EU Joint Action: Achieving Comprehensive Coordination in ORgan Donation throughout the European Union

Work Package 5 - Increasing the collaboration between donor transplant coordinators and intensive care professionals

FINAL REPORT
Part One:

Deliverable 7: Variations in end-of-life care pathways for patients with a devastating brain injury in Europe

April 2015

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Additional Information on MS responses to the Country Questionnaire and additional Comments from the Clinical Reference Group are available in the Interim Report, March 2014

Deliverable 7: Variations in end-of-life care pathways for patients with a devastating brain injury in Europe.

1. Materials and Methods

1.1 Study design

The study was designed by project leads, designated by the participating institutions and by the clinical reference group.

A transnational, multi-centre, observational study was undertaken, with a dedicated data collection on patients dying as a result of a devastating brain injury in participating hospitals across Europe. Data collection was focused on patients dying as a result of the brain injury from March 1st 2013 to August 31st 2013.

Data for the patient questionnaires were entered electronically via a secure on-line database on the ACCORD central website. The data from each hospital were only accessible to those who had entered the data and to the central ACCORD team, who undertook the analyses.

Participating hospitals were required to identify and collect data on a maximum of 50 consecutive patients who died within a six month study period of pathologies known to be common causes of brain death (and by implication, common causes of death in potential organ donors). These pathologies were defined by their ICD 9 or ICD 10 codes among their primary or secondary diagnoses.

The data collected contained no patient identifiable information. It was the responsibility of each participating member state to seek ethical approval for the study as appropriate. Quality Assurance of the data was the responsibility of the Project Leads and Clinical Reference Group members in each MS. The analyses presented below are of the data as entered into the ACCORD central on-line database.

1.2 Inclusion Criteria

Participating hospitals were designated by the participating institutions. Hospitals participated on a voluntary basis.

Hospital Criteria:

- Interest and commitment from the hospital to participate in data collection, complete the study and instigate changes in practice in line with the aims of the ACCORD project.
- Ability to appoint a credible clinical project leader who could commit the necessary time, resources and lead change.
- Ability to manage the care of critically ill ventilated patients and with experience of the deceased donation process.
- At least 20 deaths a year of patients with a severe brain injury, during the last five years.

A deliberate decision was taken to choose a variety of hospitals, for instance large centres with regional neurosurgical or paediatric facilities as well as those without such specialist services.

Patient Criteria

The criteria for inclusion into or exclusion from the study are listed below:

- Aged between 1 month and 80 years.
- Male and female patients.
- Patients with a devastating brain injury defined as those who have one or more of a set of ICD-9 or ICD-10 codes among their primary or secondary diagnoses at death, representing the main causes of brain death.
- Patients who were confirmed dead on arrival at the first medical institution they arrived at were excluded from the study.

A list of the ICD-9/10 codes used is shown in **Appendix 1**

1.3 Questionnaires

Three Questionnaires were used:

Country Questionnaire

Information was collected on 11 national indicators for each country - i.e. indicators that could be relevant to a well-established deceased donation programme. The indicators were whether a participating Member State had:

- a legal definition for brain death;
- a legal definition for cardio-respiratory (circulatory) death;
- professional guidance/standards/codes of practice for the diagnosis of brain death;
- professional guidance/standards/codes of practice that support clinicians who are treating potential organ donors;
- national independent ethical codes of practice or guidance that support organ donation;
- relevant guidance on the withdrawal or limitation of life sustaining treatment in critically ill patients;
- national criteria to alert the Donor Transplant Coordinator to a potential organ donor;
- guidance or best practice documents for the process of obtaining consent for organ donation from families;
- formal training provided for healthcare professionals in the organ donation process;
- a national organisation responsible for organ donation;
- a regulatory body that has oversight of organ donation;

The Country Questionnaire is attached at **Appendix 2**

Hospital Questionnaire

The hospital questionnaire probed the following aspects of the services that were provided:

- Number of staffed beds in the hospital where it is possible to mechanically ventilate a critically ill patient.
- Are neurosurgical facilities on site?
- Are interventional neuro-radiology facilities on site?

- Does the hospital perform solid organ transplants?
- Is the hospital a designated trauma centre?
- Number of actual organ donors in the hospital in 2011
- What is the availability of the Key Donation within the hospital?
- What is the clinical background of the hospital's Key Donation Person or the Team Leader?
- Does the hospital have a written local policy/guideline/protocol for
- managing the organ donation process?
- Does the hospital have written criteria of when to alert the key donation person of a potential organ donor?
- Does the hospital have the following facilities necessary to support the diagnosis of death and organ donation available 24 hours a day?
- CT Scanner
- MRI Scanner
- HLA and virology testing
- Trans-Cranial Doppler
- EEG
- Cerebral angiography.

The Hospital Questionnaire is included at **Appendix 3**

Patient Questionnaire

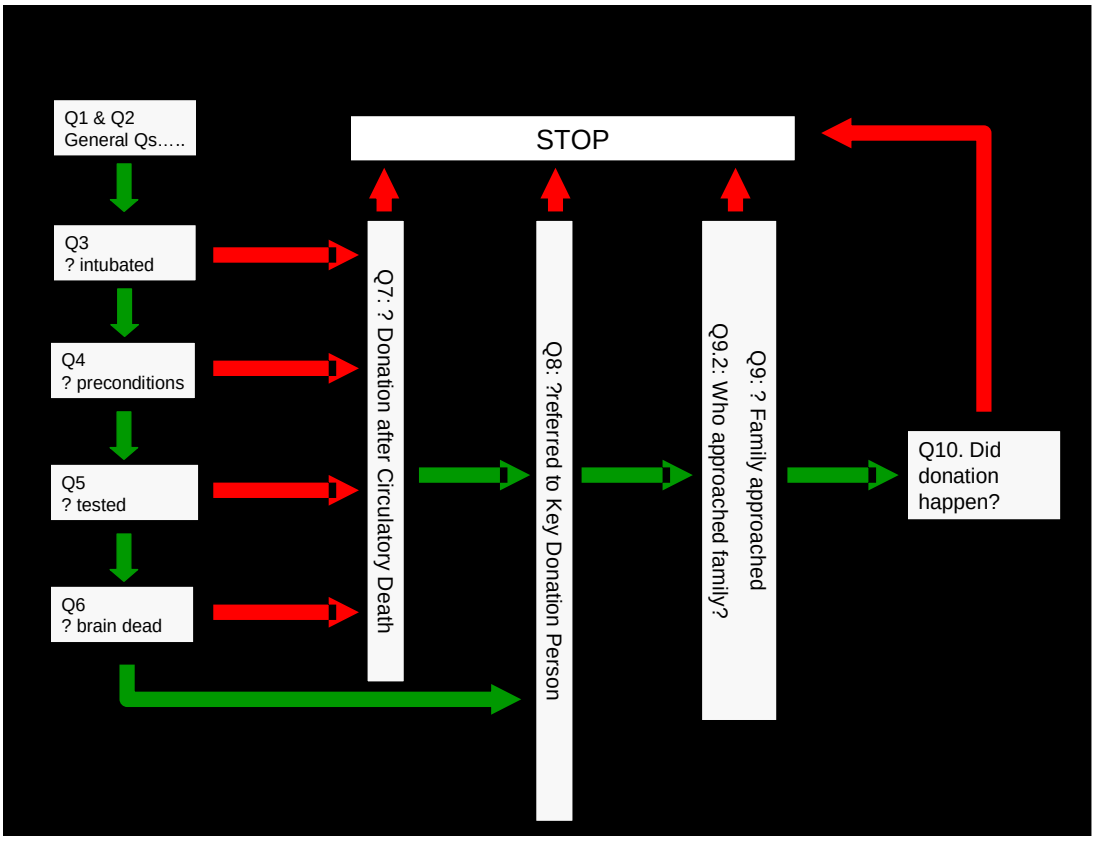
The patient questionnaire was constructed with reference to a pathway that maintains the potential for organ donation and is shown schematically in **Figure 1**. It captures the key decision making aspects during the treatment and management of patients dying from brain injury that either remove the possibility of organ donation or preserve that option.

In order to be an organ donor a patient:

- Must be intubated and ventilated.
- Must be haemodynamically stable.
- Must be recognised as potentially brain dead.
- Must be tested for brain death.
- Must be confirmed dead by neurological criteria.
- If brain death is not a possibility then DCD donation should be considered if appropriate.
- Must be referred to a Key Donation Person.

- The family must be approached and informed of the possibility for organ donation.

Figure 1



The Patient Questionnaire is attached as **Appendix 4.**

2. Results

These results have previously been published in an Interim Report (March 2014)

2.1 Country Questionnaire

Figure 2 shows numbers of actual donors per million population (pmp) in 2011 against the number of positive national indicators for each country as reported in the country questionnaire.

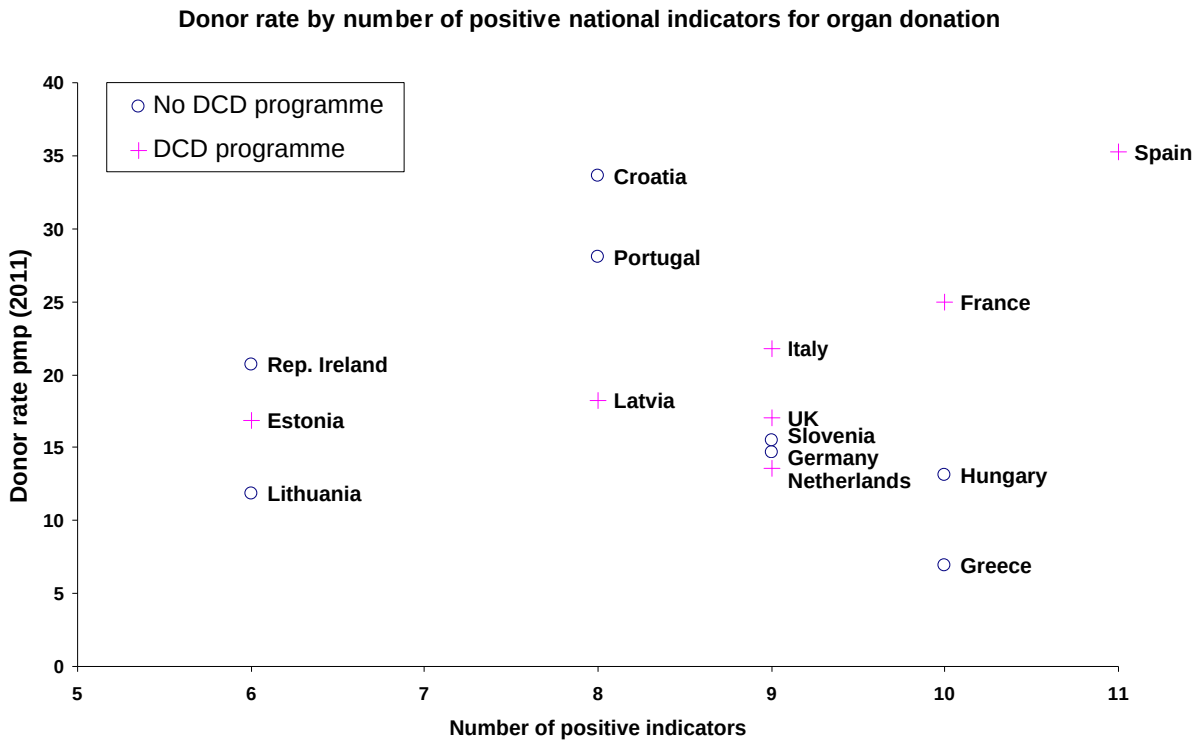


Figure 2: Donor rate by number of positive national indicators for organ donation in countries participating in ACCORD.

Commentary: There is poor statistical correlation between the number of "positive" indicators and the deceased donor rate across all MS (assessed using Spearman's Rank correlation coefficient, r=0.2). There is some correlation for those with a DCD programme when considered in isolation (r=0.71), but not for those without a DCD programme (r=-0.40). No individual positive indicator correlated significantly with the deceased donor rate. This is an important observation, as it suggests that these legislative, administrative and logistical issues, whilst important in the overall donation systems and structures, do not alone lead to a high donation rate and that the initial hypothesis – that clinical decision making influences the number of donors – may be valid.

2.2 Hospital Questionnaire

From the participating countries, 67 participating hospitals were recruited. All countries were committed to recruiting a minimum of 2 hospitals, but 5 countries (see **Table 1**) recruited additional hospitals. It is clear that this limited number of hospitals may not reflect clinical decision making in all hospitals in the MS. The outcomes presented must therefore be interpreted with this caveat.

The data from relevant questions in the hospital questionnaires are presented below. They are descriptive only, in order to demonstrate the number of hospitals, and their resources, from which patient-level data were collected. As there was an expectation that each MS would select a range of hospitals these data should not be seen as representing variations between MS. They are presented only for information.

Table 1: Number of audited hospitals by country

Country	Number of audited hospitals
Croatia	**2**
Estonia	**2**
France	**2**
Germany	**2**
Greece	**2**
Hungary	**2**
Ireland	**2**
Italy	**4**
Latvia	**2**
Lithuania	**2**
Portugal	**3**
Slovenia	**2**
Spain	**17**
The Netherlands	**4**

UK	**19**
Total	**67**

Figure 3 shows the distribution of the participating hospitals according to the number of staffed beds where critically ill patients can be mechanically ventilated, distinguishing between paediatric and adult.

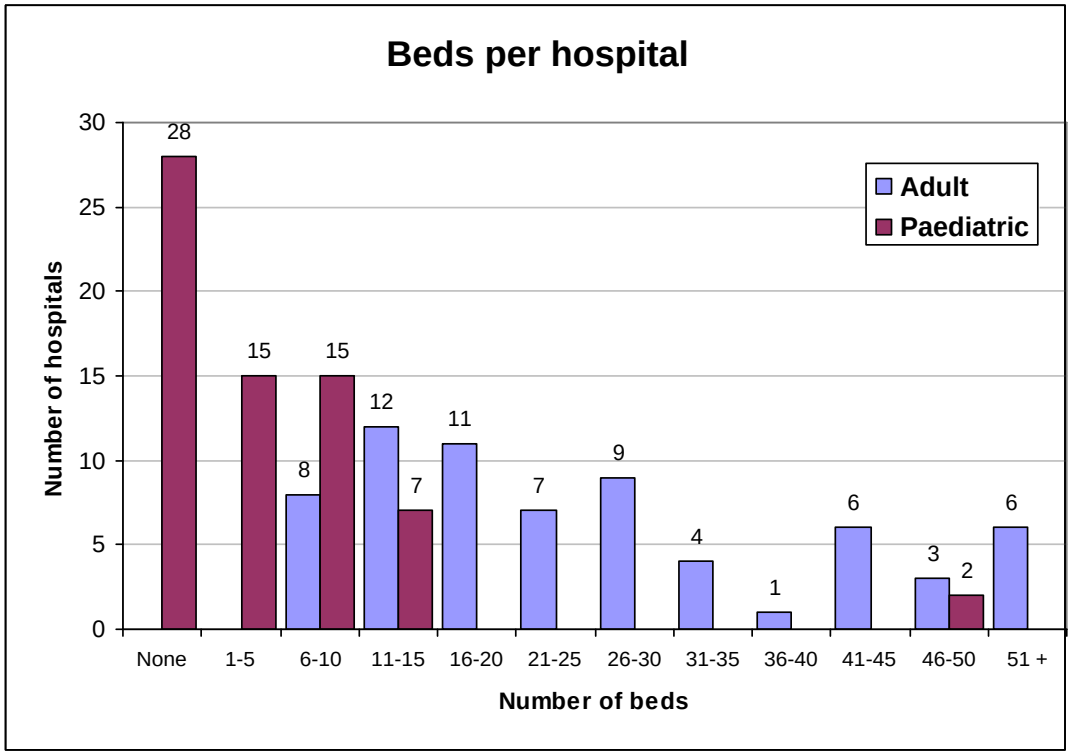


Figure 3: Number of staffed beds with mechanical ventilation capacity per participating hospital.

The figure makes evident the variation in the number of beds across the hospitals. For adult beds, this number ranges from 6 to 97 beds, with a median of 22 beds. For hospitals with at least one paediatric bed, number of paediatric beds ranges from 1 to 50 beds, with a median of 6 beds.

Forty five (67%) of the hospitals had neurosurgical facilities on site, compared to 22 (33%) without neurosurgery. The same distribution of hospitals was noted with regards to the availability of interventional neuro-radiology on site. Forty three hospitals (37%) were designated trauma centres and 25 (37%) were hospitals where solid organ transplants were performed.

With regards to the Key Donation Person at participating hospitals, 35 (52%) had a key donation person available full time for the activity of donor coordination, compared to 15 (22%) where the key person was part-time dedicated to the activity, 15 (22%) where the key person was available on request and 2 (3%) with no available key donation person. The key donation person, where available, (or the lead of the coordination team, where applicable) was a physician in 41 (61%) hospitals, a nurse in 24 (36%) and had a different professional background in 1 (1%).

There were 61 (91%) hospitals with written local policies/guidelines/protocols for managing the deceased donation process, with 53 (79%) having written criteria for referring possible/potential donors to the key donation person. Such criteria were therefore missing in 14 (21%) hospitals.

The availability of specific resources on a 24 hour basis for facilitating organ donation was also assessed. CT scan was available in all participating hospitals, MRI in 41 (61%), trans-cranial doppler in 34 (51%), EEG in 38 (57%), cerebral angiography in 38 (57%) and HLA and virology testing in 41 (61%),

2.3 Patient Questionnaire

During the period from March 1st to August 31st 2013, 1,670 patients meeting the inclusion criteria were reported to have died as a result of a devastating brain injury in participating hospitals.

Figures 4 and 5 below represent the full cohort of data collected from the patient questionnaires for the DBD and DCD pathways. Step diagrams for each of the participating member states are shown in **Appendix 5**.

In all the Step diagrams relating to DCD pathways the label “DCD possible” implies that Donation after Circulatory Death was possible where Donation after Brain Death was ruled out for clinical or other reasons.

Figure 4

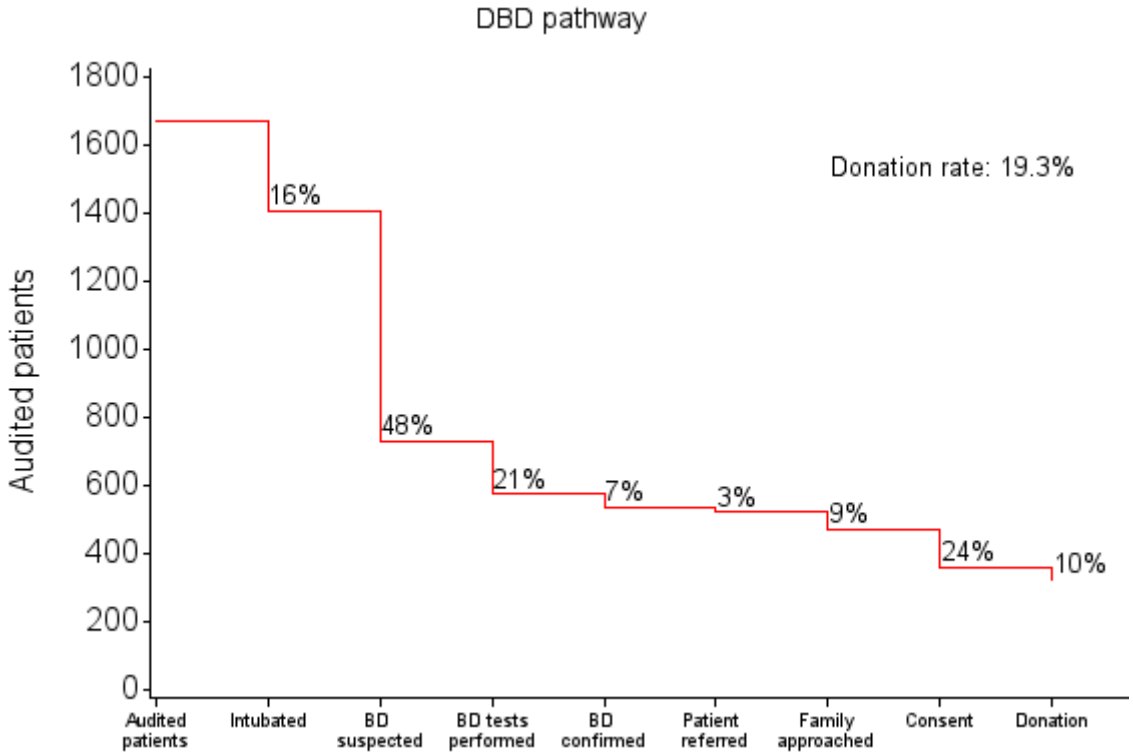
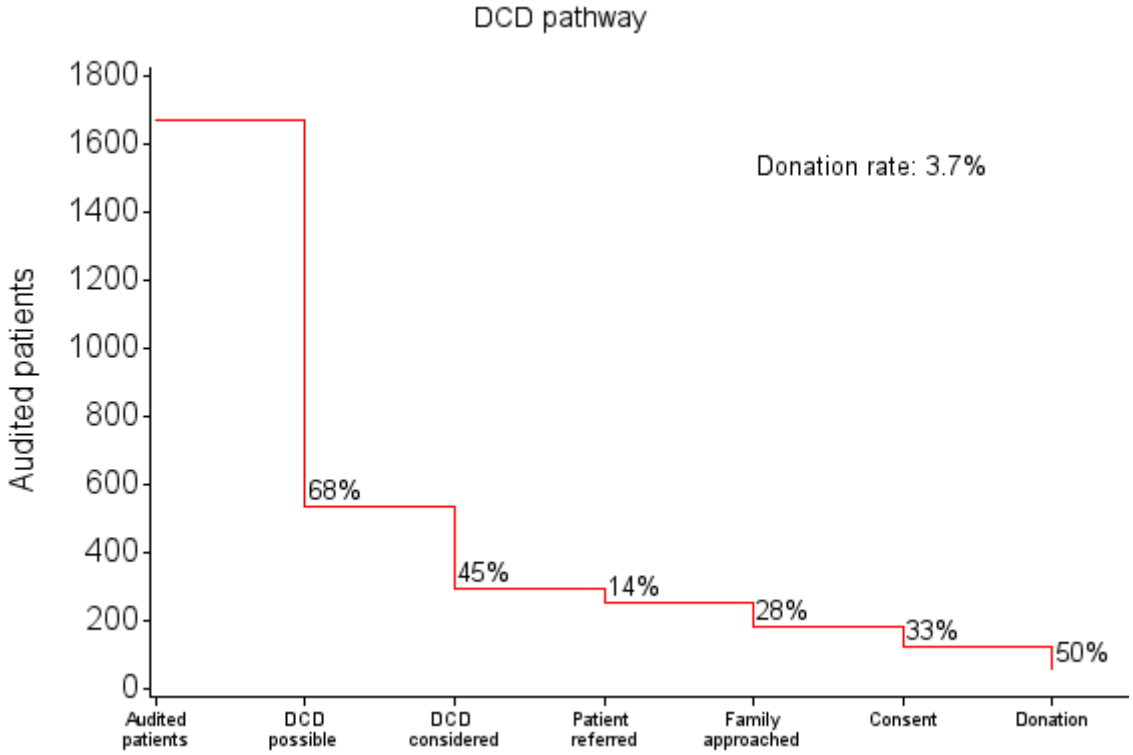


Figure 5



2.3.1 Demographic and clinical data

Figures 6-11 represent, by country, demographic data from the entire patient cohort (1670). With the exception of Figure 11, these data probably reflect variations in hospital structures and the mortality patterns in different MS, rather than variations in clinical decision-making, and are thus unlikely to be amenable to interventions that would increase the number of possible donors.

