9%	7.8%	9%	8.9%	2.1%

DSO, German Foundation for Organ Transplantation (*Deutsche Stiftung Organtransplantation*)

eTABLE 2

Nationwide analysis of all hospitalizations in German university hospitals, 2010–2015*

	2010	2011	2012	2013	2014	2015	DSO In-House Coordination Project 2010–2012 (Category A)
Hospitalizations	1 734 079	1 764 864	1 788 274	1 802 465	1 833 099	1 838 750	–
Deaths, total	33 560	33 725	34 492	35 932	35 065	37 580	–
Deaths with primary or secondary brain damage	7829	8034	8244	8545	8682	9377	10 224
Deaths with an absolute contra- indication to organ donation	1020	1135	1069	1155	1195	1263	1830
Deaths without invasive respiratory therapy	2031	2050	2201	2225	2283	2421	2423
Potential organ donors	4778	4849	4974	5195	5204	5693	5971
DSO contacts as a percentage of potential donors (contact quotient)	826 (17.3%)	847 (17.5%)	793 (15.9%)	641 (12.3%)	615 (11.8%)	649 (11.4%)	1820 (30.5%)
Actual donations as a percentage of potential donors (realization quotient)	397 (8.3%)	374 (7.7%)	344 (6.9%)	257 (4.9%)	260 (5.0%)	276 (4.8%)	631 (10.6%)
Actual donations as a percentage of DSO contacts (conversion quotient)	48.1%	44.2%	43.4%	40.1%	42.3%	42.5%	34.7%

* The results of the DSO In-House Coordination Project (category A hospitals only) are given in the rightmost column for comparison.
DSO, German Foundation for Organ Transplantation (*Deutsche Stiftung Organtransplantation*)

eTABLE 3a

ICD codes: selection of patients who died with primary or secondary brain damage (Step 2 of the analysis)

C70.0	I61.1	I67.4	Q03.8	S15.7
C70.9	I61.2	I67.5	Q03.9	S18
C71.0	I61.3	I67.6	Q04.0	
C71.1	I61.4	I67.7	Q04.1	
C71.2	I61.5	I67.80	Q04.2	
C71.3	I61.6	I67.88	Q04.3	
C71.4	I61.7	I67.9	Q04.4	
C71.5	I61.8	O22.5	Q04.5	
C71.6	I61.9	P10.0	Q04.6	
C71.7	I62.00	P10.1	Q04.8	
C71.8	I62.01	P10.2	Q04.9	
C71.9	I62.02	P10.3	S06.1	
D32.0	I62.09	P10.4	S06.20	
D32.9	I62.1	P10.8	S06.21	
D33.0	I62.9	P10.9	S06.22	
D33.1	I63.0	P11.0	S06.23	
D33.2	I63.1	P11.1	S06.28	
D33.3	I63.2	P11.2	S06.30	
G00.0	I63.3	P11.3	S06.31	
G00.1	I63.4	P11.4	S06.32	
G00.2	I63.5	P11.50	S06.33	
G00.3	I63.6	P11.51	S06.34	
G00.8	I63.7	P11.59	S06.38	
G00.9	I63.8	P11.9	S06.4	
G01	I63.9	P52.0	S06.5	
G91.1	I64	P52.1	S06.6	
G91.8	I65.0	P52.2	S06.70	
G91.9	I65.1	P52.3	S06.71	
G93.1	I65.2	P52.4	S06.72	
G93.5	I65.3	P52.5	S06.73	
G93.6	I65.8	P52.6	S06.79	
G94.0	I65.9	P52.8	S06.8	
G94.1	I66.0	P52.9	S06.9	
I60.0	I66.1	Q00.0	S07.1	
I60.1	I66.2	Q00.1	S07.8	
I60.2	I66.3	Q00.2	S07.9	
I60.3	I66.4	Q01.0	S09.7	
I60.4	I66.8	Q01.1	S15.00	
I60.5	I66.9	Q01.2	S15.01	
I60.6	I67.0	Q01.8	S15.02	
I60.7	I67.10	Q01.9	S15.03	
I60.8	I67.11	Q02	S15.1	
I60.9	I67.2	Q03.0	S15.2	
I61.0	I67.3	Q03.1	S15.3	

eTABLE 3b

ICD codes: exclusion of cases with a coded contraindication to organ transplantation (Step 3 of the analysis)