Figure 6 – Total number of audited patients

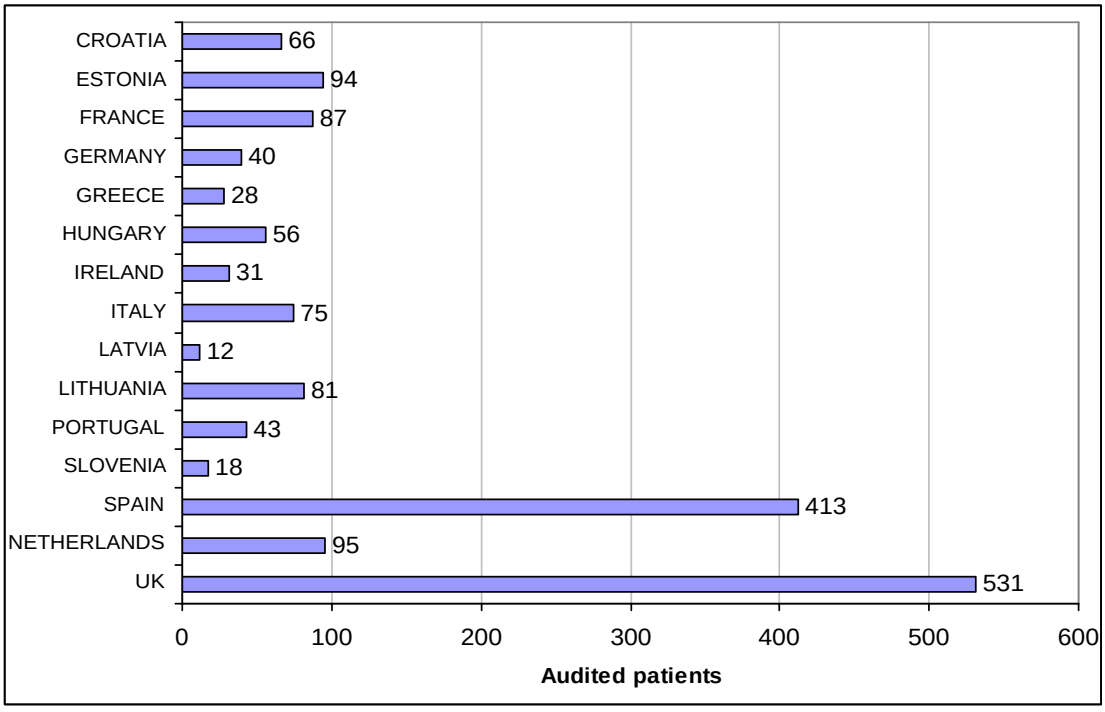
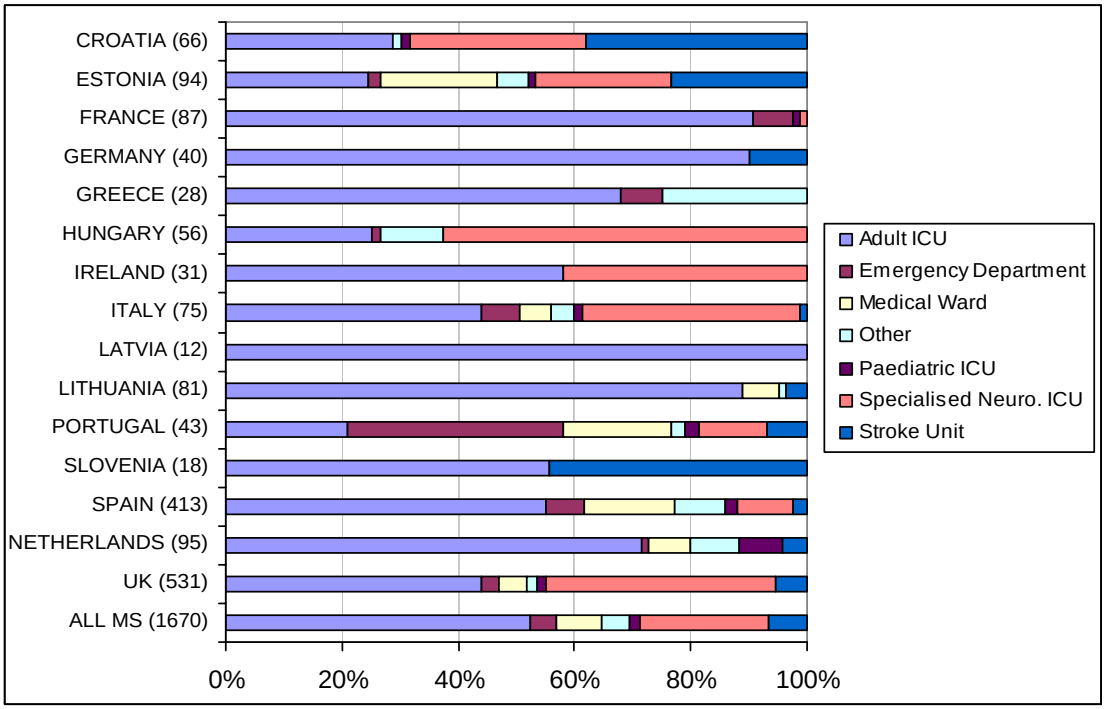
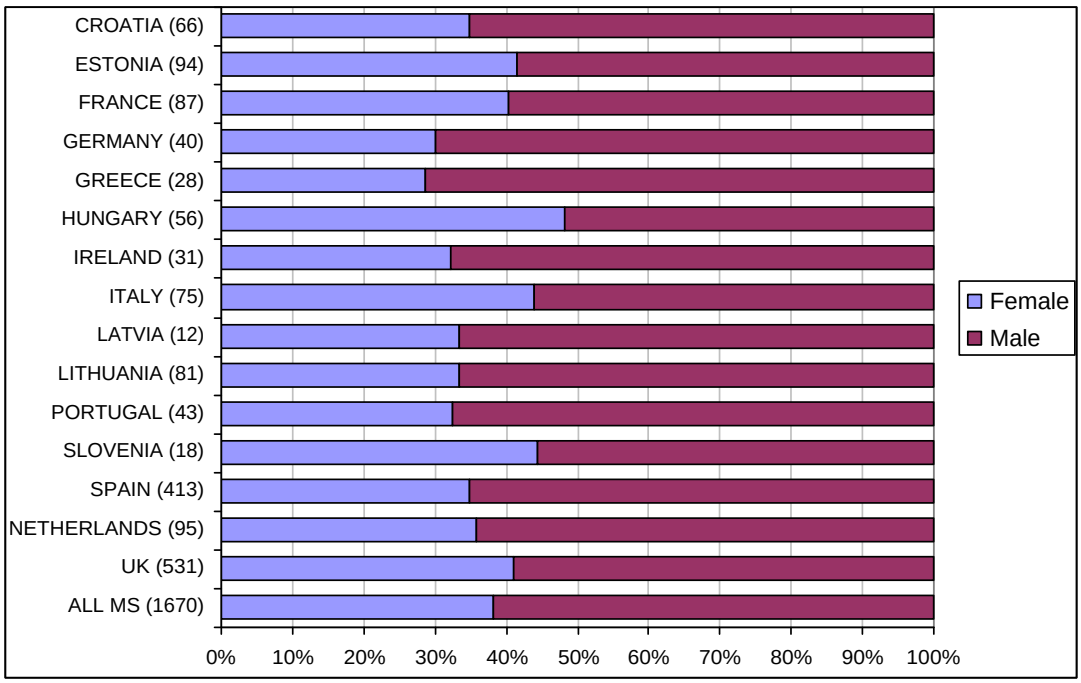


Figure 7 – Clinical area where the patient was confirmed dead



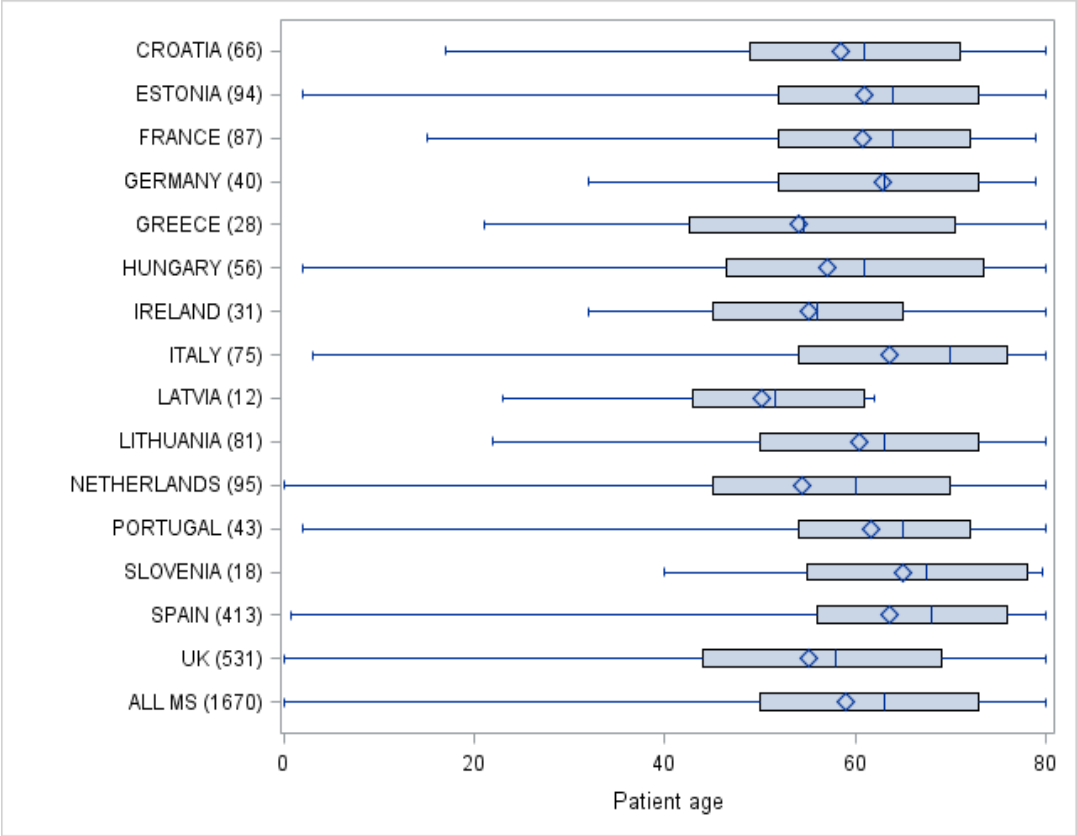
Whilst Figure 7 appears to show marked variation between countries in the part of the hospital in which patients with a devastating brain injury died, this may be the result of the resources available within the hospital. For those MS that collected data from only 2 hospitals and/or from a limited number of patient questionnaires, this analysis should be treated with caution. It is also likely that in some countries/hospitals the audit may have focussed primarily or exclusively in critical care units. This fact is relevant since it may highly influence the percentage of patients dying with no intubation and mechanical ventilation and thus evolving to a brain death condition.

Figure 8 – Gender of patients



62% of audited patients were male, ranging between 52% - 72% for individual member states (Figure 8).

Figure 9 – Age of patients



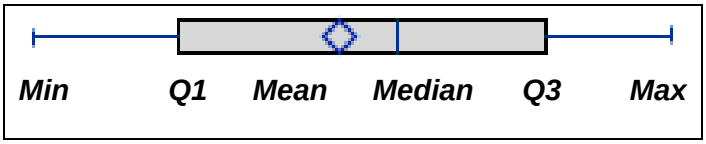
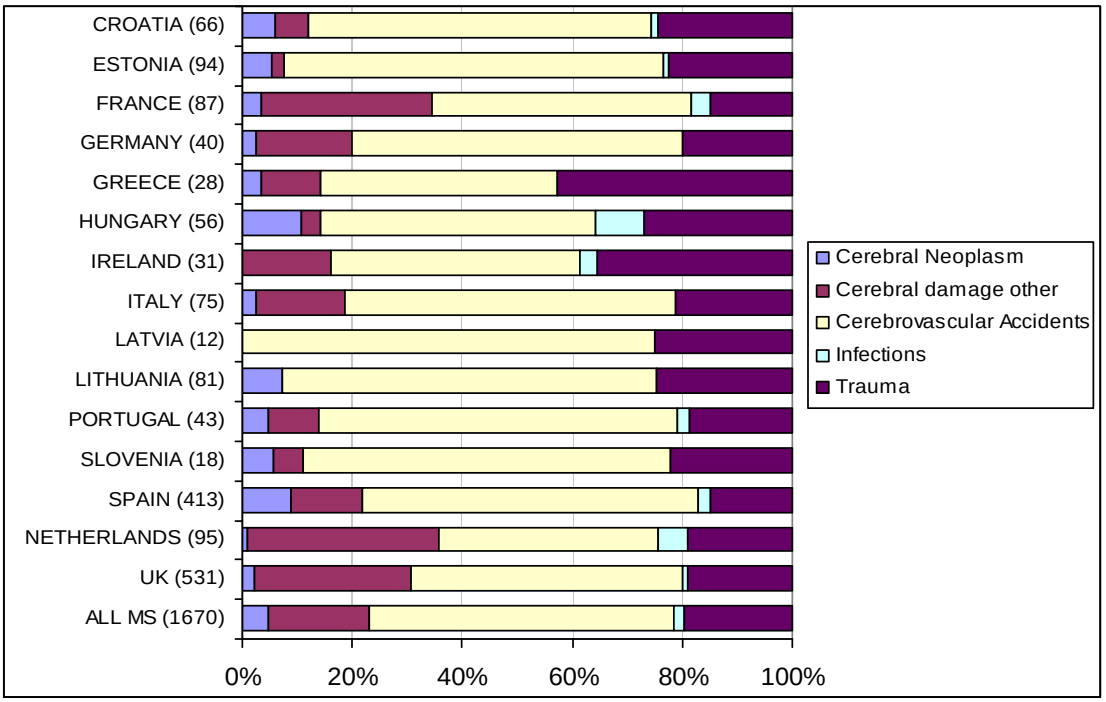


Figure 9 shows age of patients included in the study for the entire cohort and for individual countries. Although these differences are not marked it is of interest that –

- 11 MS audited patients at the upper age limit (80 years), showing that there are many patients at this limit who die in circumstances that may allow donation.
- 7 MS did not audit any paediatric patients (<18), yet the recruited hospitals for these MS had paediatric beds. This may reflect the small number of paediatric patients that die from the identified list of causes of death.

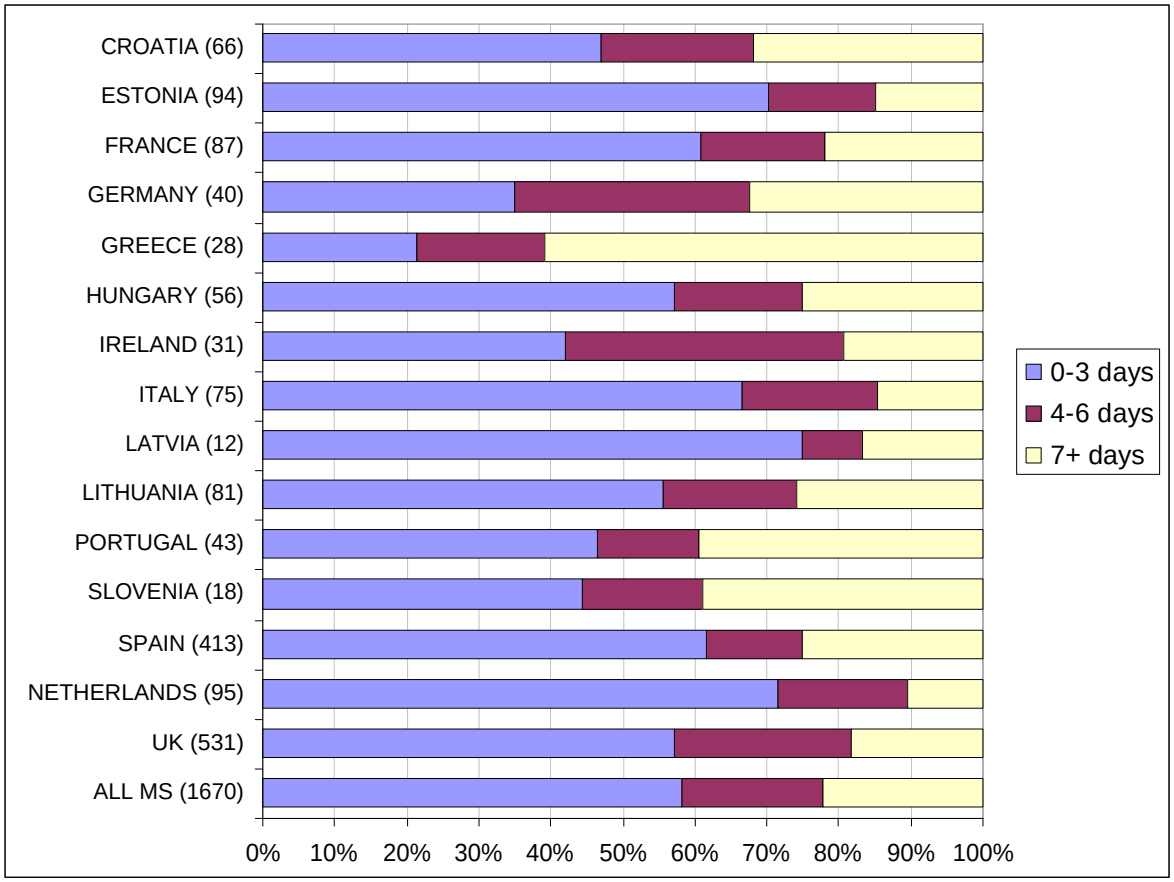
- Median age is 63 years.

Figure 10 – Primary Cause of Death



Perhaps the most interesting observation in Figure 10, where the primary cause of death is shown, is that whilst in most countries deaths from trauma represented approximately 15-20% of all deaths, there are 4 MS where this figure exceeds 25% - Greece, Hungary, Ireland and Latvia. There are also 3 MS with relatively high percentages of death from "other" cerebral damage rather than the more general majority of deaths from cerebrovascular accidents.

Figure 11. Days from Brain Injury to Death



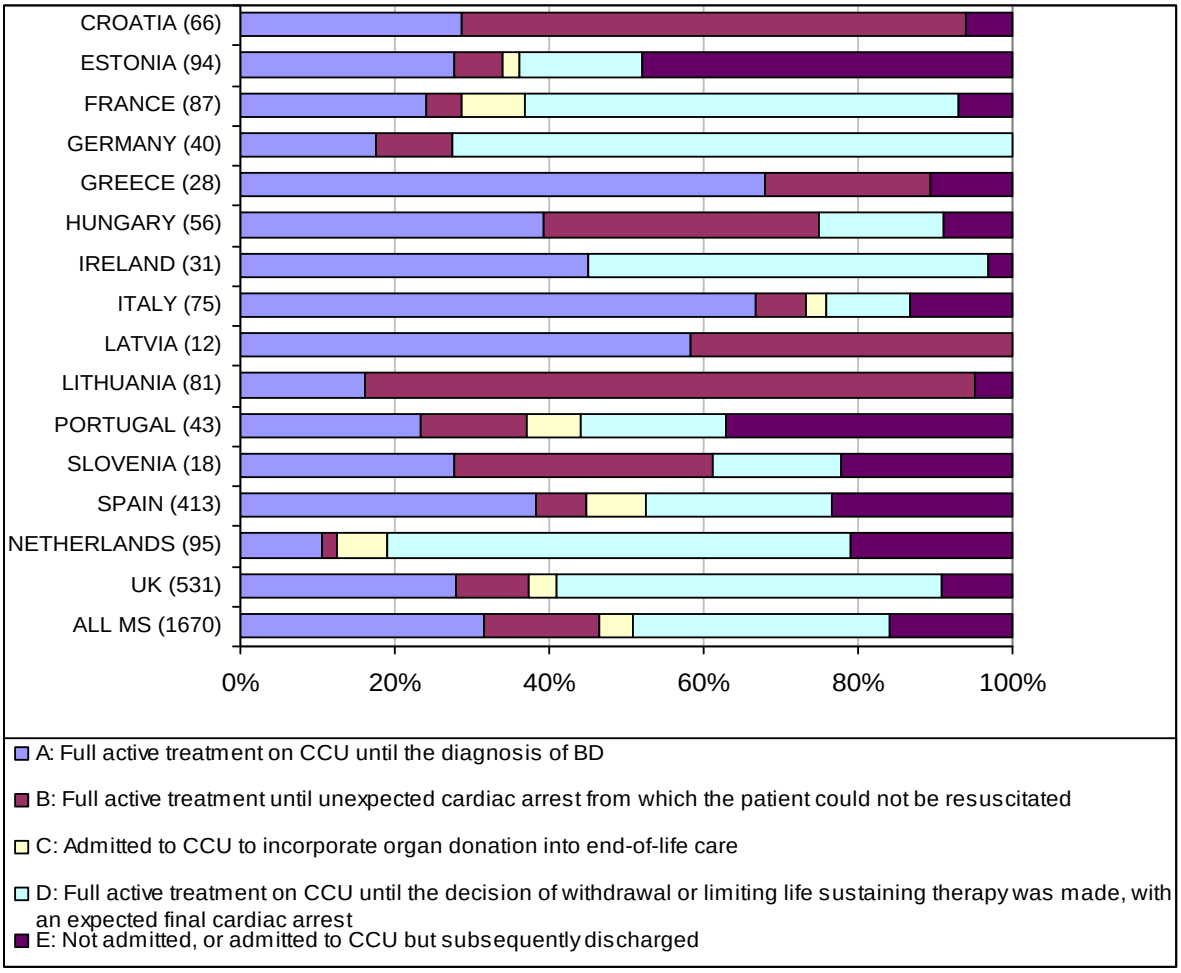
In 3 MS (Estonia, Italy, and The Netherlands) less than 15% of patients died more than 7 days after the brain injury, whereas in Croatia, Germany, Greece, Portugal and Slovenia this figure exceeded 30% (Figure 11). This may be the result of a number of other factors shown in Figures 7 and 10 above, and/or clinical practice (e.g. whether Withdrawal/Limitation of Life Sustaining Treatment is common practice) as shown in Figure 12 below.

2.3.2 Patient Pathway data

Figures 12-21 represent, by country, data from the main sections (1-10) of the patient questionnaire. These sections follow the “ideal donation pathway” that would preserve the option of eventual DBD as shown in Figure 1 in para 1.3. It is important to emphasise that deviation from this pathway may very often be justified within relevant frameworks of clinical care, and that what follows is simply a description of current practice presented in a way that highlights the opportunities to increase the option of organ donation. The intention of the data exercise was to identify areas that were amenable to change, within the individual legal and clinical frameworks of each MS. However they do show marked variations at most stages of the pathway, with at least the possibility that changes in practice may be identified that could preserve the option of organ donation for as long as possible for as many patients as possible. It should be noted that every participating hospital has access to their own detailed data, which was available to them in the planning of Part Three (the PDSA cycles)

Section 1

Figure 12: Care of Patient



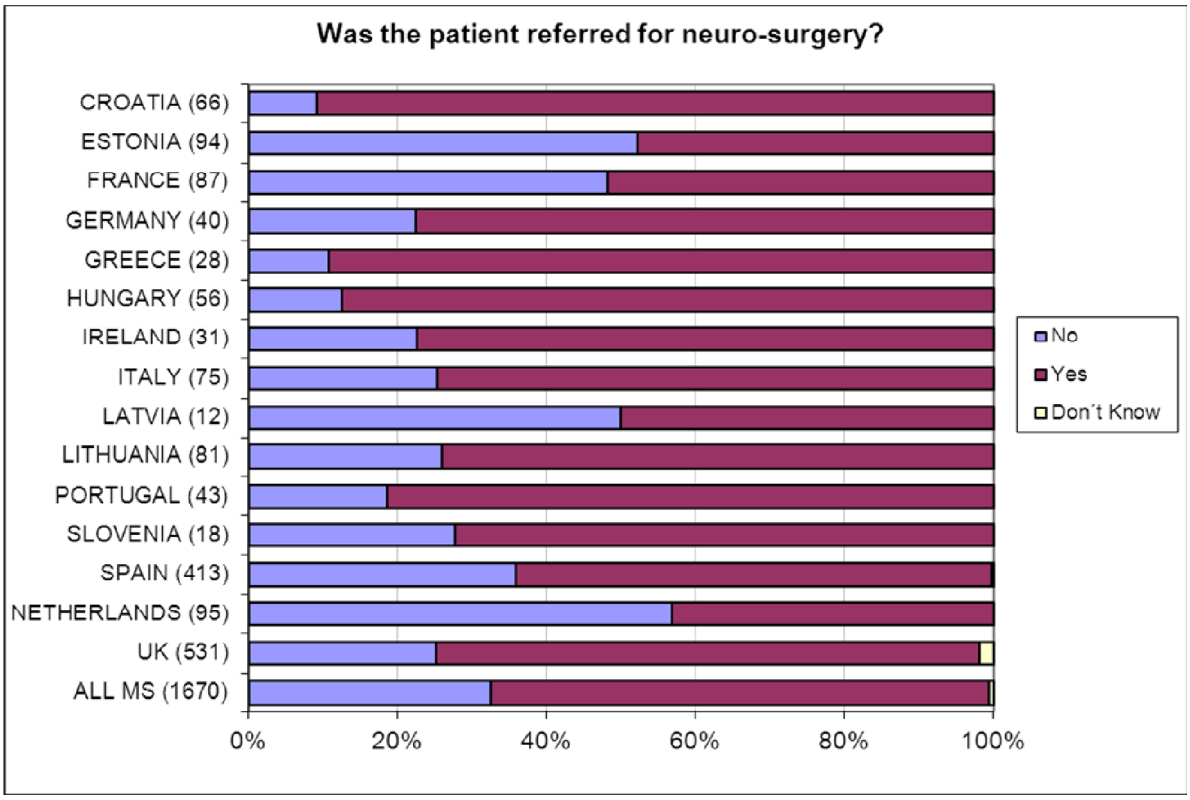
This question was designed to identify the overall care of the patient during his/her final illness, and to provide the most succinct description of the variations between clinical practice in hospitals/countries participating in the study. It shows very marked variation.

The range of patients receiving “full active treatment” until the diagnosis of brain death or unexpected cardiac arrest (A+B) is 13%-100% whilst those in whom treatment was withdrawn or limited (D) range from 0% to 73% (11% to 73% in those with at least one such patient). Clearly if life sustaining treatment is withdrawn or limited, leading to an expected final cardiac arrest, DBD donation is not a possibility. In 7 MS a small percentage of patients were admitted to critical care to incorporate

organ donation in their end-of-life care, but in the remaining 8 MS this practice was not identified at all.

Section 2

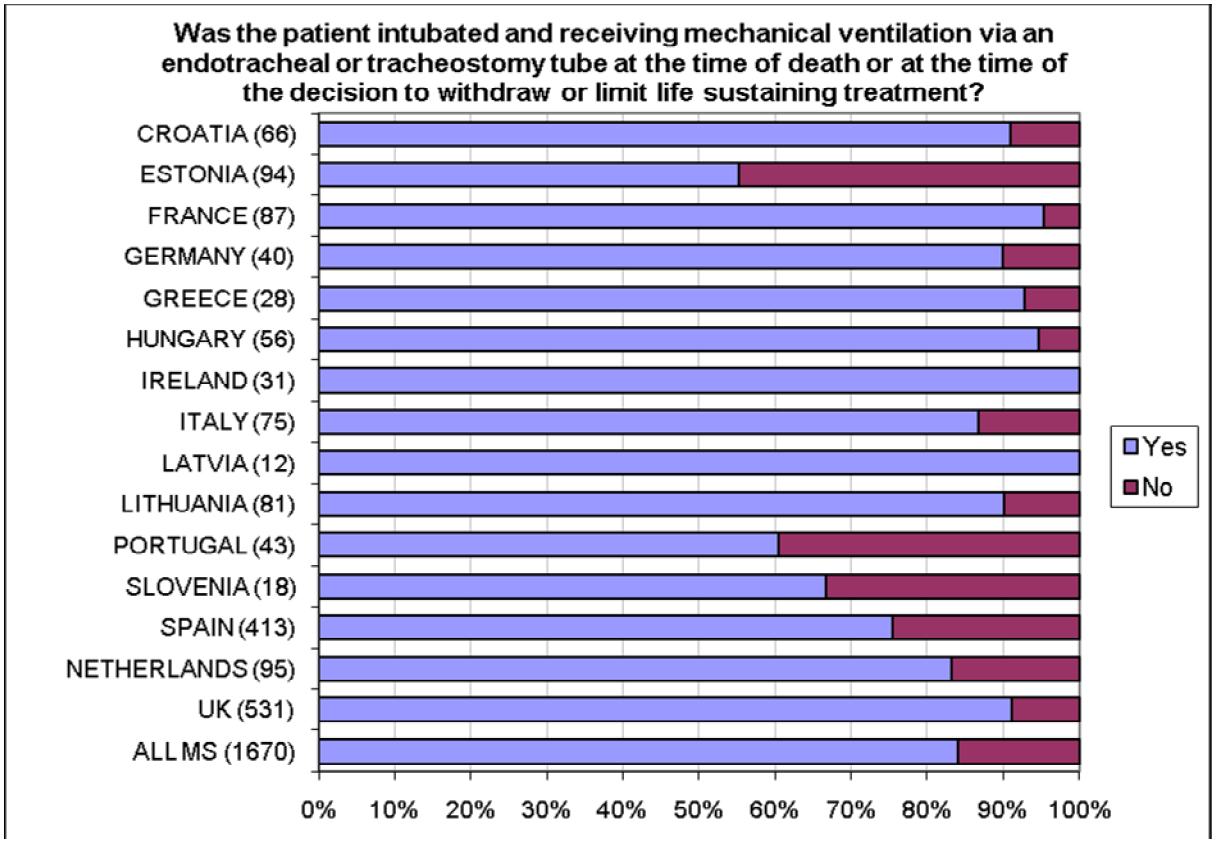
Figure 13: Referral to neurosurgery



The percentage of patients referred for a neurosurgical opinion ranged from under 50% in Estonia to 91% in Croatia

Section 3

Figure 14: a) Intubation and ventilation

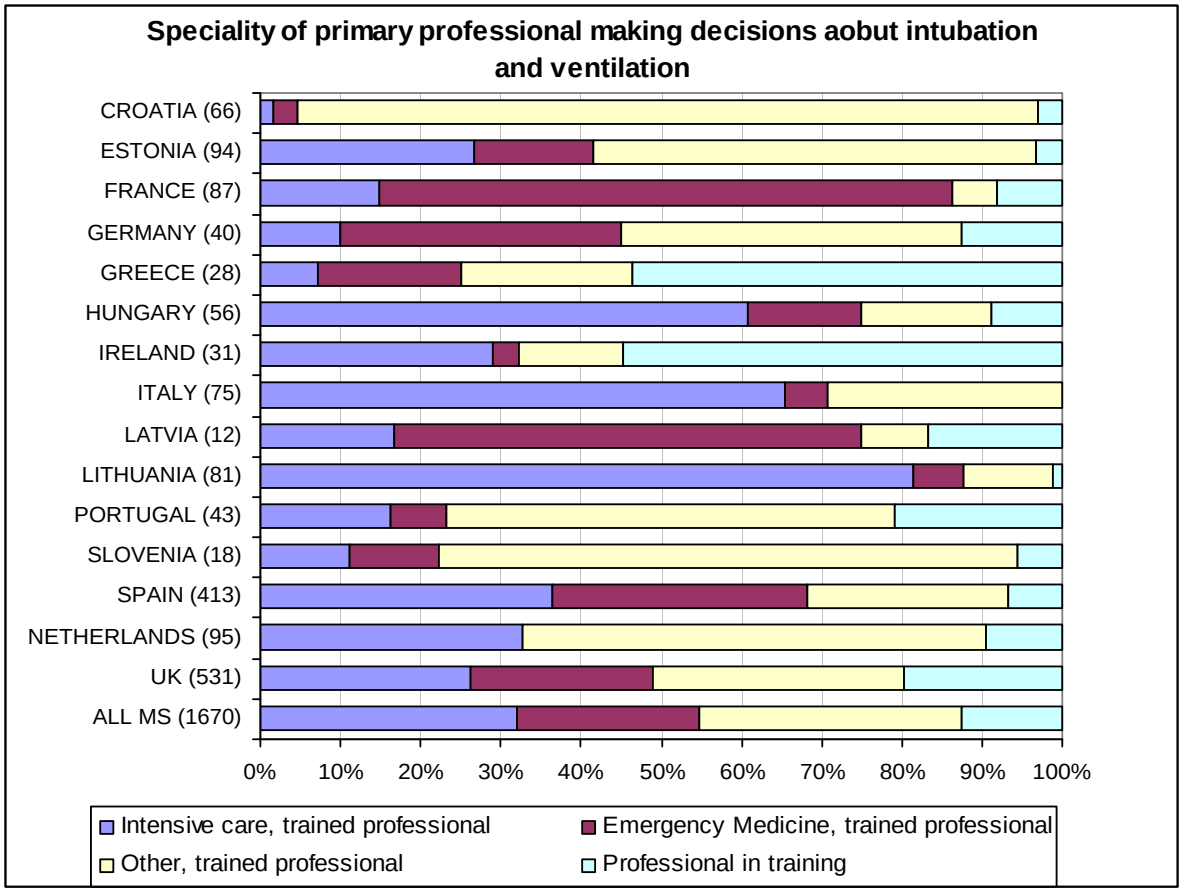


Whilst in most countries over 85% of patients on whom data was submitted were intubated and receiving mechanical ventilation at the time of their death or the decision to withdraw or limit life sustaining treatment, in Estonia, Portugal, Slovenia and Spain the percentage was below 80%. This finding may relate to the audited units at the said hospitals.

The reason given for the patient not being intubated and receiving mechanical ventilation are:

	N	%
Not appropriate	53	21.5
Not needed	34	13.8
Not of overall benefit to the patient due to the severity of the acute event	145	58.9
Other	5	2.0
Not reported	9	3.7

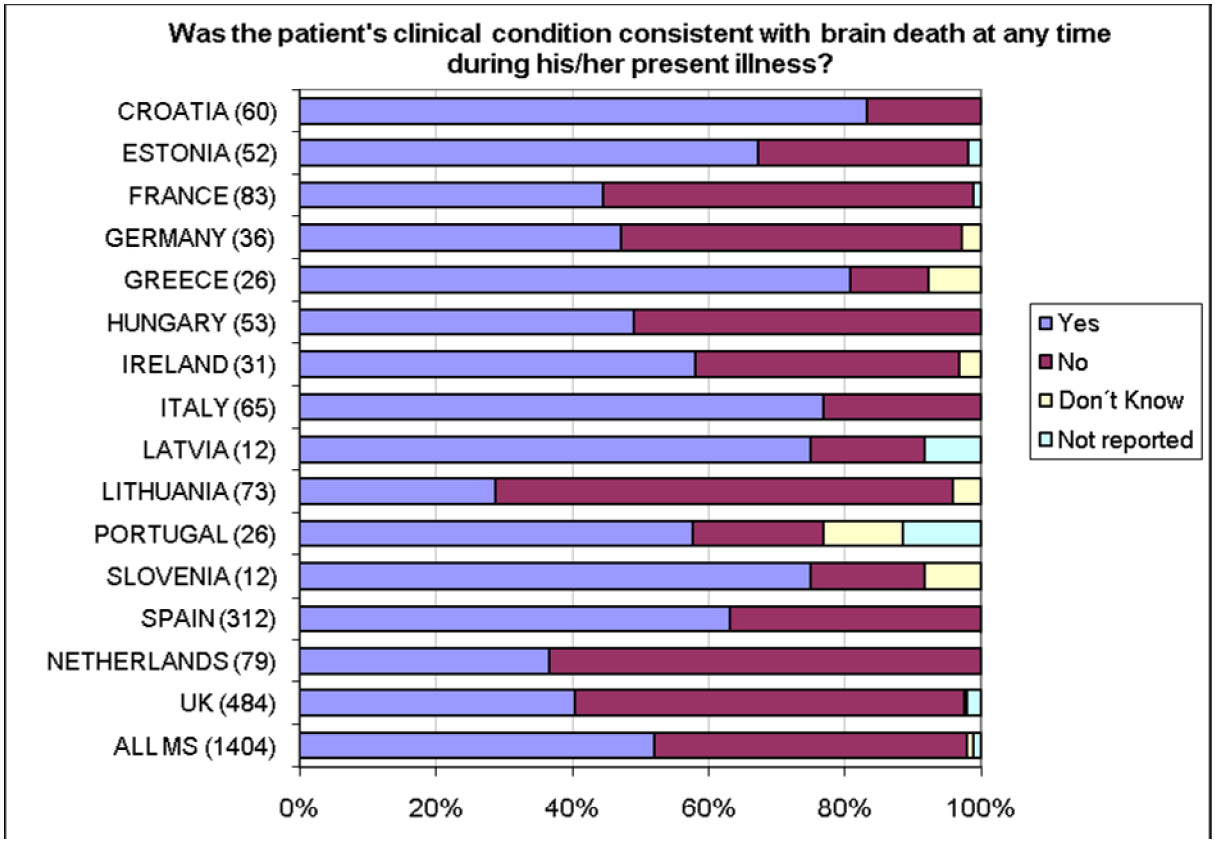
Figure 14 b) Speciality of Decision Makers



There is considerable variation in the specialty of the primary physician making decisions about intubation and ventilation, although in the majority of MS it was either a trained intensive care or emergency medicine professional. In two MS – Greece and Ireland – over 50% of decisions were reported as being made by a professional in training.

Section 4

Figure 15: Brain Death suspected



The percentage of patients whose condition was consistent with brain death prior to their death varied from over 80% in Croatia to 20% in Lithuania.

Section 5

Figure 16: a) Brain Death testing

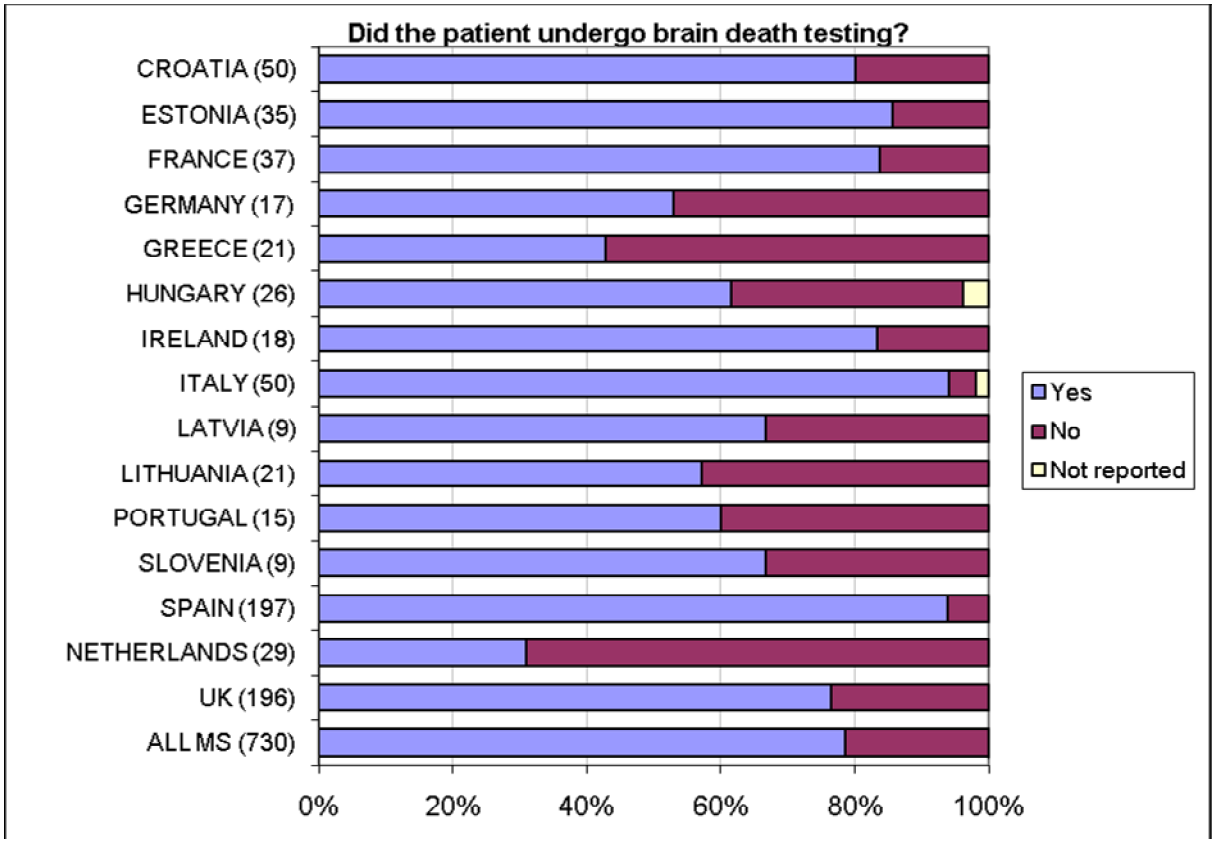
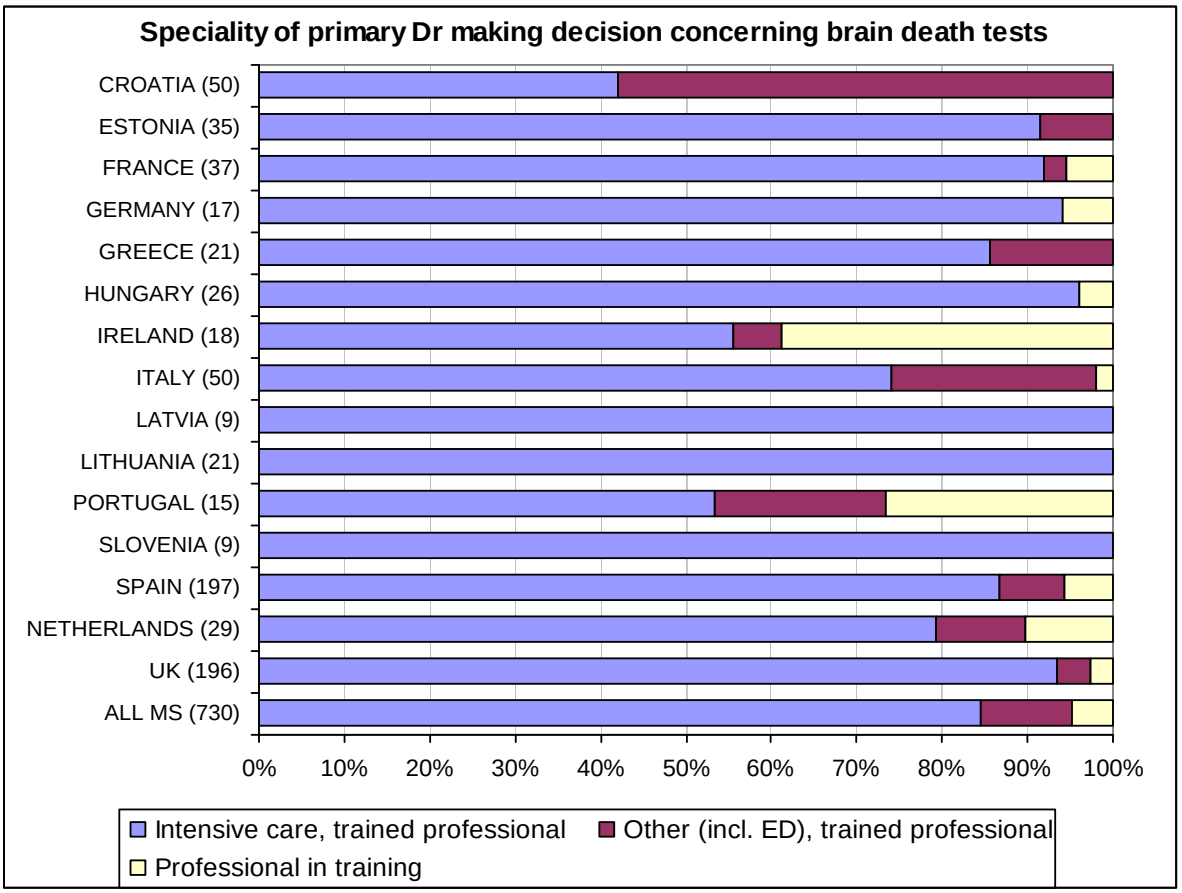


Figure 16 relates only to those patients identified in Section 4 as having a clinical condition consistent with brain death – i.e. it identifies the percentage of patients who could have undergone formal tests of brain death who were in fact tested. In at least one MS (Germany) brain death test are normally only used when there is a potential for organ donation, whereas in others (e.g. UK) they are seen as appropriate even in a patient with no organ donation potential. Whilst this may explain some of the variation it is striking that in Italy and Spain the rate of brain death testing is 94% whilst in Germany, Greece, Lithuania, Portugal and The Netherlands it is less than 60%.

The reasons given for not testing are:

	N	%
Absolute or relative medical contraindication	30	19.9
Cardiac arrest before testing could be performed	25	16.6
Cardiorespiratory instability	34	22.5
Family declined organ donation	17	11.3
Family reasons not to test	5	3.3
Not identified as potentially BD	8	5.3
Reversible causes of coma and / or apnoea could not be satisfactorily excluded	9	6.0
Unable to examine all brain stem reflexes or undertake ancillary tests	4	2.6
Other	19	12.6

Figure 16 b) Speciality of Decision Makers



As in Figure 14 (intubation and ventilation) trained professionals (usually in either intensive care or emergency medicine) made the decision about brain death tests in the majority of MS, although in Ireland and Portugal more than 25% of decisions are reported as having been made by a professional in training.

Section 6

Figure 17: a) Brain Death confirmation

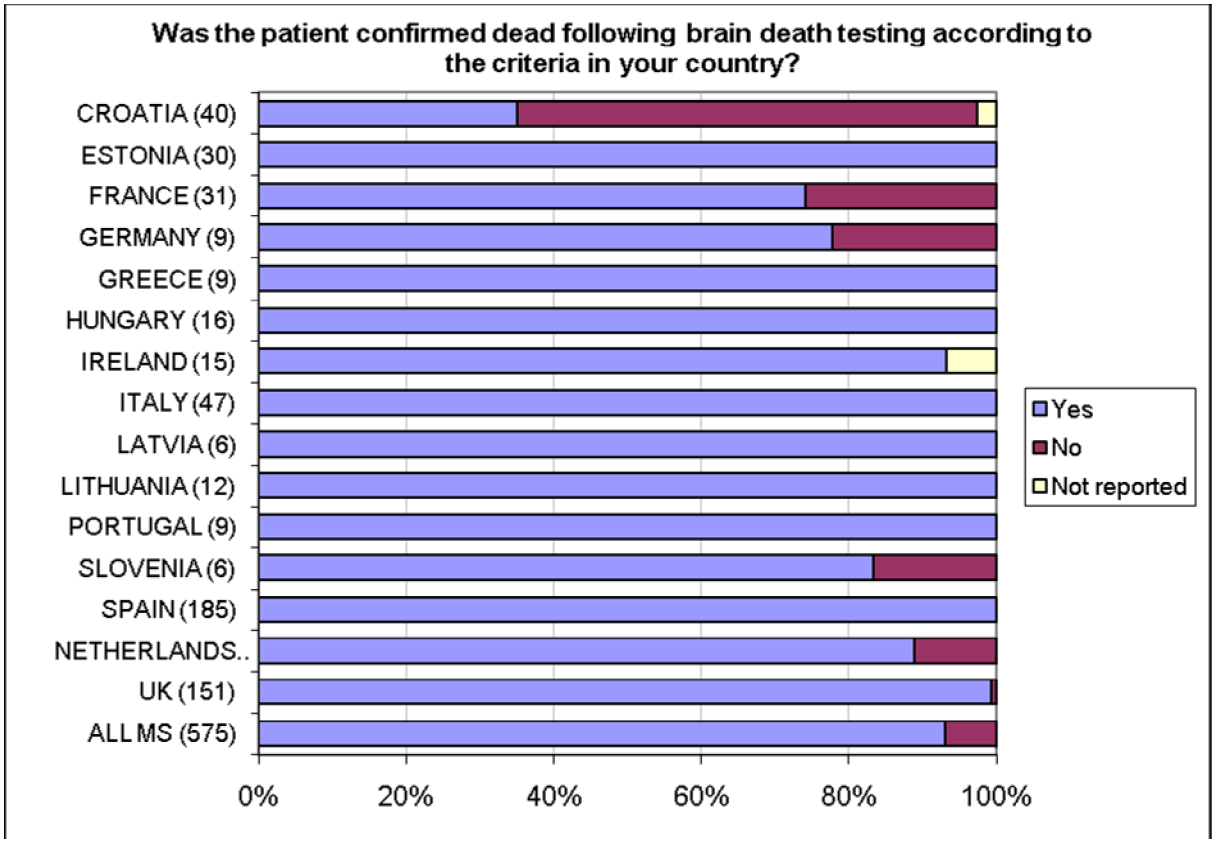
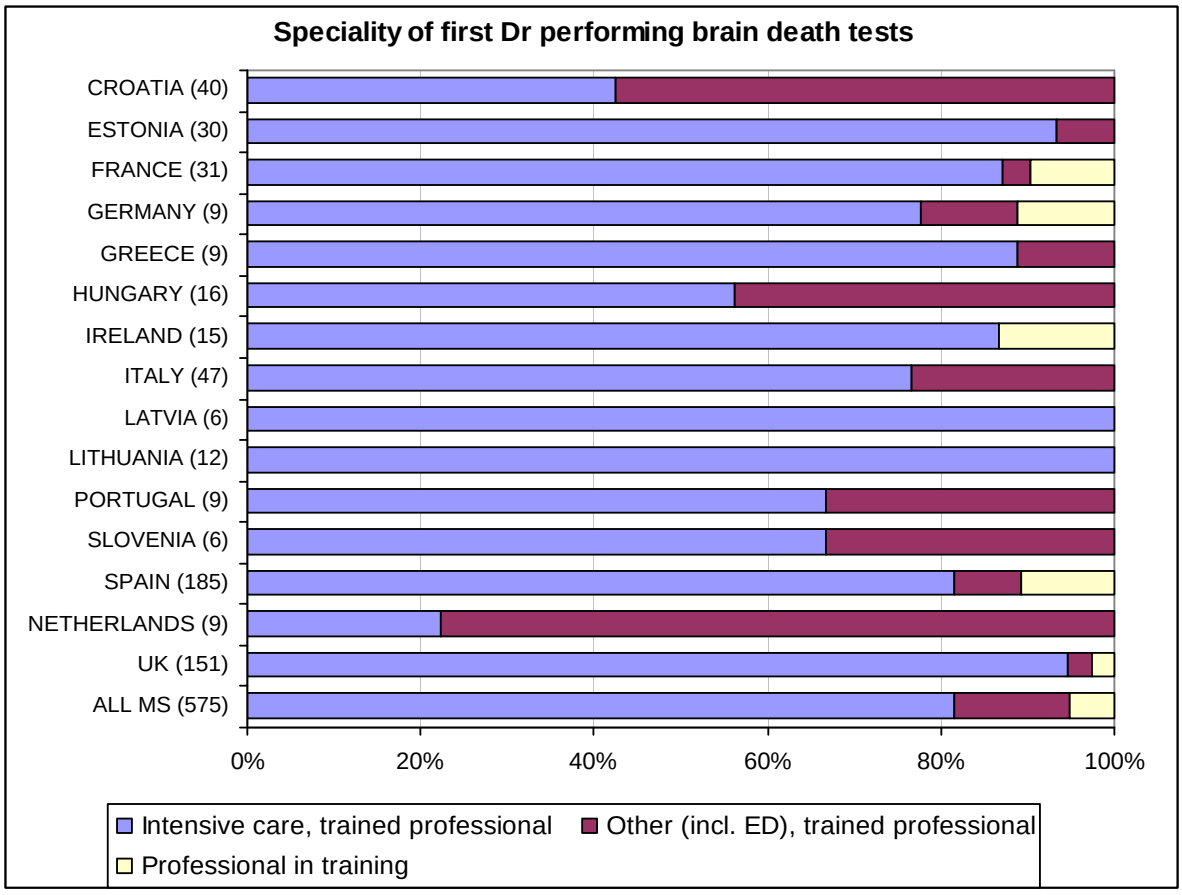


Figure 16 analysed only those patients for whom tests for brain death were performed. It is notable that five MS have over 10% of patients who, when tested, do not meet the national criteria for brain death. In three MS the numbers are too small for meaningful comment. In Croatia (25/40 not confirmed) the reasons given are: 8 “ancillary tests failed to confirm brain death”, 15 “positive brain stem reflex”, 2 “not apnoeic”. In France (8/31 not confirmed): 1 “ancillary tests failed”, 2 “Instability”, 1 “family refusal during tests” 3 “contraindication discovered during tests”, 1 “not reported”.