A15.0	B17.1	C09.9	C17.8	C31.0
A15.1	B17.2	C10.0	C17.9	C31.1
A15.2	B17.8	C10.1	C18.0	C31.2
A15.3	B19.0	C10.2	C18.1	C31.3
A15.4	B19.9	C10.3	C18.2	C31.8
A15.5	B20	C10.4	C18.3	C31.9
A15.6	B21	C10.8	C18.4	C32.0
A15.7	B22	C10.9	C18.5	C32.1
A15.8	B23.0	C11.0	C18.6	C32.2
A15.9	B23.8	C11.1	C18.7	C32.3
A16.0	B24	C11.2	C18.8	C32.8
A16.1	C01	C11.3	C18.9	C32.9
A16.2	C02.0	C11.8	C19	C33
A16.3	C02.1	C11.9	C20	C34.0
A16.4	C02.2	C12	C21.0	C34.1
A16.5	C02.3	C13.0	C21.1	C34.2
A16.7	C02.4	C13.1	C21.2	C34.3
A16.8	C02.8	C13.2	C21.8	C34.8
A16.9	C02.9	C13.8	C22.0	C34.9
A17.0	C03.0	C13.9	C22.1	C37
A17.1	C03.1	C14.0	C22.2	C38.0
A17.8	C03.9	C14.2	C22.3	C38.1
A17.9	C04.0	C14.8	C22.4	C38.2
A18.0	C04.1	C15.0	C22.7	C38.3
A18.1	C04.8	C15.1	C22.9	C38.4
A18.2	C04.9	C15.2	C23	C38.8
A18.3	C05.0	C15.3	C24.0	C39.0
A18.4	C05.1	C15.4	C24.1	C39.8
A18.5	C05.2	C15.5	C24.8	C39.9
A18.6	C05.8	C15.8	C24.9	C40.0
A18.7	C05.9	C15.9	C25.0	C40.1
A18.8	C06.0	C16.0	C25.1	C40.2
A19.0	C06.1	C16.1	C25.2	C40.3
A19.1	C06.2	C16.2	C25.3	C40.8
A19.2	C06.8	C16.3	C25.4	C40.9
A19.8	C06.9	C16.4	C25.7	C41.01
A19.9	C07	C16.5	C25.8	C41.02
B15.0	C08.0	C16.6	C25.9	C41.1
B15.9	C08.1	C16.8	C26.0	C41.2
B16.0	C08.8	C16.9	C26.1	C41.30
B16.1	C08.9	C17.0	C26.8	C41.31
B16.2	C09.0	C17.1	C26.9	C41.32
B16.9	C09.1	C17.2	C30.0	C41.4
B17.0	C09.8	C17.3	C30.1	C41.8

C43.1	C49.0	C58	C79.1	C88.00
C43.2	C49.1	C60.0	C79.2	C88.01
C43.3	C49.2	C60.1	C79.3	C88.10
C43.4	C49.3	C60.2	C79.4	C88.11
C43.5	C49.4	C60.8	C79.5	C88.20
C43.6	C49.5	C60.9	C79.6	C88.21
C43.7	C49.6	C73	C79.7	C88.30
C43.8	C49.8	C74.0	C79.81	C88.31
C43.9	C49.9	C74.1	C79.82	C88.70
C44.0	C50.0	C74.9	C79.83	C88.71
C44.1	C50.1	C75.0	C79.84	C88.90
C44.2	C50.2	C75.1	C79.88	C88.91
C44.3	C50.3	C75.2	C80	C90.00
C44.4	C50.4	C75.3	C81.0	C90.01
C44.5	C50.5	C75.4	C81.1	C90.10
C44.6	C50.6	C75.5	C81.2	C90.11
C44.7	C50.8	C75.8	C81.3	C90.20
C44.8	C50.9	C75.9	C81.7	C90.21
C44.9	C51.0	C76.0	C81.9	C91.00
C45.0	C51.1	C76.1	C82.0	C91.01
C45.1	C51.2	C76.2	C82.1	C91.10
C45.2	C51.8	C76.3	C82.2	C91.11
C45.7	C51.9	C76.4	C82.7	C91.20
C45.9	C52	C76.5	C82.9	C91.21
C46.0	C53.0	C76.7	C83.0	C91.30
C46.1	C53.1	C76.8	C83.1	C91.31
C46.2	C53.8	C77.0	C83.2	C91.40
C46.3	C53.9	C77.1	C83.3	C91.41
C46.7	C54.0	C77.2	C83.4	C91.50
C46.8	C54.1	C77.3	C83.5	C91.51
C46.9	C54.2	C77.4	C83.6	C91.70
C47.0	C54.3	C77.5	C83.7	C91.71
C47.1	C54.8	C77.8	C83.8	C91.90
C47.2	C54.9	C77.9	C83.9	C91.91
C47.3	C55	C78.0	C84.0	C92.00
C47.4	C56	C78.1	C84.1	C92.01
C47.5	C57.0	C78.2	C84.2	C92.10
C47.6	C57.1	C78.3	C84.3	C92.11
C47.8	C57.2	C78.4	C84.4	C92.20
C47.9	C57.3	C78.5	C84.5	C92.21
C48.0	C57.4	C78.6	C85.0	C92.30
C48.1	C57.7	C78.7	C85.1	C92.31
C92.40	C96.1	Z.21		
C92.41	C96.2			
C92.50	C96.3			
C92.51	C96.7			
C92.70	C96.9			

C92.71	C97			
C92.90	F02.4			
C92.91	J65			
C93.00	K23.0			
C93.01	K93.0			
C93.10	M49.00			
C93.11	M49.01			
C93.20	M49.02			
C93.21	M49.03			
C93.70	M49.04			
C93.71	M49.05			
C93.90	M49.06			
C93.91	M49.07			
C94.00	M49.08			
C94.01	M49.09			
C94.10	M90.00			
C94.11	M90.01			
C94.20	M90.02			
C94.21	M90.03			
C94.30	M90.04			
C94.31	M90.05			
C94.40	M90.06			
C94.41	M90.07			
C94.50	M90.08			
C94.51	M90.09			
C94.70	O98.0			
C94.71	O98.4			
C95.00	P35.3			
C95.01	P37.0			
C95.10	R75			
C95.11	U60.1			
C95.20	U60.2			
C95.21	U60.3			
C95.70	U60.9			
C95.71	U61.1			
C95.8	U61.2			
C95.90	U61.3			
C95.91	U61.9			
C96.0	Z20.6			