Figure 17 b) Speciality of Testing Doctor



Croatia and The Netherlands were the two MS in which trained professionals in intensive care were not the first doctor to perform the majority of brain death tests, whilst in Latvia and Lithuania these professionals did so for 100% of reported patients.

Section 7

Figure 18: DCD route considered

a) Section 1 answered 'D' only AND Section 3 answered 'Yes'

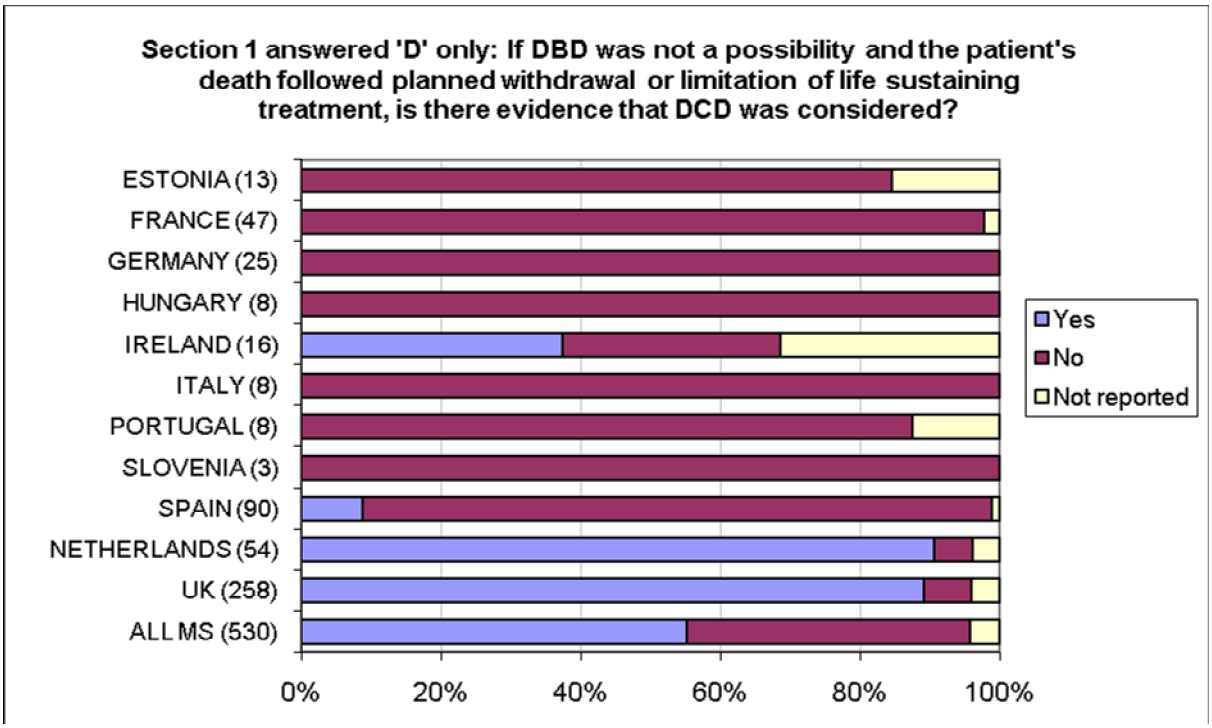


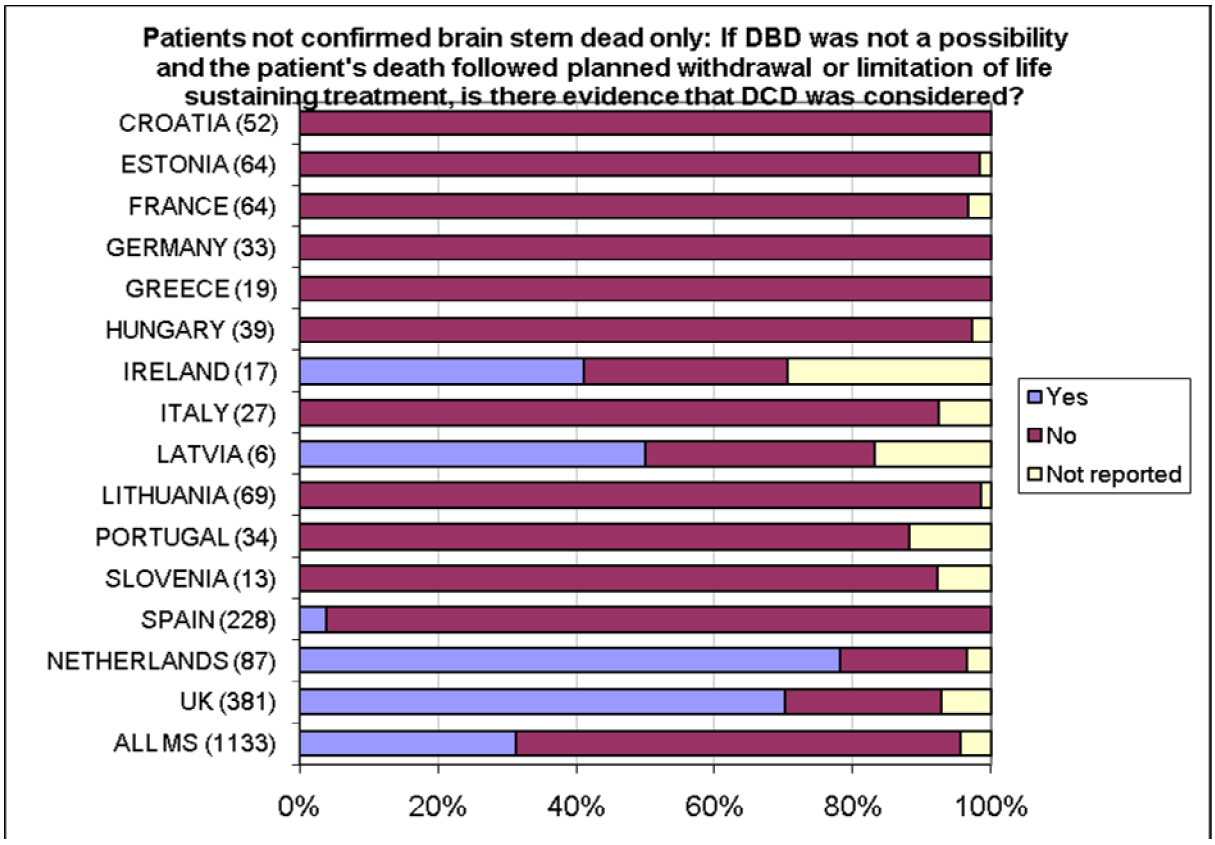
Figure 18 analysed only those patients whose overall care as described in Section 1 was "D" – i.e. the planned withdrawal or limitation of life sustaining treatment and subsequent cardiac arrest. In addition, they were intubated and ventilated. DCD donation could therefore be considered. These data show that in only 4 MS was this donation route in fact considered – in over 90% of patients in The Netherlands and UK, in 38% of patients in Ireland and in 9% of patients in Spain. Of the other MS, the reasons given were -

- Estonia*: DCD not lawful (5), No DCD programme in this country (7), Not identified as potential donor (1)
- France*: controlled DCD not lawful in this country (33), No DCD programme in this country (12), Not reported (2)
- Germany: DCD not lawful in this country (29)

- Hungary: DCD not lawful in this country (9)
- Italy*: No DCD program in this hospital (8)
- Portugal: DCD not lawful in this country (7)
- Slovenia: DCD not lawful in this country (3)

**Note that the country questionnaire indicates that these countries (amongst others) have DCD programs, and so 'No DCD program in this country' or 'DCD not lawful in this country' do not appear to be valid reasons for not considering DCD donation. However some of these inconsistencies may in part be related to different regulation and practice between controlled and uncontrolled DCD donors – for example in France, where there is no controlled DCD donation but uncontrolled donation is practised.*

b) Section 6 not answered 'Yes' only (not confirmed brain dead)

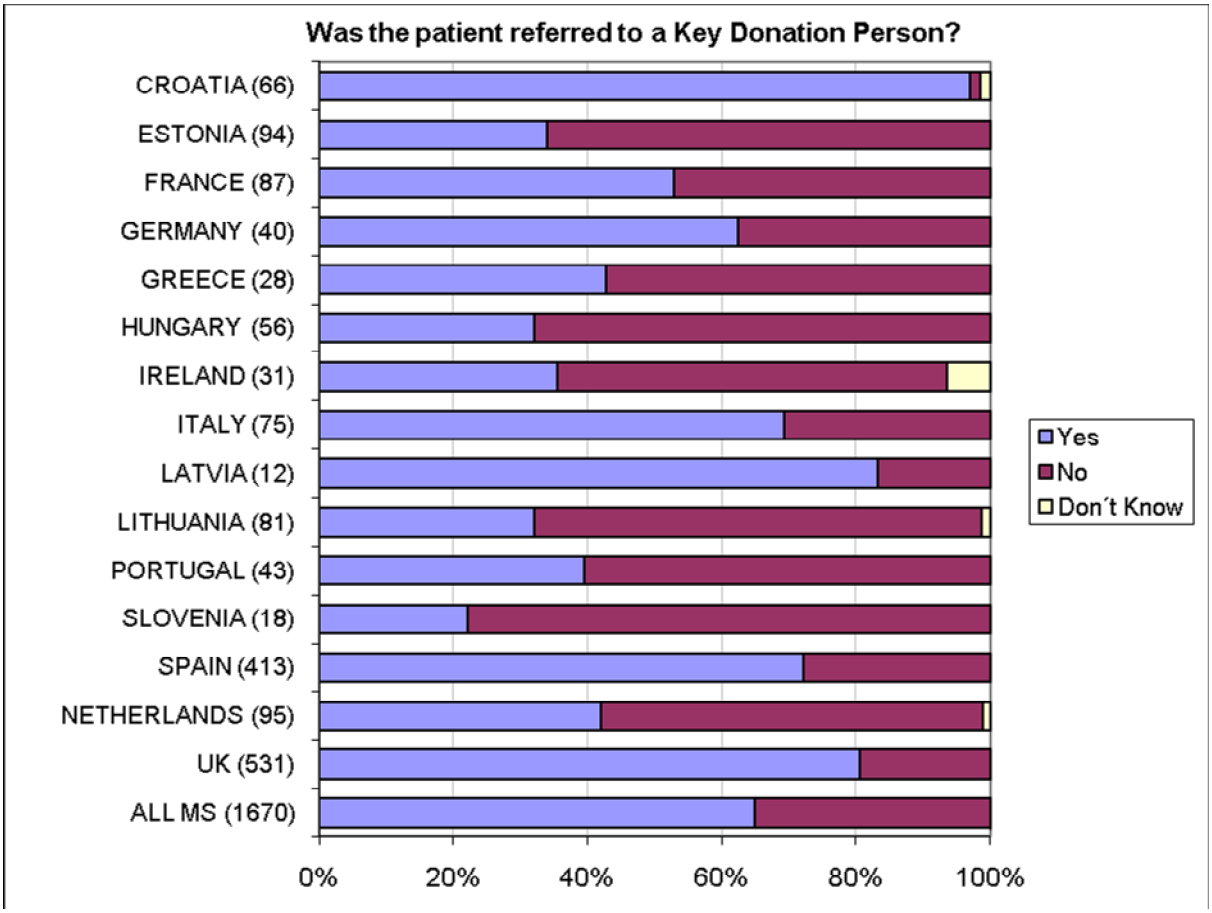


When only those patients who were not confirmed brain dead are analysed, a similar pattern is seen as in a) above, with the addition of Latvia as a MS where DCD was considered in circumstances where brain death was not confirmed.

Section 8

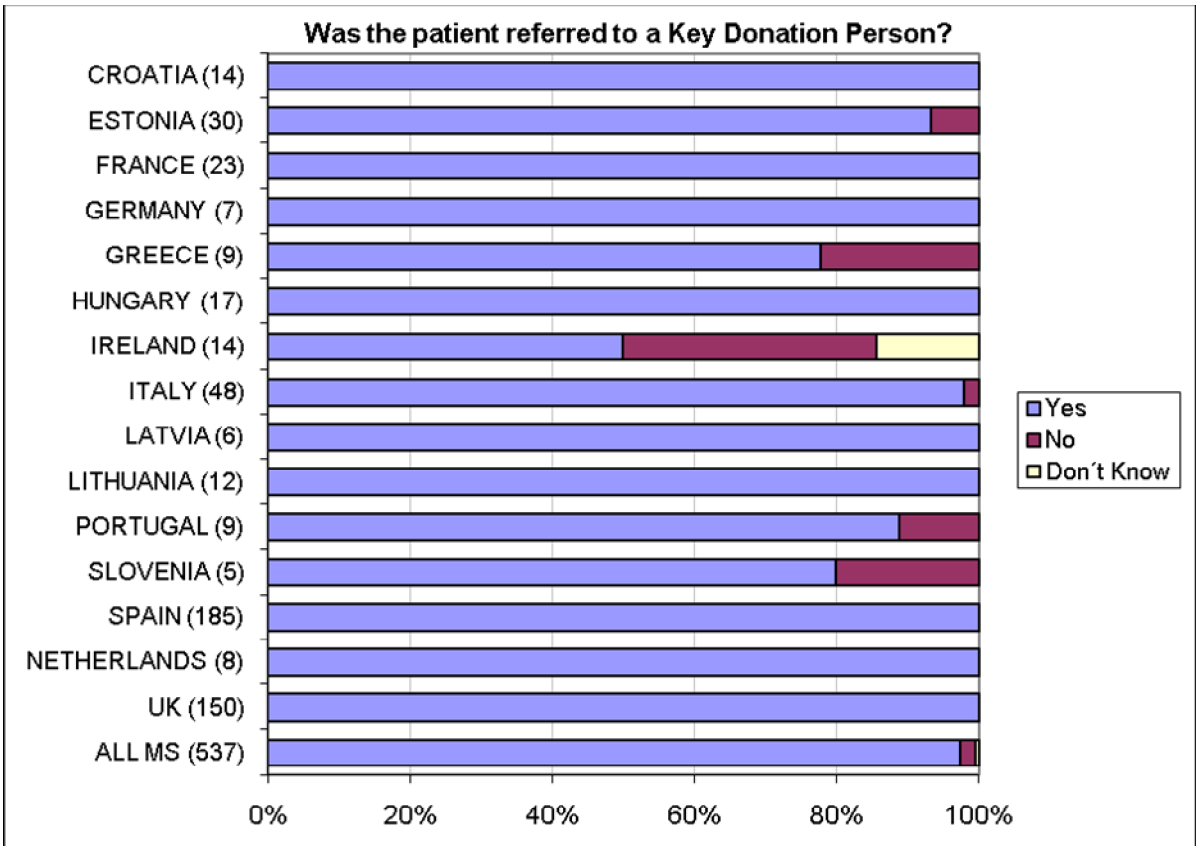
Figure 19: Referral

a) ALL patients

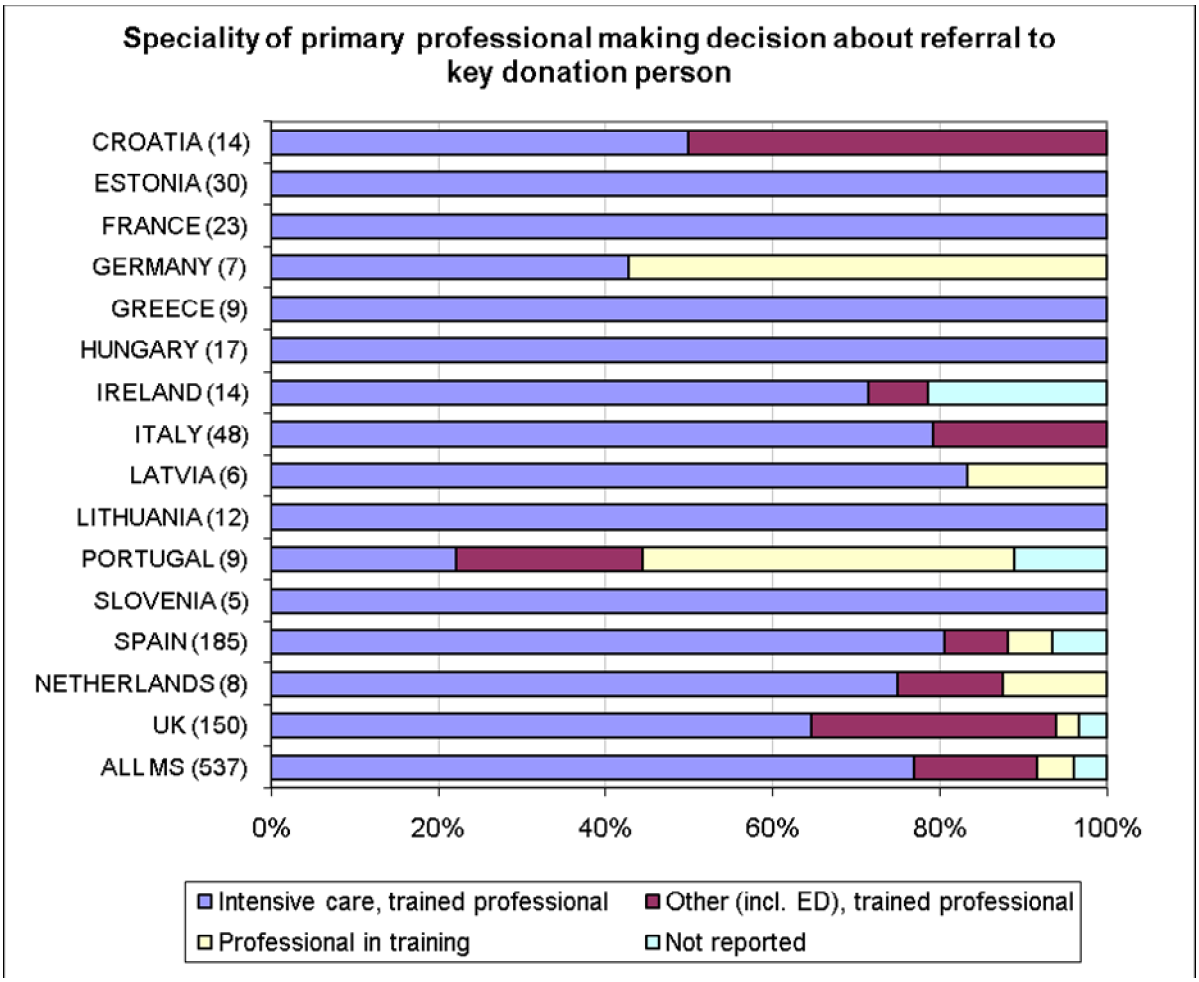


This graph represents all audited patients. Referral of patients to a Key Donation Person varies between MS – in some, it is expected that ALL patients will be referred, whether there is a realistic possibility of donation or not, whereas in others referral will only be made when brain death has been (or is about to be) confirmed or a decision has been made to withdraw or limit life-sustaining treatment. This graph should therefore be interpreted with caution. However, it shows a very important area for improvement. The lawfulness of referring a possible donor (not dead yet) to a DTC is put under question in many countries.

b) Patients in whom Brain Death was confirmed



This table shows referral only for those patients in whom brain death was confirmed. It therefore represents the pool of brain dead patients for whom DBD may be a possibility if there are no major contraindications to donation and appropriate consent for donation is given. In all MS except Ireland, over 75% of such patients were referred to the key donation person whilst in Ireland 50% of such patients were not referred.



As in b) above, this table refers only to those patients in whom brain death was confirmed. It therefore represents the pool of brain dead patients for whom DBD may be a possibility if there are no major contraindications to donation and appropriate consent for donation is given. As would be expected, the majority of such referrals were made by trained intensive care professionals in most MS, although in Germany and Portugal 40% or more of referrals were made by a professional in training.

Section 9

Figure 20: Family approach

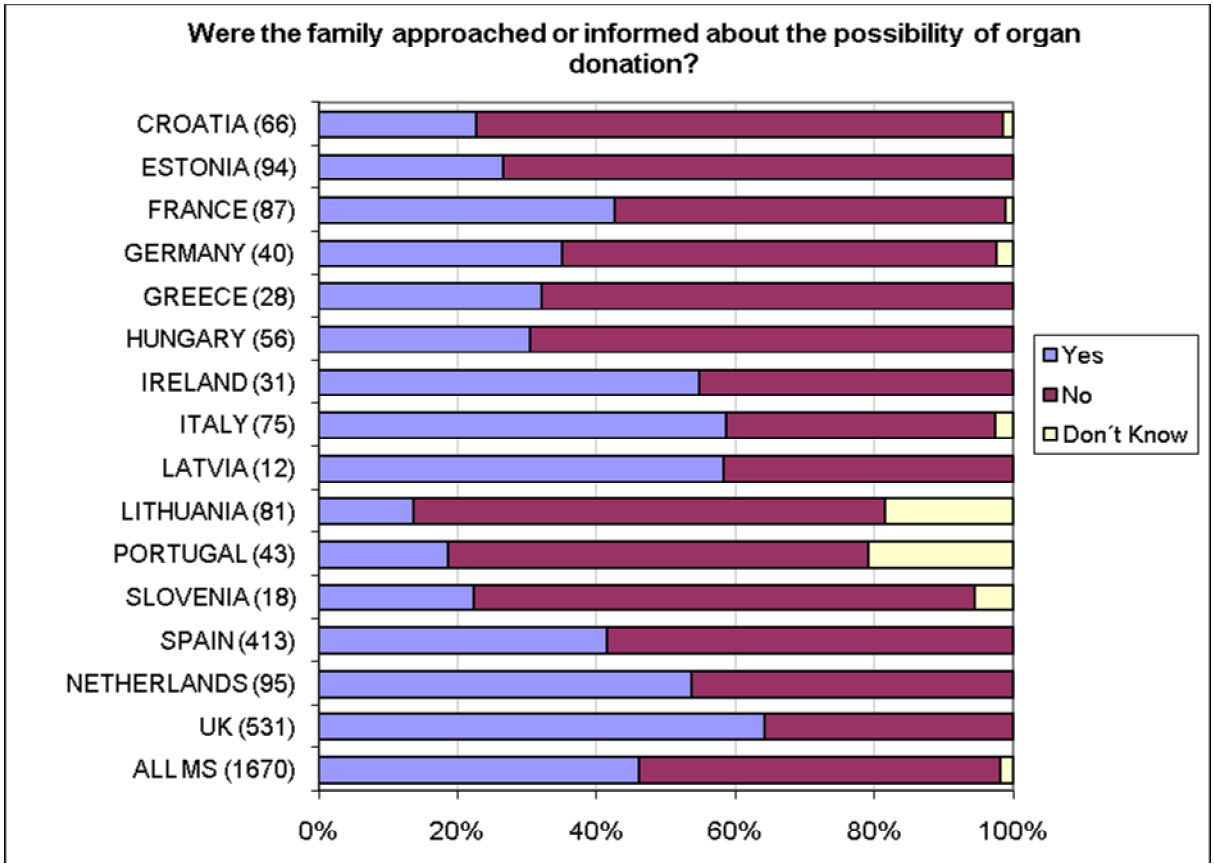
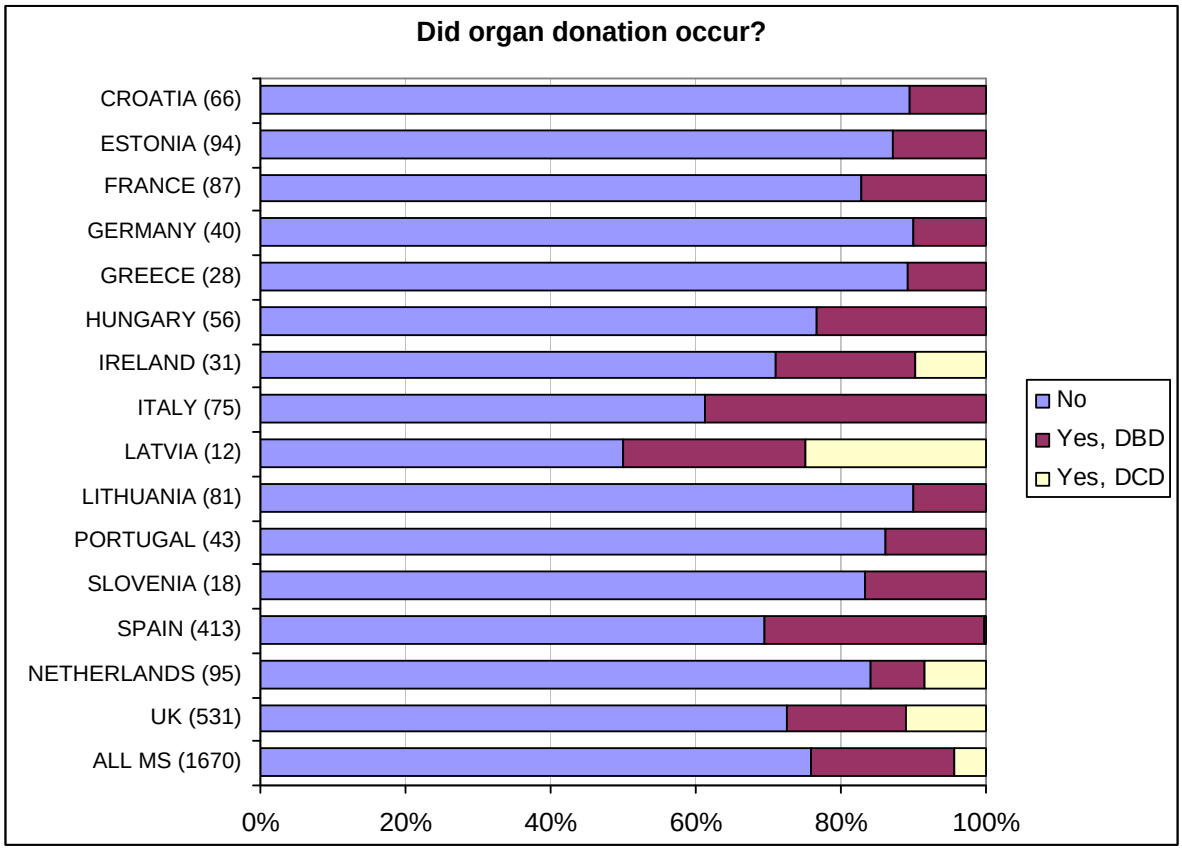


Figure 20 shows the answers for all patients, regardless of whether they were referred to a key donation person. In 52% of patients the reasons could be considered to be appropriate – e.g. absolute medical contraindications, judicial objections to donation, etc. However in a further 48% the reasons were less clear.

Section 10

Figure 21: Donation



Comment

All the data analysed above are as they were reported during the study. Each participating MS was responsible for quality assurance of their data. There are almost certainly a number of apparent internal inconsistencies – these may result from aspects of care or practice that were not adequately captured in the questionnaires or from varied interpretations of the questions and possible answers. Whilst these are unlikely to have a significant impact on the overall findings it is essential that each participating country examines its own data in detail, in order to fully interpret and understand the data and to learn all the lessons from this project.

3. Univariate and Multivariate Analyses

Introduction.

All data reported were analysed to investigate and identify factors associated with a higher likelihood of donation in order to inform any changes in policy or practice at a national, regional or local level. Both univariate and multivariate analyses were performed. Where appropriate, all relevant factors from the country, hospital and patient questionnaires were considered in a data set that contained information for each of the patients reported through the patient questionnaire. Appropriate modelling was undertaken to use the hospital and country level information relevant to each patient as part of the analysis. This modelling accounted for the fact that patients are grouped within hospitals within countries.

3.1 Methods

The primary outcome of interest was whether donation occurred. This was examined for all donation (DBD or DCD), DBD donation only and DCD donation only. Secondary outcomes in the multivariate analysis were whether the patient was intubated and ventilated, whether tested for brain death, and whether there was consideration of DCD donation (using relevant sub-sets of the patient cohort). All models considered binary outcomes and were analysed using logistic regression modelling. Results are presented in terms of the odds of donation (or the relevant outcome) relative to a baseline group for each factor. An odds ratio of greater than one indicates a greater chance of donation relative to the baseline group. A p value of <0.05 was used to define statistical significance.

Univariate Analysis

The association between each factor and whether or not the patient became an organ donor (DBD or DCD) was first explored using univariate logistic regression modelling.

Multivariate Analysis

Five models (see below) were developed using multivariate logistic regression. Only factors that were statistically significant were included in the

final models. The factors considered in each model are shown in Table 1. Variables were considered for inclusion in a forward, step-wise fashion, starting with patient-level questions (or factors), then hospital-level, then country-level. Random effects for hospitals were included after this process to account for additional variation due to hospitals that is inadequately captured by other factors in the model.

Analysis issues

A large majority of hospital- and country-level factors are binary. Often hospital level factors are answered in the same way across hospitals within the same country. These two aspects of the data create an issue whereby the effect of a country partially or completely obscures the effects of some hospital- or country-level questions, due to one question (or two or more questions in combination) acting as an indicator for that country. The consequence is that some questions cannot be used in the model at all, and some cannot be used in the presence of others, as effects cannot be understood in isolation from countries.

Two of the fifteen countries dominate the cohort – Spain (25%) and the UK (32%). This creates considerable imbalance that cannot be completely countered with risk-adjustment, owing to the heterogeneity of explanatory variables across countries. Results must be interpreted with caution.

Model 1. All Deceased Donation

Modelling explored factors associated with DBD or DCD donation (vs. no donation). This model included the whole cohort of patients (n=1670) and used donation (either DBD or DCD) as the binary outcome.

Model 2. DBD Donation

This analysis looked more specifically at those patients with at least some possibility of DBD donation. Therefore the cohort of patients analysed was restricted to those who were receiving mechanical ventilation (n=1404), since the need for mechanical ventilation is an absolute requirement for the diagnosis of brain death and thus for DBD. Regression modelling examined factors associated with DBD donation (vs. DCD donation or no donation).

Models 3 and 4 explored the patient pathway from admission to brain death testing in two discrete stages, to consider secondary outcomes. Model 3 examined factors associated with the decision to intubate or not. Model 4 examined factors associated with the decision to brain death test or not, amongst those patients who were intubated and where a brain death diagnosis was likely.

Model 3. Intubation and Ventilation

As intubation and ventilation are a pre-requisite to the management of a patient who may progress to a possible diagnosis of brain death, this analysis explored the factors associated with intubation and ventilation using the whole cohort of patients (n=1670). The binary outcome was Intubation and Ventilation or not.

Model 4. Brain Death

A number of patients who were intubated and ventilated progressed to a stage where Brain Death was a likely diagnosis. This analysis used this cohort of patients (n=730) to identify factors associated with brain death testing (v no testing).

Model 5. DCD Donation

This specific analysis was performed to investigate factors associated with DCD donation only. The assumptions made were that this should be restricted to those countries/hospitals with a DCD programme, and the cohort of patients chosen were those whose end-of life care was described in the patient questionnaire as being consistent with possible DCD donation – i.e. whose death followed ICU treatment to incorporate donation into end-of-life care or a decision to withdraw or limit life sustaining therapy with an expected final cardiac arrest (scenarios C and D in question 1 of the patient questionnaire). (n=561). Multivariate logistic regression was used to assess factors associated with DCD donation (vs. DBD donation or no donation).

Table 1. Factors considered for analysis.

Factor	Model				
	1	2	3	4	5
Country level factors					
DCD program	+	+	+	+	
[1] Professional guidance/standards/codes of practice for diagnosis of BD					
[1] Professional guidance/standards/codes of practice to support clinicians who are treating potential organ donors					
Ethical codes of practice	+	+	+	+	+
Guidance on withdrawal of limitation of life-sustaining treatment	+	+	+	+	+
Who is responsible for OD	+	+	+	+	+
National criteria to alert KDP	+	+	+	+	+
Guidance or best practice regarding approach to families	+	+	+	+	+
[1] Provide formal training for healthcare professionals in OD process					
[1] National organisation responsible for OD					
Regional organisations responsible for OD	+	+	+	+	+
[1] Regulatory body that has oversight of OD					
Hospital level factors					
Number of adult ICU beds	+	+	+	+	+
Neurosurgical facilities on site	+	+	+	+	+
Interventional neuroradiology facilities on site	+	+	+	+	+
Hospital performs solid organ transplants	+	+	+	+	+
Designated trauma centre	+	+	+	+	+
Availability of KDP	+	+	+	+	+
Clinical background of KDP	+	+	+	+	+
Written policy/guideline/protocol for managing OD process	+	+	+	+	+
Written criteria to alert KDP	+	+	+	+	+
[1] 24 hour access to CT scanner					
24 hour access to MRI scanner	+	+	+	+	+
24 hour access to HLA and virology testing	+	+	+	+	+
24 hour access to Trans Cranial Doppler	+	+	+	+	+
24 hour access to EEG	+	+	+	+	+
24 hour access to cerebral angiography	+	+	+	+	+
Patient level factors					
Unit/ward where death was confirmed	+	+	+	+	+
Age	+	+	+	+	+
Gender	+	+	+	+	+
Main cause of death	+	+	+	+	+
Number of days from admission to brain injury	+	+	+	+	+
Number of days from brain injury to date of death	+	+	+	+	+
Was patient referred to neurosurgery	+	+	+	+	+
Was patient transferred to another hospital for neurosurgical treatment	+	+	+	+	+

Did the patient receive any neurosurgical or neuroradiological treatment	+	+	+	+	+
Speciality of primary intubation and ventilation decision maker			+	+	
2nd professional involved in intubation and ventilation decision making			+	+	
Patients GCS at time of intubation and ventilation decision	+		+	+	
Was patient's condition consistent with brain death at any time?			+	+	
Did patient undergo brain death testing	+	+		+	
Speciality of primary testing decision maker				+	
2nd professional involved in testing decision making				+	

[1] These factors could not be used because they were answered identically across all hospitals/countries in the cohort and were thus acting as surrogate indicators for a particular hospital or country.

Some factors have been used differently across the different models, for example combining levels within a factor to accommodate small numbers.

3.2 Results

3.2.1 Univariate Analysis of factors associated with donation:

The following country/hospital factors are univariately associated with a higher likelihood of donation – either DBD or DCD. It should be emphasised that in this analysis a significant factor may in fact be a surrogate marker for a more clinically-relevant factor. For example, 24hr access to MRI would be expected in all hospitals with neurosurgery, and access to HLA and virology testing reflects the presence of a transplant unit.

- If hospital performs transplants
- 24hr access to MRI scanner
- 24hr access to HLA and virology testing
- having a DCD program in the country
- country provides guidance on withdrawal of treatment (correlates with DCD program factor)
- there are national independent ethical codes of practice or guidance that support organ donation in the country
- responsibility for the optimisation of potential organ donors is between both key donation person and critical care doctors in the country
- there are regional organisations responsible for organ donation in the country

The following patient-level factors are univariately associated with donation rates:

- Unit type (neuro ICU most likely to result in donation, followed by adult ICU)
- Age (older patients less likely to donate)
- Gender (men less likely to donate)
- Cause of death (trauma most likely to lead to donation)
- Number of days from brain injury to date of death (longer time associated with lower donation rates)
- Care of patient during final illness (full active treatment until diagnosis of brain death most likely to lead to donation)

3.2.2 Multivariate Analysis Results

The full results for all models are in Appendix 6, Tables 1-5, which include more detailed analyses of sub-groups within significant factors. The results below list the significant factors and summarise the more detailed analyses.

Model 1:

The following factors were found to be significantly associated with DBD or DCD donation. (Cohort: All patients. N= 1670. 492/1670 patients became donors – 29.5%) A p value of <0.05 was used to define statistical significance.

- **Unit**
  Donation was more likely when the patient was confirmed dead in ICU or Neurosurgical ICU

- **Age**
  Patients aged between 18-49 years were more likely to become donors than those aged 70 or more.

- **Sex**
  Donation was more likely when the patient was female

- **Cause of death**
  Deaths from cerebral damage or cerebral neoplasm were associated with lower donation rates when compared with death from cerebrovascular accidents.

- **Days from brain injury to death**
  Dying 1-2 days after brain injury was associated with the highest donation rates and dying 11+ days after brain injury with the lowest

- **Number of adult beds**
  Hospitals with 20-34 adult ICU beds were associated with lower donation rates compared with hospitals with less than 20 or more than 50 beds.

- **Clinical background of Key Donation Person (KDP)**
  Donation was more likely if the clinical background of the KDP is neither a nurse nor a doctor

- **Written policy/guideline/protocol for Organ Donation process**
  Donation was more likely where there was a written policy/guideline on the organ donation process

- **DCD programme**
  Donation was more likely where there was a DCD programme

- **Ethical codes of practice**
  Donation was more likely where there was an Ethical Code of Practice

- **Responsibility for Organ Donation**
  Donation was more likely where the Key Donation Person (KDP) and Critical Care doctor shared responsibility for donation.

- **Patient referred for neurosurgery**
  Donation was more likely when the patient had been referred to neurosurgery.

- **Discipline of person making intubation/ventilation decision**
  Donation was more likely if the discipline of the person making the decision about intubation/ventilation was from an Emergency department

Model 2.

Model 2 looked more specifically at those patients with at least some possibility of DBD donation – i.e. those who were receiving mechanical ventilation, and using DBD donation as the end-point.
The following factors were found to be significantly associated with DBD donation (Cohort: mechanically ventilated patients only. N=1404. 328/1404 patients became DBD donors – 23.4 %) A p value of <0.05 was used to define statistical significance.

- **Unit**
  DBD donation was significantly more likely when the patient was confirmed dead in ICU or Neurosurgical ICU.

- **Age**
  Patients aged between 18-49 years were most likely to become donors, with decreasing chance of donation in older age groups.

- **Sex**
  DBD donation was significantly more likely if the patient was female

- **Days from brain injury to death**
  Dying 1-2 days after brain injury was associated with the highest donation rates, with decreasing chance of donation with longer times to death post brain injury, especially 11+ days.

- **DCD programme**
  DBD donation was significantly more likely where there was a DCD programme

- **Ethical codes of practice**
  DBD donation was significantly more likely where there was an Ethical Code of Practice

- **Responsibility for OD**
  DBD donation was significantly more likely where the KDP and Critical Care doctor shared responsibility for donation

Model 3.

The following factors were found to be significantly associated with Intubation and Ventilation. (Cohort: All patients. N=1670. 1404/1670 patients were intubated and mechanically ventilated – 84.1%) A p value of <0.05 was used to define statistical significance.

- **Unit**
  Intubation and ventilation of a patient was positively associated with death in ICU or Neurosurgical ICU

- **Age**
  The older the patient the less likely they were to be intubated and ventilated

- **Cause of death**
  Intubation and ventilation of a patient was positively associated with death in ICU or Neurosurgical ICU and death from cerebral damage or trauma as compared with death from cerebrovascular accidents.

- **Profession involved in decision about intubation**
  Intubation and ventilation were less likely if neither ICU nor ED clinicians were involved in the decision about intubation and ventilation

- **2nd decision maker involved**
  Intubation and ventilation were less likely if a second decision maker was involved.

- **Hospital performs organ transplants**
  Intubation and ventilation of a patient was positively associated with hospitals performing organ transplants

- **24 hr access HLA and virology testing**
  Intubation and ventilation of a patient was positively associated with the availability of 24 hour access to HLA and virology testing (the clinical relevance of this finding is not immediately apparent).

- **Ethical codes of practice**

Intubation and ventilation of a patient was positively associated with an ethical code of practice

- **National criteria to alert KDP**

Model 4.

The following factors were found to be significantly associated with BD testing. (Cohort: Patients were intubated and ventilated and BD was a likely diagnosis. N=730. 574/730 patients were tested – 78.6%). A p value of <0.05 was used to define statistical significance.

- **Unit**
  Compared with ICUs, death in a Neuro ICU was more likely to lead to testing, and death in ED was less likely to lead to testing.

- **Age**
  Patients aged 18-49 years were most likely to be tested and those aged under 18 years least likely.

- **Sex**
  Higher testing rates were found when the patient was female

- **Cause of death**
  Compared with trauma and cerebrovascular accidents, patients dying due to cerebral damage or cerebral neoplasm were less likely to be tested.

- **Days from brain injury to death**
  Higher testing rates were associated with patients dying more than 24 hours after brain injury

- **Profession involved in decision about testing**
  Higher testing rates were associated with the clinician involved in the decision to test coming from ICU

- **Second decision maker**
  Higher testing rates were associated with a second decision maker being involved in the decision

- **Hospital performs organ transplants**
  Higher testing rates were found when the hospital does not perform solid organ transplants

- **Availability of KDP**
  Availability of a KDP when requested was associated with increased testing.

- **Clinical background of KDP**
  If the clinical background of the KDP is a nurse then this is associated with lower testing rates than for doctors.

- **Country has DCD programme**
  Higher testing rates were found when the country has a DCD programme

- **Ethical codes of practice**
  Higher testing rates were found when the country has an ethical code of practice

- **Guidance on withdrawal or limitation of life sustaining treatment**
  Higher testing rates were found where there is no guidance on withdrawal or limitation of lifesaving treatment,

Model 5.

The following factors were found to be significantly associated with DCD donation. (Cohort: patients whose end-of life care was described in the patient questionnaire as being consistent with possible DCD donation – i.e. ICU treatment to incorporate donation into end-of-life care or a decision to withdraw or limit life sustaining therapy with an expected final cardiac arrest (scenarios C and D in question 1 of the patient questionnaire) N=561. 67/561 patients became DCD donors – 11.9%). A p value of <0.05 was used to define statistical significance.

- **Unit**
  DCD donation is most likely when the patient was confirmed dead in ICU or Neurosurgical ICU.

- **Age**
  Patients aged 18-49 years were most likely to become DCD donors, with other age groups have comparable odds of donation

- **Sex**
  DCD donation is most likely when the patient was male

- **Written criteria to alert KDP**
  Not having written criteria to alert a KDP is associated with greater DCD donation

- **24 hr access Trans cranial Doppler**
  DCD Donation was less likely in hospitals with 24 hour access to trans cranial Doppler.

Modelling by Country

An attempt was made to develop models for DBD and DCD donation and DBD only donation separately for UK, Spain, and all other countries combined. Due to common practices within countries and other data limitations this was not possible when using the models developed for the full cohort of patients.

Tables 6-8 (Appendix 7) provide summary data for relevant factors (that is, the information under the headings 'Factor', 'Level', 'N', '[outcome]' and '(%)' in the tables) separately for UK, Spain and all other countries. This allows observation of the differences across countries by factor, to understand how the UK and Spain might influence the model.

In summary, the main differences relating to donation (DBD or DCD) are:

- The percentage of patients who became donors was 30.5 in Spain, 27.5 in UK and 18.0 in the remaining countries.
- Donation by patients up to the age of 50 was approximately 40% in both Spain and UK, 33% in others.
- The percentage of older patients (60 yrs and over) who donated was highest in Spain (26.4%), lower in UK (19.2%), and even lower in others (11.7%).

- Whilst the numbers are very small, 33% of UK patients whose cause of death was a cerebral tumour were donors, compared with about 3% in Spain and others.
- Only in Spain is the percentage of patients who donated lower in ICUs with 20-34 beds – in UK and others this observation is not made.
- In Spain and other countries, over 85% of KDPs are doctors – in UK, 100% are nurses.
- The KDP is involved in the DBD process before brain death testing in 100% of patients in Spain, in 0% of patients in the UK, and to a varied degree in other countries.

Looking only at DBD donation, i.e. the cohort of patients who were intubated and ventilated, the main differences are:

- In Spain, 40.0% of intubated and ventilated patients became donors, compared with 18% in UK and 19.1% in other countries.
- In Spain, the high percentage of patients who die in neurosurgical ICU who are donors (48.7) compared with UK (21.2) and others (27.0).
- The higher likelihood of donation in Spain for patients of all age groups, with very little reduction with increasing age, when compared to both UK and other countries.

3.3 Discussion

The limitations of a univariate analysis are well recognised, as factors that individually appear to be significant may do so as the result of other, related factors. Therefore, whilst interesting, the results must be interpreted with great caution. Nevertheless, and despite the limitations, the factors found to be significant in the univariate analysis at country/hospital and patient levels, are all capable of plausible explanation even though the data to support such explanations may be limited. Of particular interest are the country and hospital factors that were found to be significantly associated with donation in this analysis, which were not found to correlate with a country's donor rate pmp in the Interim Report. This suggests that these factors, such as having a DCD program in the country, the country provides guidance on withdrawal of treatment, the presence of national independent ethical codes of practice or guidance that support organ donation in the country and the regional organisations responsible for organ donation in the country, may influence whether or not donation happens at the level of the individual possible donor, but that other factors have a strong influence on the overall donation rate per million population.

As highlighted in the Methods section, the multivariate analysis is complex for a number of reasons, and thus these results must also be interpreted with caution. In particular, two of the fifteen countries dominate the cohort, with Spain and the UK contributing 57% of the patient cohort between them. This creates considerable imbalance that cannot be completely countered with risk-adjustment, owing to the heterogeneity of explanatory variables across countries.
These differences are highlighted when the raw values for significant variables are examined – a striking example being that in Spain the KDP is always involved in a patient with the potential to be a DBD donor before brain death tests are performed, yet never involved in the UK until after the tests have been performed.

As a consequence some of the significant findings may be counter-intuitive or may be difficult to explain. To a limited extent the possible explanations for the findings are discussed below, but this is largely speculative. It is important, of course, not to dismiss out of hand findings that appear to be difficult to explain – it is possible that there are underlying aspects of practice that are indeed relevant to some of these findings.

It is intended to make the data set for each country available to that country for further in-depth analyses that may provide support for, or against, these and any other possible explanations.

Factors Associated with Donation

(DBD and DCD, DBD only and DCD only – i.e. Models 1,2 and 5)

Factors consistently significant in all models.

Only three factors were consistently significant in all donation models– the unit where death occurred, the age of the patient and an active DCD programme.
Patients were more likely to donate if they died in ICU or Neuro ICU than in ED or any other unit, and were less likely to donate as they became older. It is self-evident that if donation (either DBD or DCD) is the endpoint, donation will be more likely when the patient dies in a country/hospital with a DCD programme than in a country/hospital without a DCD programme. However it is of interest that this factor is also associated with a higher likelihood of DBD donation.

These results are probably to be expected, although the differences between Spain and all other countries in the impact of increasing age on the likelihood of donation are of particular interest.

Factors that varied between models.

Sex: Overall donation and DBD donation were more likely if the patient was female rather than male, However, DCD only donation was less likely if the patient was female. This gender bias is not widely recognised, although it has recently been reported (see: Ann Transplant. 2013 Sep 25;18:508-14. Gender issues in solid organ donation and transplantation. Ge F[1], Huang T, Yuan S, Zhou Y, Gong W.) It could reflect higher co-morbidity in males, or a difference in the consent rates.

Cause of death: Overall, and for DBD donation only, donation was less likely if the cause of death was cerebral damage or a cerebral neoplasm. The factor was not significant for DCD donation. Although the number of patients with a cerebral neoplasm was small, there is a clear difference between the UK

(33% of such patients were donors) and both Spain and the other countries where approximately 3% only were donors.

Number of ICU beds: Only in Spain was the observation seen that patients who died in a unit with 20-34 beds were less likely to donate than in smaller or larger units, but this was a significant factor for donation overall and for DBD donation only. This may reflect the sample of Spanish hospitals that took part in the project.

An Ethical Code of Practice: Overall donation and DBD donation are more likely if the country has an ethical code of practice.

Responsibility for donation: overall donation and DBD donation were more likely where the KDP and Critical Care doctor shared responsibility for donation. This was not found to be significant for DCD donation.

Clinical Background of KDP: For donation overall, there is a trend towards a lower likelihood of donation when the KDP was a nurse.

Referral to Neurosurgery: This was an independent factor associated with a higher likelihood of donation.

Written Policy/Guideline/Protocol: These were associated with a higher likelihood of donation.

Written Criteria to alert KDP: This reduced the likelihood of DCD donation.

24 Hr access to Trans-Cranial Doppler: This also reduced the likelihood of DCD donation. No obvious explanation for these two findings is apparent.

Factors significant in models 3 and 4

Second Decision Maker: The presence of a second decision maker made intubation and ventilation less likely but brain death testing more likely.

When the Hospital has a Transplant Unit, this was associated with a higher likelihood of intubation and ventilation but a lower likelihood of brain death testing.

An Ethical Code of Practice: intubation and ventilation and brain death testing are more likely if the country has an ethical code of practice.

A DCD programme: this factor is also associated with a higher likelihood of testing for brain death. The reasons for this are not immediately clear.

Cause of death: If the cause of death was cerebral damage or a cerebral neoplasm, these patients were less likely to be tested for brain death. They were, however, more likely to be intubated.

Females were more likely to have brain death tests performed.

24 Hr access to HLA and virology testing. This was positively associated only with the decision to intubate and ventilate the patient.

National Criteria to alert the KDP: Once again, this was positively associated only with the decision to intubate and ventilate the patient.

Availability of KDP: The lowest likelihood of brain death testing occurred when the KDP was available full time, when compared to part time or available when requested.

Guidance on withdrawal or limitation of life sustaining treatment: When available this significantly reduced the likelihood of brain death testing.

4. Summary and Conclusions from Deliverable 7.

It is important to recognise that the data in this study come from the small number of participating hospitals, and may therefore not be representative of practice throughout each MS. However the data clearly demonstrate variations, of which perhaps the most important relate to the nature of care given to patients during their final illness. In some MS the withdrawal or limitation of life sustaining treatment was almost unknown, whereas at the other extreme it occurred in 73% of patients. This practice effectively rules out the possibility of DBD donation, as it is anticipated that the patient will suffer a final cardiac arrest. DCD donation after the confirmation of circulatory death is therefore the only donation possibility.

The data from each participating hospital have been used in Deliverable 8 of the project to plan, and help to implement, rapid improvement methodology at

whichever step of the process was identified, by the hospital, as being amenable to change.

Appendices to Part One

Appendix 1: ICD 9 and ICD 10 Codes

ICD – 9 Codes

	348.5	Cerebral oedema
	800-804	Skull fractures
Cerebral Neoplasm	191 – 191.9	Malignant neoplasm of the brain
	225	Benign neoplasm of the brain
Trauma	851	Cerebral lacerations and contusions
	852	Subarachnoid, subdural and extradural haemorrhage following injury
	854	Intracranial injury of other or unspecified nature
Cerebrovascular Accidents	430	Subarachnoid Haemorrhage
	431	Intracranial Haemorrhage
	432	Other unspecified Intracranial haemorrhage
	433 - 433.2	Occlusion of precerebral arteries
	434 - 434.11	Occlusion of cerebral arteries including embolism and thrombosis
	436	Other but ill defined cerebrovascular disease
Infection	320 – 323	Meningitis and encephalitis
Cerebral Damage	348.1	Cerebral Anoxia
	348.4	Compression of the brain

ICD – 10 Code

Trauma	S02	Fracture of skull and facial bones
	S061	Traumatic cerebral oedema
	S062	Diffuse brain injury
	S063	Focal brain injury
	S064	Extradural haemorrhage
	S067	Intracranial haemorrhage with prolonged coma
	S068	Other intracranial injuries
	S069	Intracranial injury unspecified
Cerebrovascular Accidents	I60	Subarachnoid haemorrhage
	I61	Intracranial haemorrhage
	I62	Other non traumatic intracranial haemorrhage
	I63	Cerebral infarction
	I64	Stroke not specified as stroke or infarction
	I65	Occlusion and stenosis of precerebral arteries
	I66	Occlusion and stenosis of cerebral arteries
Cerebral Damage	G931	Anoxic brain damage
	G935	Compression of brain
	G936	Cerebral oedema

Cerebral Neoplasm	C71 D33	Malignant neoplasm of the brain Benign neoplasm of the brain
Infections	G00 – G03	Meningitis

Appendix 2 : Country Questionnaire

Country.....

1. Does your country have a legal definition for death?

Brain death criteria		Cardiorespiratory criteria	
☐ **Yes**	☐ **No**	☐ **Yes**	☐ **No**

2. Please describe the law in your country in relation to DBD organ donation.

Please provide a reference to any relevant documents and an internet link if possible.....
.....
.....
.....

3. Please describe the law in your country in relation to DCD organ donation.

Please provide a reference to any relevant documents and an internet link if possible.....
.....
.....
.....

4. Does your country have any professional guidance/standards/codes of practice for the diagnosis of brain death?

☐ **Yes** ☐ **No**

Please provide a reference to any relevant documents and an internet link if possible……..
……
……
……..

5. Does your country have any professional guidance/standards/codes of practice that support clinicians who are treating potential organ donors?

☐ **Yes** ☐ **No**

Please provide a reference to any relevant documents and an internet link if possible.....
.....
.....
.....

6. Are there any national independent ethical codes of practice or guidance that support organ donation in your country?

☐ **Yes** ☐ **No**

Please provide a reference to any relevant documents and an internet link if possible.....
.....
.....
.....

7. Does your country provide relevant guidance on the withdrawal or limitation of life sustaining treatment in critically ill patients?

☐ **Yes** ☐ **No**

Please provide a reference to any relevant documents and an internet link if possible.....
.....
.....
.....

8. Who is responsible for the optimisation of potential organ donors in your country?

☐ Critical Care Dr ☐ Key Donation Person

☐ **Combination of the above** ☐ Other please state.....

Please provide a reference to any relevant documents and an internet link if possible.....
.....

9. At what stage does the Key Donation Person become involved in the organ donation process?

DBD Donation

☐ Referral to the Key Donation Person can be made ***before*** the process of brain death testing has started

☐ **Referral to the Key Donation Person is usually made *during* the process of brain death testing.**

☐ Referral to the Key Donation Person can only be made ***after*** the process of brain death testing has been completed and death has been confirmed.

DCD Donation

☐ Referral to the key donation person can be made when a patient is likely to die but before a formal decision has been made to withdraw or limit life sustaining treatment.

☐ Referral to the key donation person can only be made once there has been a formal decision to withdraw or limit life sustaining treatment.

10. Does your country have national criteria to alert the Key Donation Person to a potential organ donor?

☐ **Yes** ☐ No ☐ Regional or local criteria

Please provide a reference to any relevant documents and an internet link if possible.....
.....

11. Does your country provide any guidance or best practice documents for the process of obtaining consent for organ donation from families

☐ **Yes** ☐ **No**

Please provide a reference to any relevant documents and an internet link if possible.....
.....

12. Does your country provide any formal training for healthcare professionals involved in the organ donation process.

☐ **Yes** ☐ **No** ☐ **Training provided at a local hospital level**

Please provide a reference to any relevant documents and an internet link if possible.....
.....

13. Does your country have a national organisation responsible for organ donation?

☐ **Yes** ☐ **No**

Name of National Organisation.....

14. Are there regional organisations responsible for organ donation?

☐ **Yes** ☐ **No**

15. Does your country have a regulatory body that has oversight of organ donation?

☐ **Yes** ☐ **No**

Name of regulatory body.....

16. Please provide a list of the absolute contraindications for organ donation in your country.

DBD Organ Donation: **DCD Organ Donation:**

Please provide a reference to any relevant documents and an internet link if possible.....
.....
.....
.....

Appendix 3: Hospital Questionnaire

Hospital code.....

1. Number of staffed beds in your hospital where you can mechanically ventilate a critically ill patient.

Adult beds…… Paediatric beds…….

2. Does your hospital have neurosurgical facilities on site?

☐ Yes ☐ No ☐ Don't know

3. Does your hospital have interventional neuroradiology facilities on site?

☐ Yes ☐ No ☐ Don't know

4. Does your hospital perform solid organ transplants?

☐ Yes ☐ No ☐ Don't know

5. Is your hospital a designated trauma centre?

☐ Yes ☐ No ☐ Don't know

6. Number of actual organ donors in your hospital in 2011

DBD..... DCD.....

7. What is the availability of the Key Donation Person within your hospital?

☐ Full time ☐ Part time ☐ Available when requested ☐ Not available

What is the clinical background of your hospital's Key Donation Person or if you have a team what is the clinical background of the Team Leader?

☐ Dr ☐ Nurse ☐ No Key Donation Person

☐ Other please state……

Does your hospital have a written local policy/guideline/protocol for managing the organ donation process?

☐ Yes ☐ No ☐ Don't know

10. Does your hospital have written criteria of when to alert the key donation person of a potential organ donor?

☐ Yes ☐ No ☐ Don't know

11. Does your hospital have the ability to facilitate organ donation 24 hours a day with regards to the following resources?

Resources	Yes	No
CT Scanner		
MRI Scanner		
HLA and virology testing		
Trans Cranial Doppler		
EEG		
Cerebral angiography		

Appendix 4: Patient Questionnaire

1. Patient code.....

2. Unit/Ward where death was confirmed.

☐ Adult Intensive Care ☐ Specialised Neurosurgical Intensive Care

☐ Paediatric Intensive Care ☐ Emergency Department

☐ Medical ward ☐ Stroke Unit

☐ Other: please specify.....

3. Age.....

4. Gender ☐ Male ☐ Female

5.a Main general cause of death.....

5.b Main specific cause of death.....

Other: please specify.....

Trauma	S02	Fracture of skull and facial bones
	S061	Traumatic cerebral oedema
	S062	Diffuse brain injury
	S063	Focal brain injury
	S064	Extradural haemorrhage
	S067	Intracranial haemorrhage with prolonged coma
	S068	Other intracranial injuries
	S069	Intracranial injury unspecified
Cerebrovascular Accidents	I60	Subarachnoid haemorrhage
	I61	Intracranial haemorrhage
	I62	Other non traumatic intracranial haemorrhage
	I63	Cerebral infarction
	I64	Stroke not specified as stroke or infarction
	I65	Occlusion and stenosis of precerebral arteries
	I66	Occlusion and stenosis of cerebral arteries

Cerebral Damage	G931 G935 G936	Anoxic brain damage Compression of brain Cerebral oedema
Cerebral Neoplasm	C71 D33	Malignant neoplasm of the brain Benign neoplasm of the brain
Infections	G00 – G03	Meningitis

6. Number of days from admission to brain injury.....

7. Number of days from date of brain injury to date of death.....

Q 1. Which statement best describes the care of the patient during his/her final illness? Please tick one box only.

☐ Full Active treatment on Critical Care until the diagnosis of brain death. ***If you tick this option, please proceed straight to question 2.***
☐ Full Active treatment until unexpected cardiac arrest from which the patient could not be resuscitated. ***If you tick this option, please proceed straight to question 2.***
☐ Admitted to Critical Care in order to incorporate organ donation into end-of-life care. ***If you tick this option. please proceed straight to question 2***
☐ Full active treatment on Critical Care until the decision of withdrawal or limiting life sustaining therapy was made, with an expected final cardiac arrest without Cardio Pulmonary Resuscitation. ***If you tick this option, please proceed to question 1.1.***
☐ Not admitted, or admitted to Critical Care but subsequently discharged. ***If you tick this option, please proceed to question 1.1..***

Q 1.1. Was it likely that the diagnosis of brain death could have been made, either at the time of the decision to withdraw/limit life sustaining treatment or to not admit/discharge, or within the next 48 hours, had active treatment continued?

☐ Yes: please **answer questions *1.2 and 1.3*** and then proceed to ***question 2***.

☐ No: please **answer questions *1.2 and 1.3*** and then proceed to ***question 2.***

Q 1.2. What was the Glasgow Coma Scale (GCS) at the time the decision to limit/withdraw treatment or to not admit/discharge was made?.....

Q 1.3. Why was full active treatment not continued or the patient not admitted/discharged? Please select one primary reason for not continuing full active treatment, and one secondary reason, if needed.

Primary reason	**Secondary reason**	
☐	☐	Legal and/or ethical concerns
☐	☐	Clinical decision that further treatment was not appropriate or not effective
☐	☐	Not able to undertake brain death testing
☐	☐	No critical care bed available

☐ ☐ Family reasons

☐ ☐ Other: please specify.....

Q 2. Was the patient referred to Neurosurgery?

☐ Yes: please answer ***questions 2.1 and 2.2*** and then proceed to ***question 3.***

☐ No: please proceed to ***question 3.***

☐ Don't Know: please proceed to ***question 3.***

Q2.1. Was the patient transferred to another hospital for neurosurgical treatment?

☐ Yes ☐ No ☐ Neurosurgical facilities on site

Q2.2. Did the patient receive any neurosurgical or neuroradiological treatment?

☐ Yes ☐ No ☐ Don't Know

Q 3. Was the patient intubated and receiving mechanical ventilation via an endotracheal or tracheostomy tube at the time of death or at the time of the decision to withdraw or limit life sustaining treatment?

☐ Yes: please answer ***questions 3.2, to 3.5*** and then proceed to ***question 4.***
☐ No: please answer ***questions 3.1, to 3.5*** and then proceed to ***question 7.***

Q 3.1 What was the reason for the patient not being intubated and receiving mechanical ventilation at that moment. Please tick only one option

☐ Not needed
☐ Not appropriate
☐ Not of overall benefit to the patient due to the severity of the acute event
☐ Other: please specify.....

Q 3.2. Speciality of primary professional making decisions about intubation and ventilation. Tick one option only.

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgery/Neurology ☐ General medicine

☐ General Surgery ☐ Palliative Care

☐ Anaesthesia ☐ Paramedic

☐ Out of hospital Dr ☐ Other: please specify.....

Q 3.3 Seniority of primary professional making the decision:

☐ Trained professional ☐ Professional in training

Q 3.4. Was there a second professional involved in the decision about intubation and ventilation?

☐ Yes ☐ No ☐ Don't know

If yes:

Q 3.4a Speciality of second professional making the decision

Q 3.4b Seniority of second professional making the decision:

☐ Trained professional ☐ Professional in training

Q 3.5 What was the patient's GCS score at the time of the decision about intubation and ventilation.....

Q 4. Was the patient's clinical condition consistent with brain death at any time during his/her present illness?

☐ Yes: please proceed to ***question 5.***

☐ No: please proceed to ***question 7.***

Q 5. Did the patient undergo brain death testing?

☐ Yes: please answer ***questions 5.2 5.4*** and then proceed to ***question 6.***

☐ No: please tick the appropriate boxes below, answer ***questions 5.1 to 5.4*** and then proceed to ***question 7.***

Q 5.1 Please select one primary reason for the patient not undergoing brain death testing, and one secondary reason, if needed.

Primary reason	Secondary reason	
☐	☐	Not identified as potentially brain dead
☐	☐	Family declined organ donation
☐	☐	Family reasons not to test
☐	☐	Cardiac arrest before testing could be performed
☐	☐	Cardiorespiratory instability
☐	☐	Reversible causes of coma and / or apnoea could not be satisfactorily excluded
☐	☐	Unable to examine all brain stem reflexes or undertake ancillary tests
☐	☐	Absolute or relative medical contraindication to organ donation. Please specify contraindication.....
☐	☐	Other: please specify.....

Q 5.2 Speciality of primary Dr making decision concerning brain death tests. Tick one option only.

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgery/Neurology ☐ General Medicine

☐ General Surgery ☐ Palliative Care ☐ Anaesthesia

☐ Other please specify.....

Q 5.3 Seniority of primary Dr making the decision concerning brain death tests

☐ Trained professional ☐ Professional in training

Q 5.4 Was there a second Dr involved in the decision about performing brain death tests?

☐ Yes ☐ No ☐ Don't know

If yes:

Q 5.4a Speciality of second Dr making the decision concerning brain death tests.....

Q5.4b Seniority of second Dr making the decision concerning brain death tests

☐ Trained professional ☐ Professional in training

Q 6. Was the patient confirmed dead following brain death testing according to the criteria in your country?

☐ Yes: please answer ***questions 6.2, to 6.7*** and then proceed to ***question 8.***

☐ No: please answer ***questions 6.1 to 6.7*** and then proceed to ***question 7.***

Q6.1 What were the reasons for the patient not being confirmed brain dead following testing.

☐ Positive brain stem reflex
☐ Not apnoeic
☐ Ancillary tests failed to confirm brain death
☐ Other: please specify.....

Q 6.2 Speciality of first Dr performing brain death tests. Tick one option only.

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgery/Neurology ☐ General Medicine

☐ General Surgery ☐ Palliative Care ☐ Anaesthesia

☐ Other please specify.....

Q 6.3 Seniority of first Dr performing brain death tests

☐ Trained professional ☐ Professional in training

Q 6.4 Speciality of second Dr performing brain death tests (if applicable) tick one option only.

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgery/Neurology ☐ General Medicine

☐ General Surgery ☐ Palliative Care ☐ Anaesthesia

☐ Other: please specify.....

Q 6.5 Seniority of second Dr performing brain death tests (if applicable)

☐ Trained professional ☐ Professional in training

Q 6.6 Speciality of third Dr performing brain death tests (if applicable) tick one option only

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgery/Neurology ☐ General Medicine

☐ General Surgery ☐ Palliative Care ☐ Anaesthesia

☐ Other please specify.....

Q 6.7 Seniority of third Dr performing brain death tests (if applicable)

☐ Trained professional ☐ Professional in training

Q 7. If DBD was not a possibility and the patient's death followed planned withdrawal or limitation of life sustaining treatment, is there evidence that DCD was considered?

☐ Yes: please proceed to ***question 8.***

☐ No: please answer 7.1 and proceed to ***question 8***.

Q7.1 Please select one primary reason for DCD not being considered, and one secondary reason, if needed..

Primary Reason	**Secondary Reason**	
☐	☐	DCD not lawful in this country.

☐	☐	No DCD programme in this country.
☐	☐	No DCD programme in this hospital.
☐	☐	Not identified as a potential organ donor.
☐	☐	Patient had an absolute or relative contraindication for organ donation. Please specify contraindication
☐	☐	The nature of the withdrawal or limitation of treatment was not compatible with DCD.
☐	☐	Due to the patient's clinical condition, it was predicted that circulatory arrest would not occur within a timeframe that would allow DCD to occur.
☐	☐	Other: please specify.....

Q 8. Was the patient referred to a Key Donation Person?

☐ Yes: please answer ***question 8.2 to 8.4*** and proceed to ***question 9.***

☐ No: please answer ***question 8.1 to 8.4*** and proceed to ***question 9.***

☐ Don't Know ***please proceed to question 9***

Q 8.1 What were the reasons for not referring to the Key Donation Person.

Primary reason	**Secondary reason**	
☐	☐	Not identified as a potential organ donor.
☐	☐	Coroner/prosecutor/judicial reason/Judge.
☐	☐	Known patient wish not to be a donor.
☐	☐	Family declined donation.
☐	☐	Patient inappropriately thought to be unsuitable for organ donation.
☐	☐	Patient deemed unsuitable for organ donation because of absolute or relative

medical contraindications-.Please specify contraindication**.....**

☐ ☐ Other: please specify.....

Q8.2 Speciality of primary professional making decision about notification/referral to key donation person. Tick one option only

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgeon/Neurologist ☐ General Medicine

☐ General Surgeon ☐ Palliative Care ☐ Anaesthetist

☐ Nurse ☐ Other please specify.....

Q 8.3 Seniority of primary professional making decision about notification/referral to key donation person

☐ Trained professional ☐ Professional in training

Q 8.4 Was there a second professional involved in the decision about notification/referral to a key organ donation person

☐ Yes ☐ No ☐ Don't know

If yes:

Q 8.4a Speciality of second professional making decision about notification/referral to key donation person

Q 8.4b Seniority of second professional making decision about notification/referral to key donation person

☐ Trained professional ☐ Professional in training

Q 9. Were the family approached or informed about the possibility of organ donation?

☐ Yes: please proceed to ***question 9.2.***

☐ No: please answer ***question 9.1 and proceed to question 10***.

☐ Don't know please tick the appropriate box below and ***proceed to question 10***

Q 9.1 What were the reasons for not approaching or informing the family about organ donation.

Primary reason	Secondary reason	
☐	☐	Unable to contact the family.
☐	☐	Family had already declined the option of organ donation.
☐	☐	Coroner/prosecutor/judicial reason.
☐	☐	No critical care bed available.
☐	☐	Agreed medical contraindication to organ donation. Please specify medical contraindication
☐	☐	Other: please specify.....

Q 9.2. If the family were approached or informed about the possibility of organ donation, what was the speciality of the persons making the approach?

Please tick all boxes that apply, answer ***question 9.3*** and then proceed to ***question 10*****.**

☐ Intensive Care ☐ Emergency Medicine

☐ Neurosurgery/Neurology ☐ General Medicine

☐ General Surgery ☐ Palliative Care ☐ Anaesthesia

☐ Nurse ☐ Key organ donation person

☐ Family initiated the donation conversation

☐ Other: please specify.....

Q 9.3. Had at least one of the above professionals who had approached or informed the family about the possibility of organ donation received any formal training in how to approach a family about organ donation?

☐ Yes ☐ No ☐ Don't know

Q9.4. When were the family approached or informed about the possibility of organ donation?

☐ Before referral to the Key Donation Person.
☐ Family approached clinical staff about organ donation.
☐ After referral to the Key Donation Person.
☐ Other pleas specify.

Q 9.5. In the case of DBD when were the family approached or informed about the possibility of organ donation with regards to brain death testing

☐ Before brain death tests.
☐ After brain death tests have started, but before they have been completed and death has been confirmed.
☐ After brain death tests have been completed and death has been confirmed.

Q 9.6. In the case of DCD when were the family approached or informed about the possibility of organ donation with regards to withdrawal or limitation of life sustaining treatment

☐ Before a formal decision to withdraw or limit life sustaining treatment.
☐ After a decision has been made to limit or withdraw life sustaining treatment.

Q10. Did organ donation occur?

☐ Yes, DBD ☐ Yes, DCD

you have completed the questionnaire

☐ No: please answer ***question 10.1***:

Q 10.1 Please select one primary reason for donation not occurring and one secondary reason, if needed.

Primary reason	**Secondary reason**
☐	☐ Patient not intubated/receiving mechanical ventilation
☐	☐ Clinical condition not consistent with brain death
☐	☐ BD testing not undertaken despite clinical condition consistent with brain death

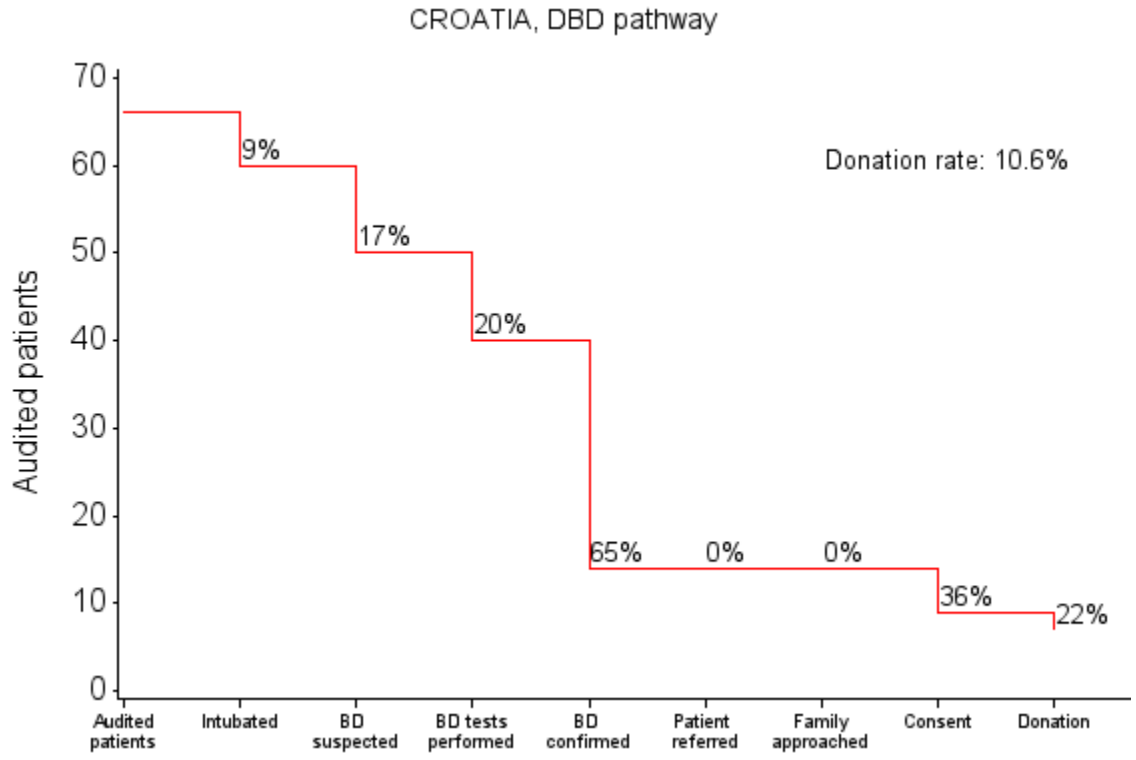
☐	☐	Brain death diagnosis not confirmed after undertaking brain death testing
☐	☐	DCD not considered
☐	☐	Family refusal
☐	☐	Coroner/prosecutor/judicial reason
☐	☐	Patient referred as a potential donor but all organs deemed medically unsuitable by the transplant centres
☐	☐	Cardiac arrest before organ recovery could occur.
☐	☐	Maastricht Category 3 DCD where the donation process was stopped as the patient did not die following withdrawal or limitation of treatment within a suitable timeframe that would allow organ donation to occur.
☐	☐	No suitable recipients for organs.
☐	☐	Logistical reasons

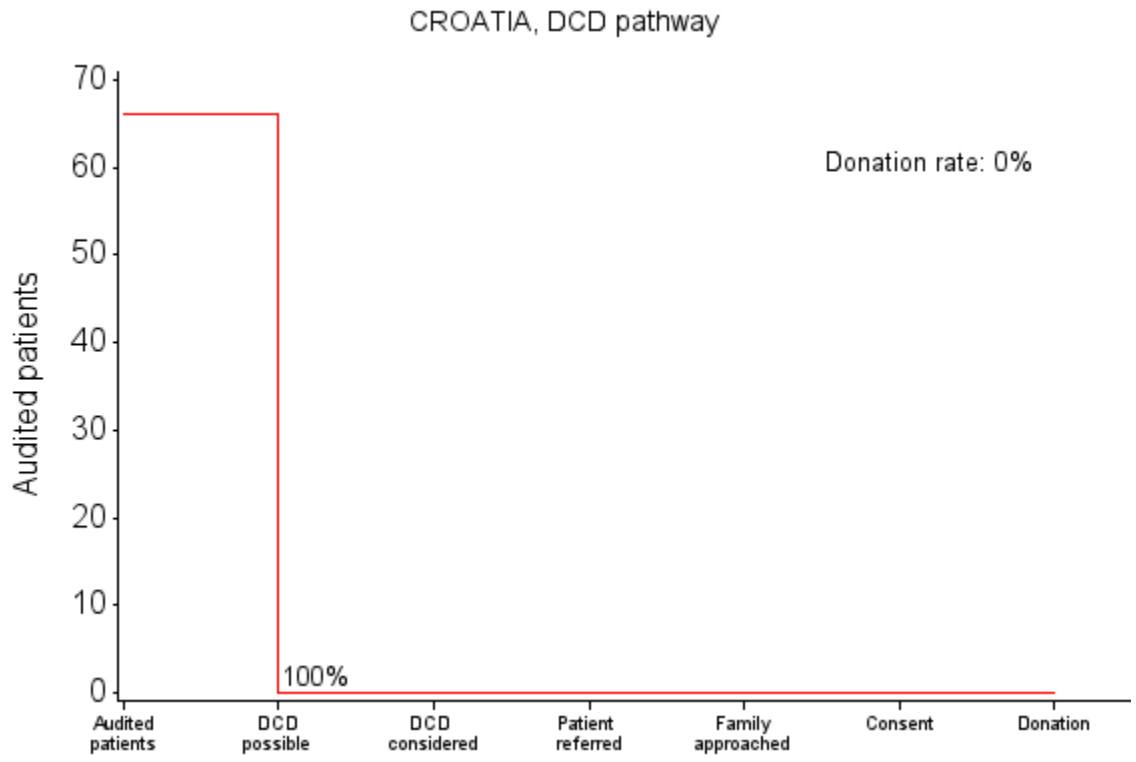
☐ Other: please specify.....

***Categories of medical contraindications to organ donation:**

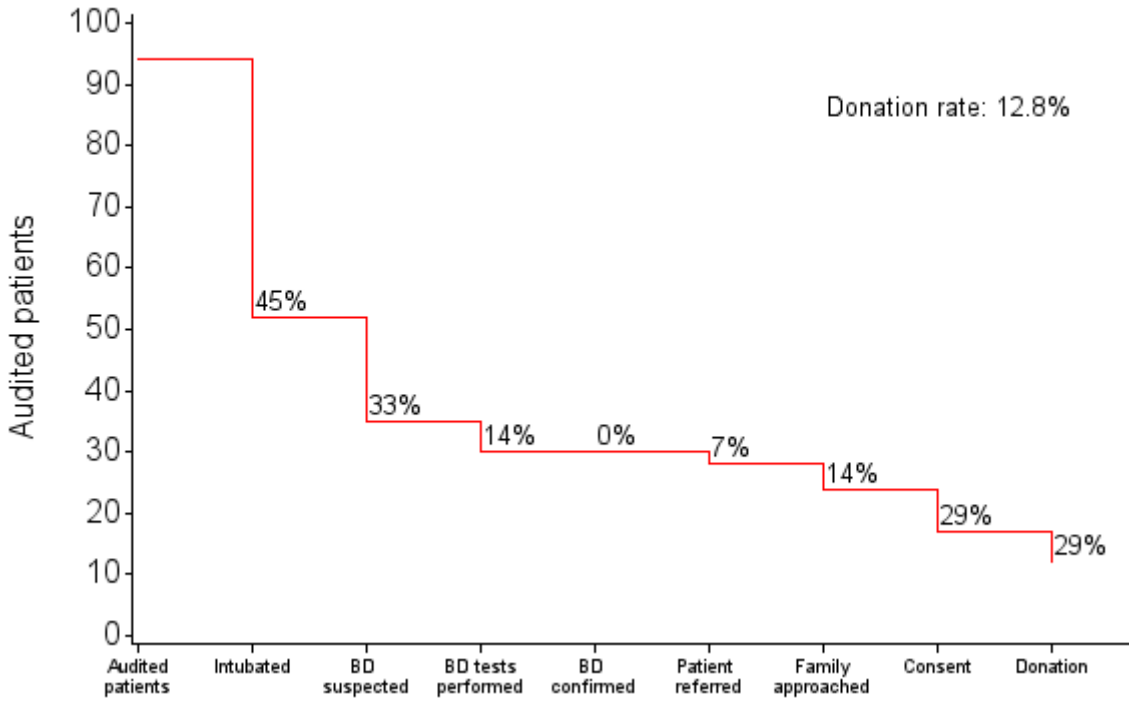
- Prior or present history of malignancy
- Prion disease
- HIV infection or disease
- HCV, HBV or HDV positive serology
- HTLV
- Sepsis/untreated/untreatable infectious disease
- Risk behaviour
- Haematological disease other than malignancy
- Autoimmune disease/connective tissue disorders
- Age criteria
- Unknown cause of death
- Unknown identity
- Other: please specify

Appendix 5: Step charts for the DBD and DCD pathway for individual Member States

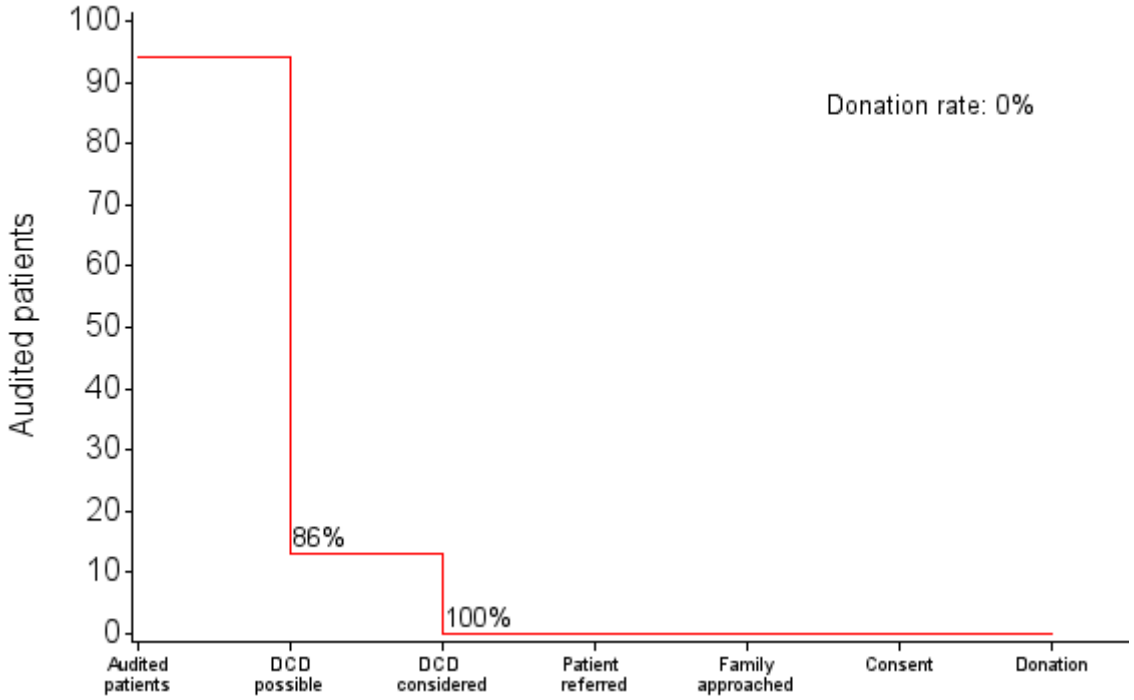




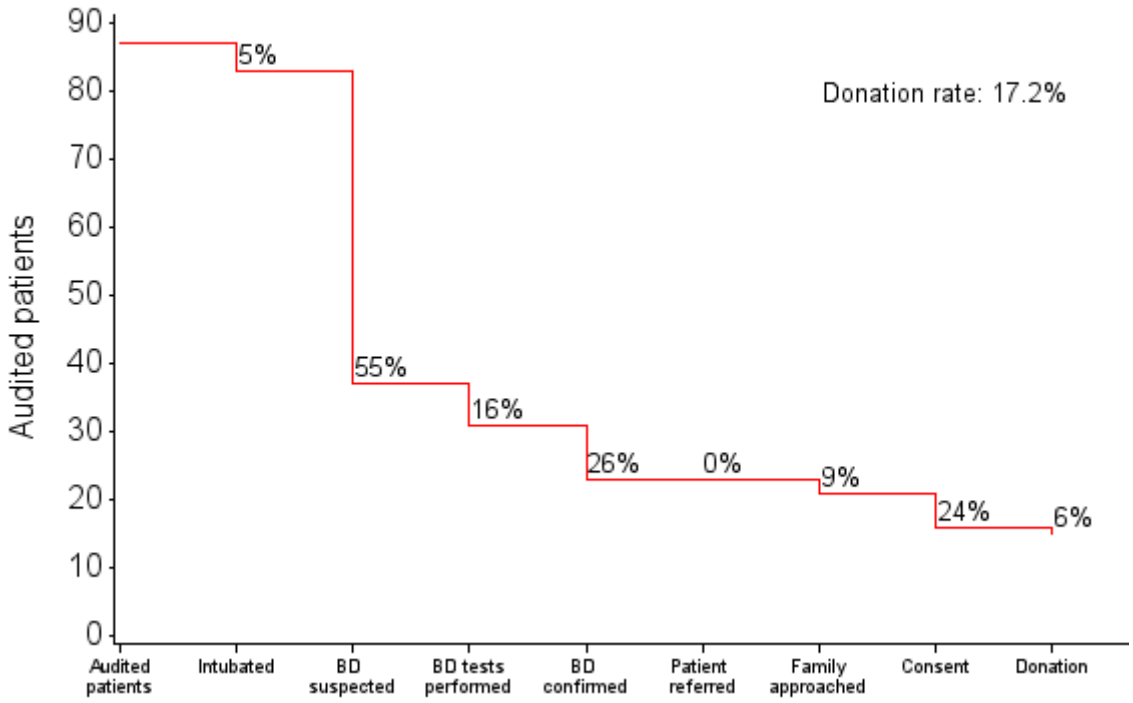
ESTONIA, DBD pathway



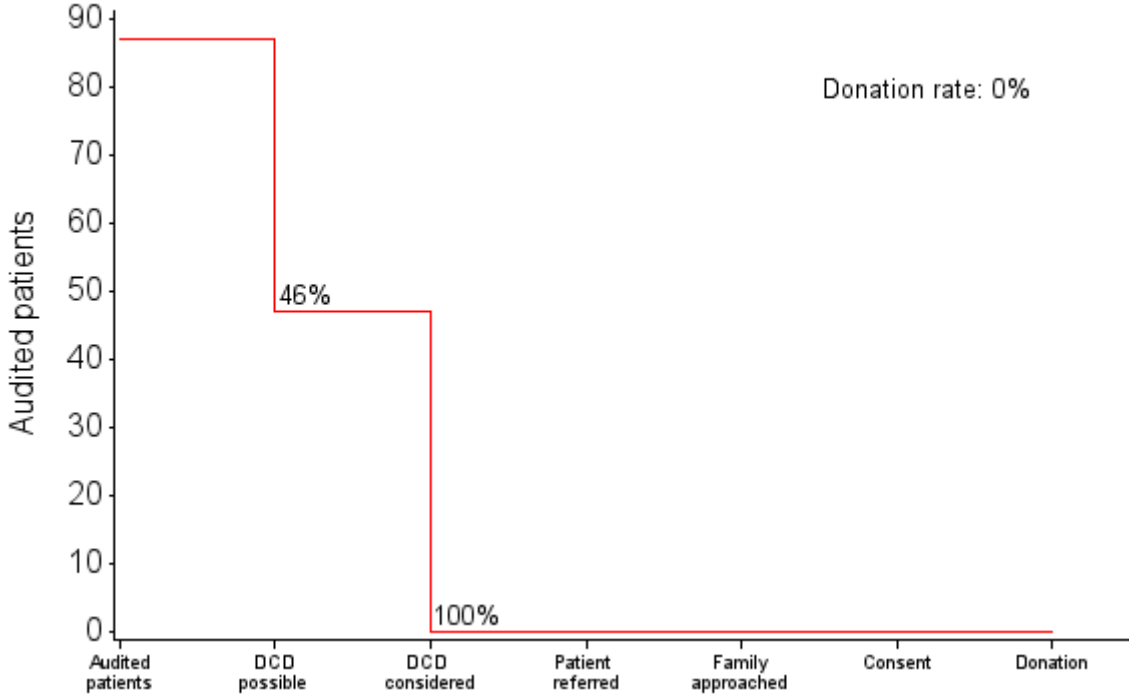
ESTONIA, DCD pathway



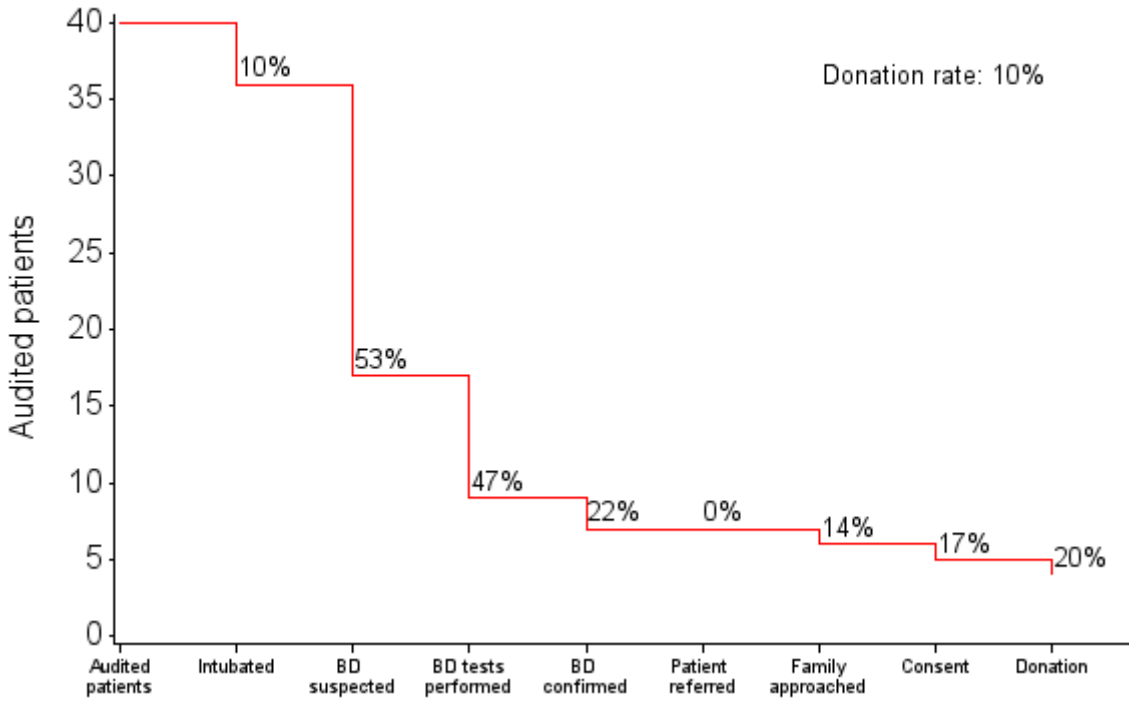
FRANCE, DBD pathway



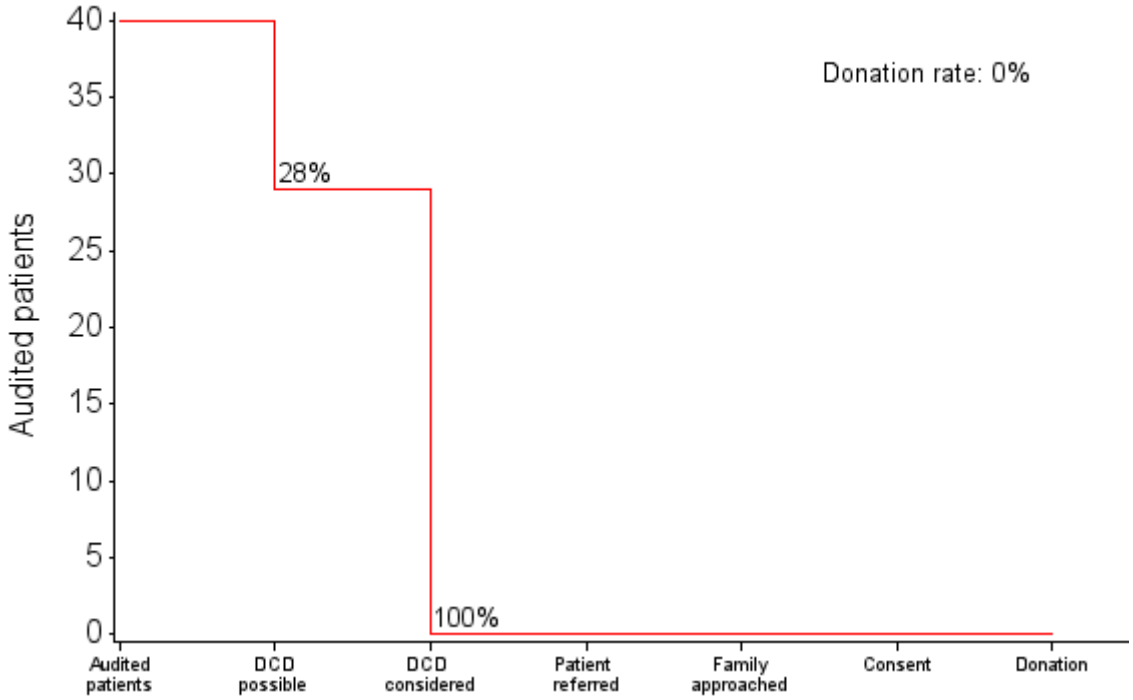
FRANCE, DCD pathway



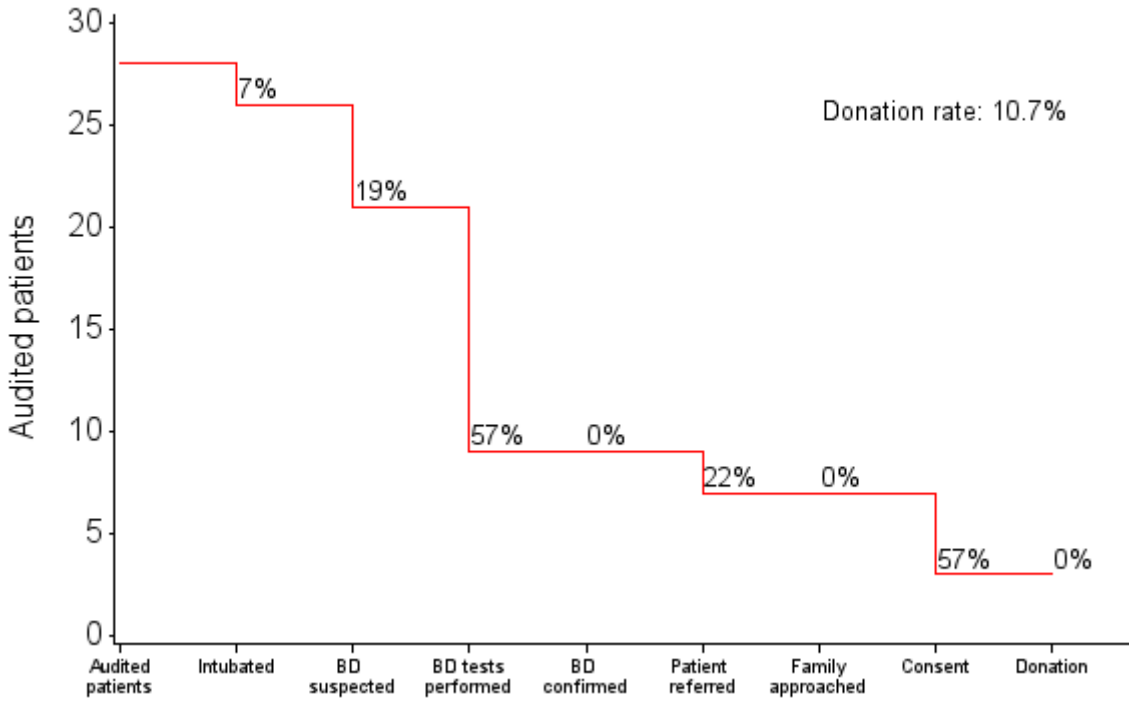
GERMANY, DBD pathway



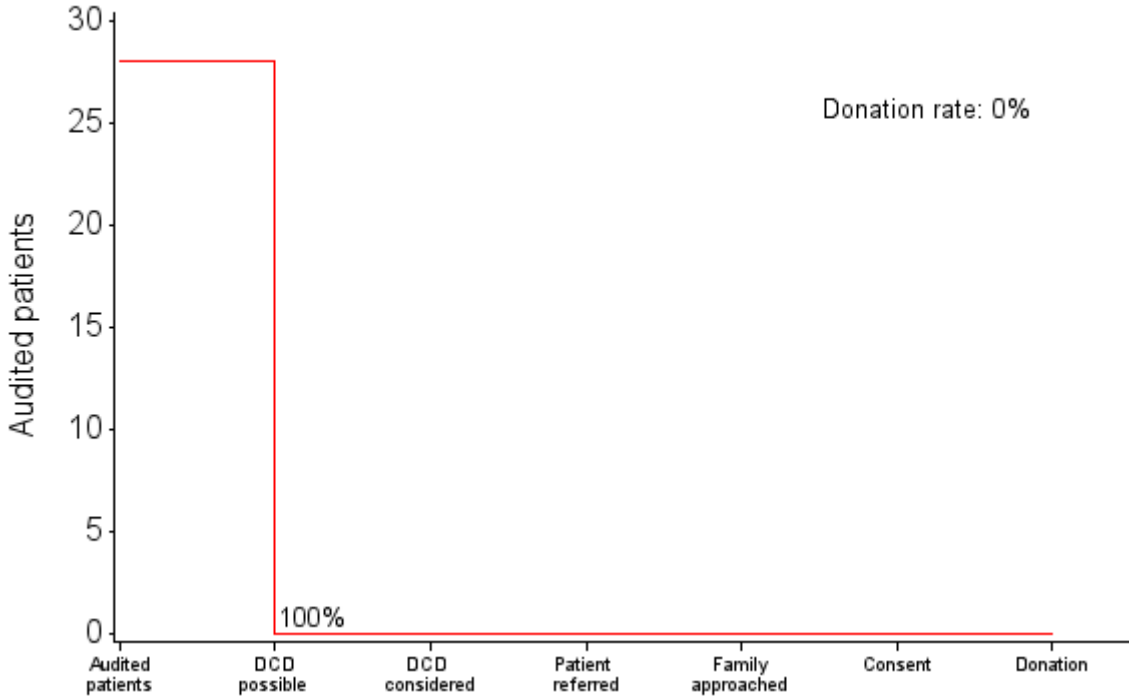
GERMANY, DCD pathway



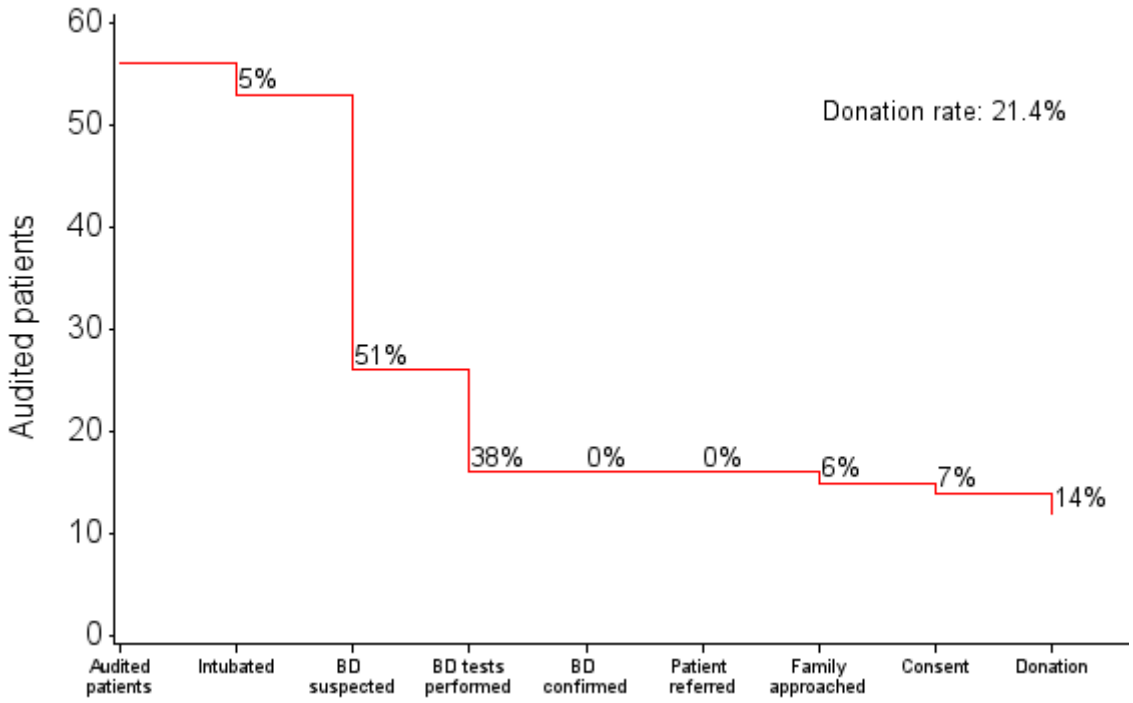
GREECE, DBD pathway



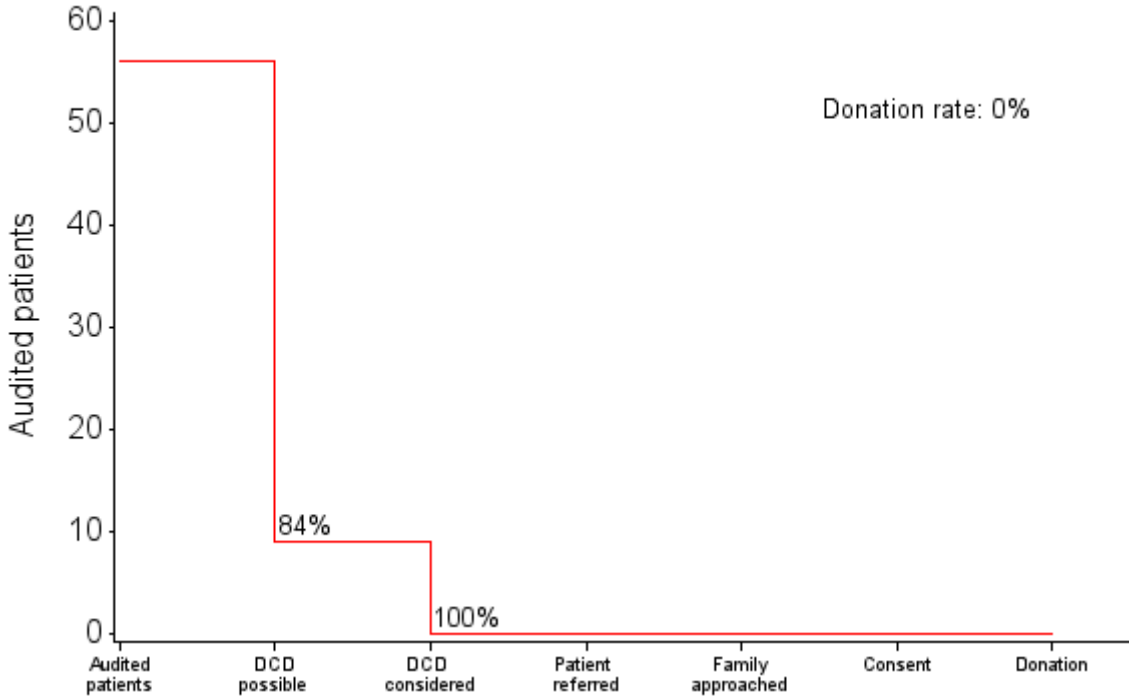
GREECE, DCD pathway

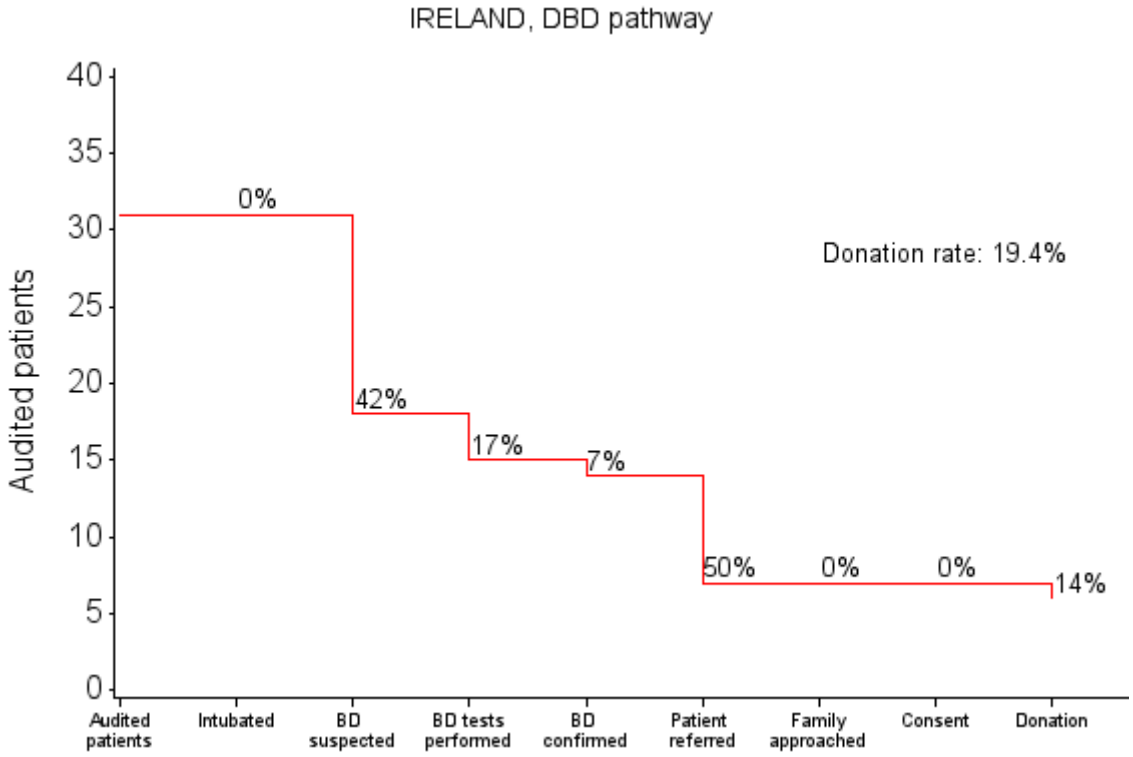


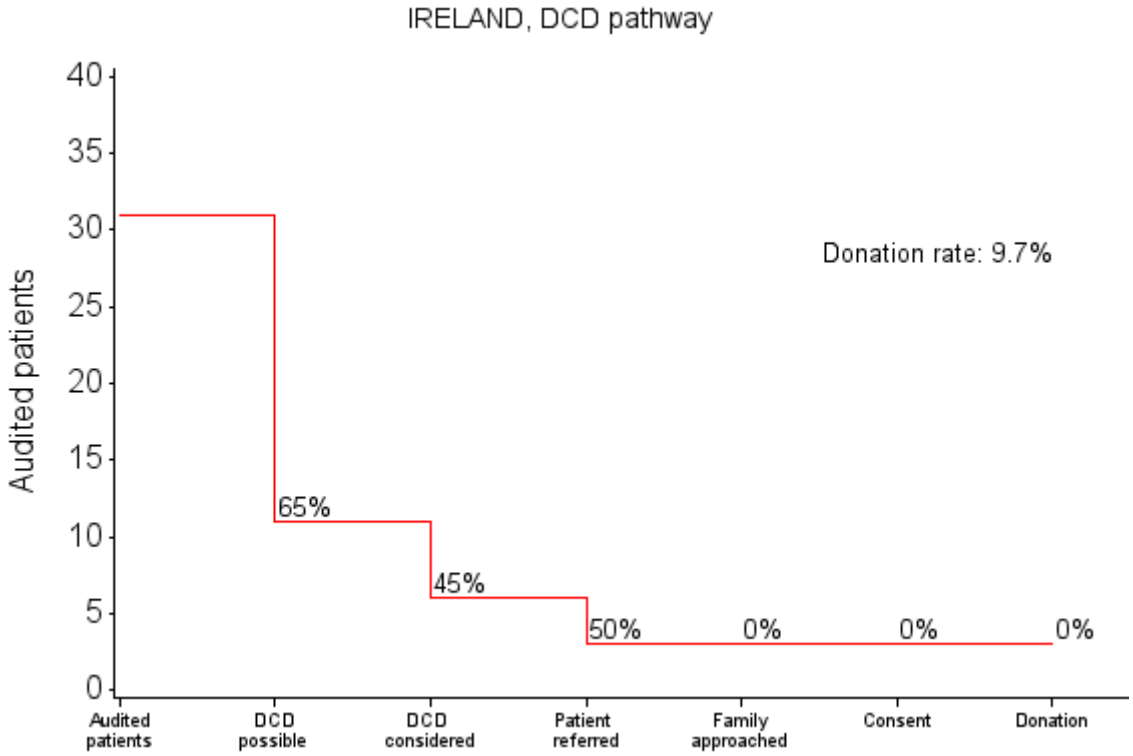
HUNGARY, DBD pathway

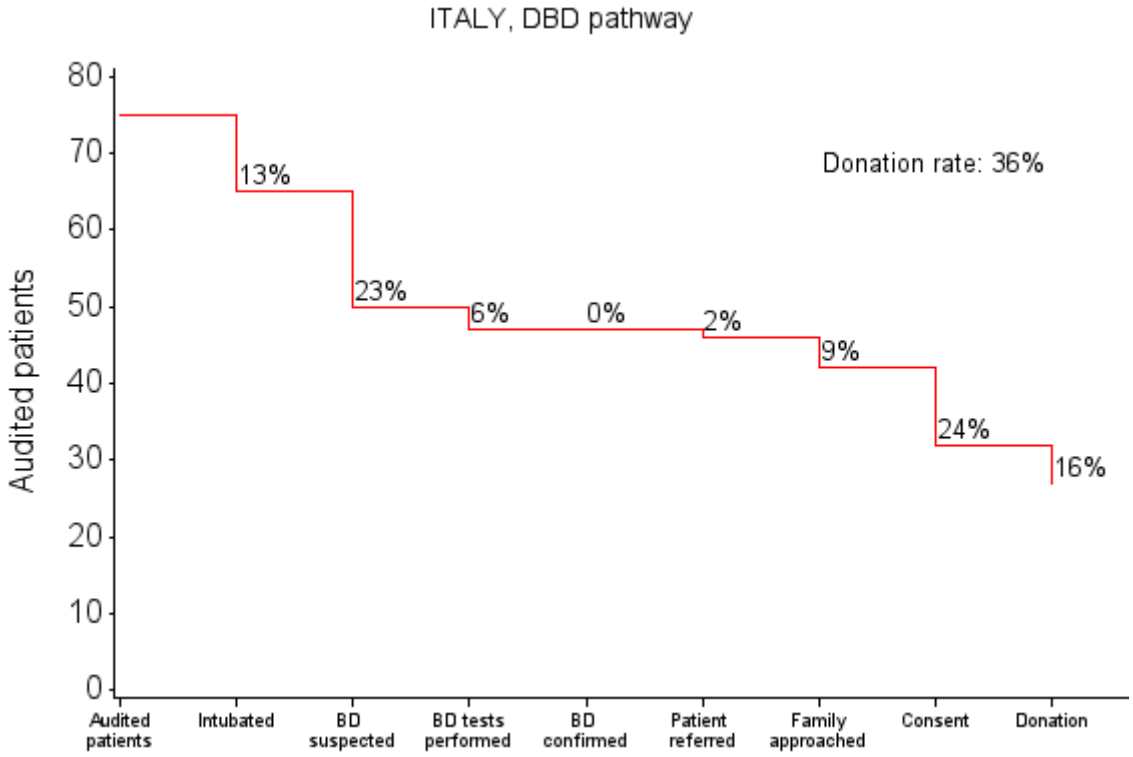


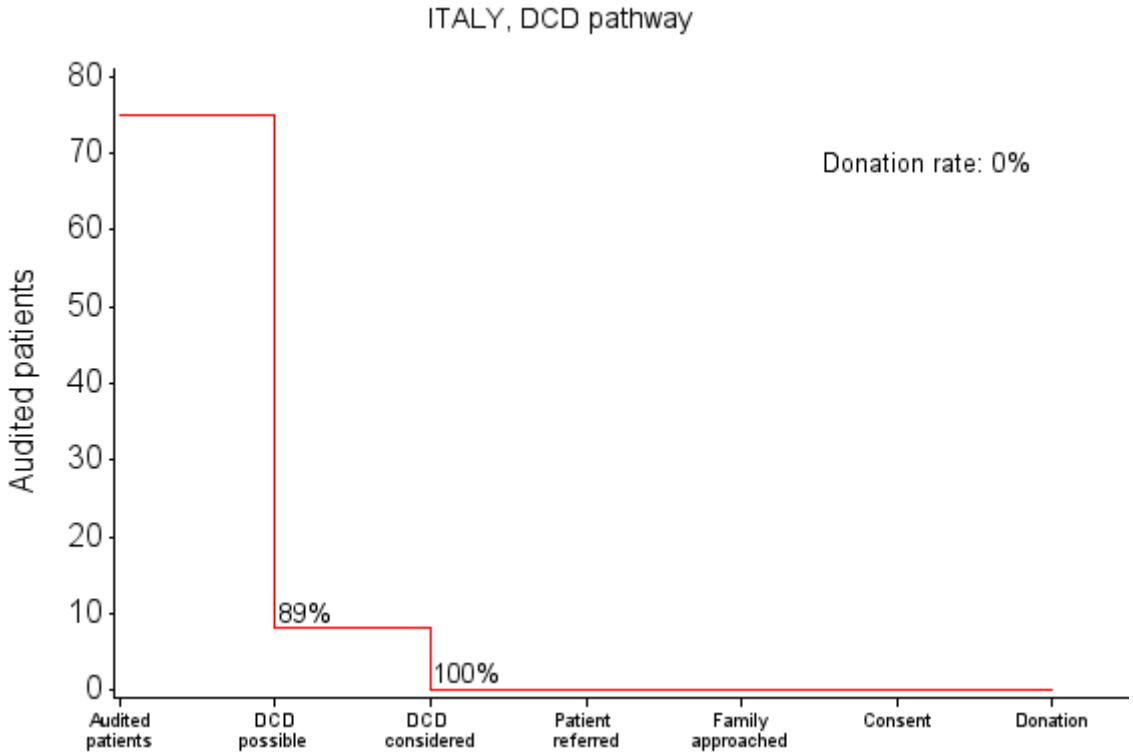
HUNGARY, DCD pathway

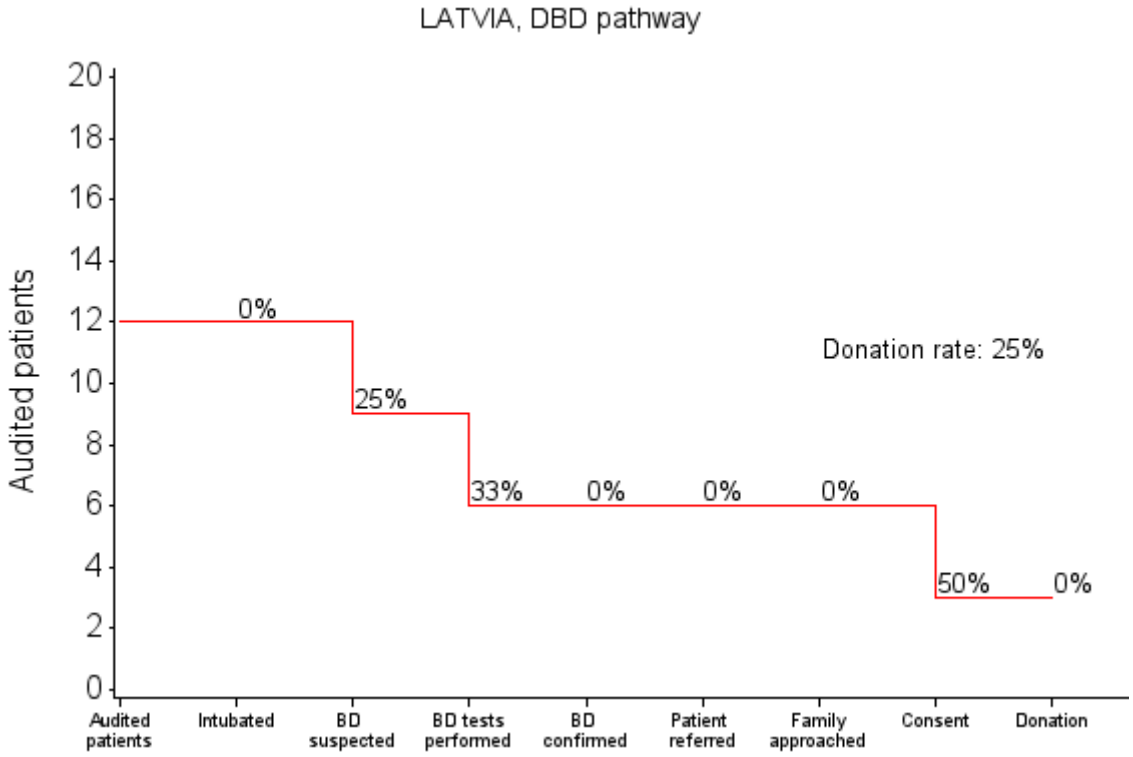


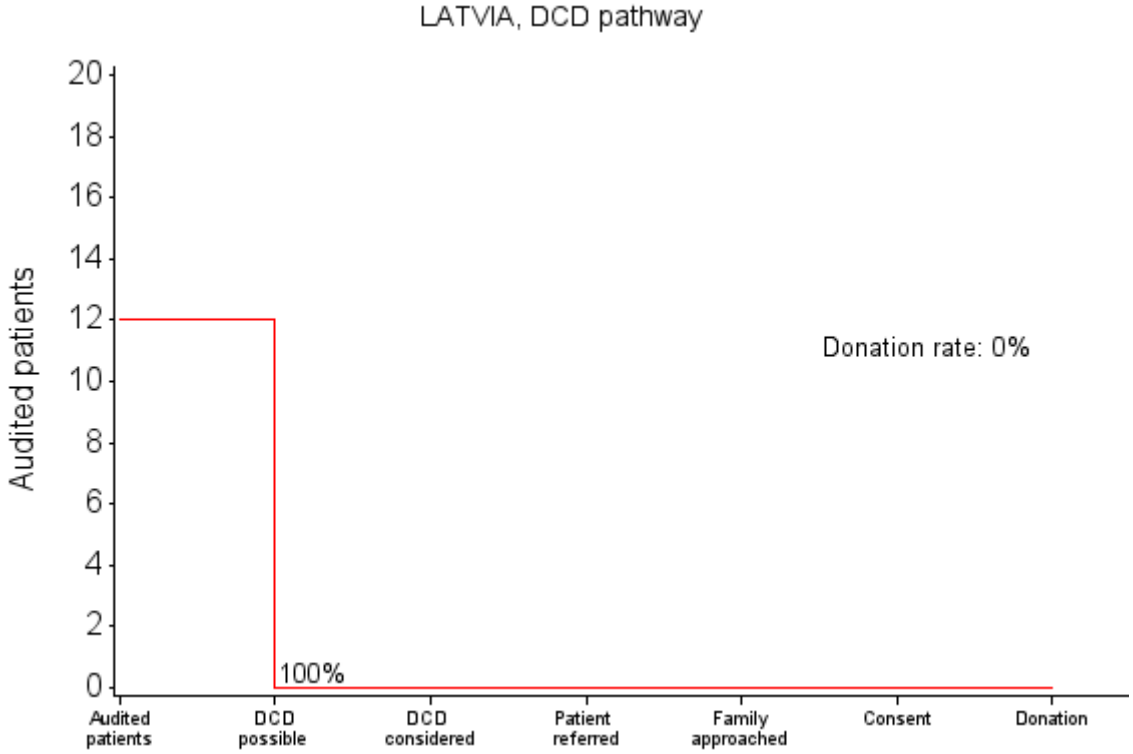

IRELAND, DBD pathway
Audited patients
40
35
30
25
20
15
10
5
0
0%
42%
17%
7%
50%
0%
0%
14%
Donation rate: 19.4%
Audited patients
Intubated
BD suspected
BD tests performed
BD confirmed
Patient referred
Family approached
Consent
Donation


IRELAND, DCD pathway
Audited patients
40
35
30
25
20
15
10
5
0
65%
45%
50%
0%
0%
0%
Donation rate: 9.7%
Audited patients
DCD possible
DCD considered
Patient referred
Family approached
Consent
Donation

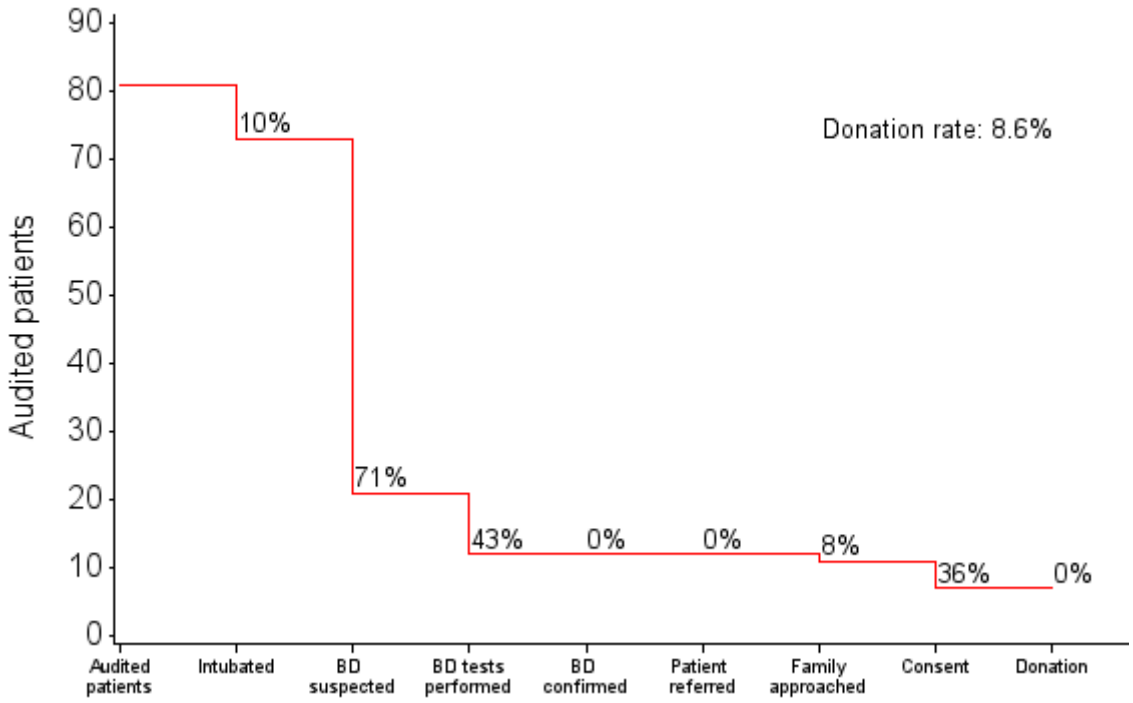

ITALY, DBD pathway
Audited patients
80
70
60
50
40
30
20
10
0
Donation rate: 36%
13%
23%
6%
0%
2%
9%
24%
16%
Audited patients
Intubated
BD suspected
BD tests performed
BD confirmed
Patient referred
Family approached
Consent
Donation


ITALY, DCD pathway
Audited patients
80
70
60
50
40
30
20
10
0
Donation rate: 0%
89%
100%
Audited patients
DCD possible
DCD considered
Patient referred
Family approached
Consent
Donation

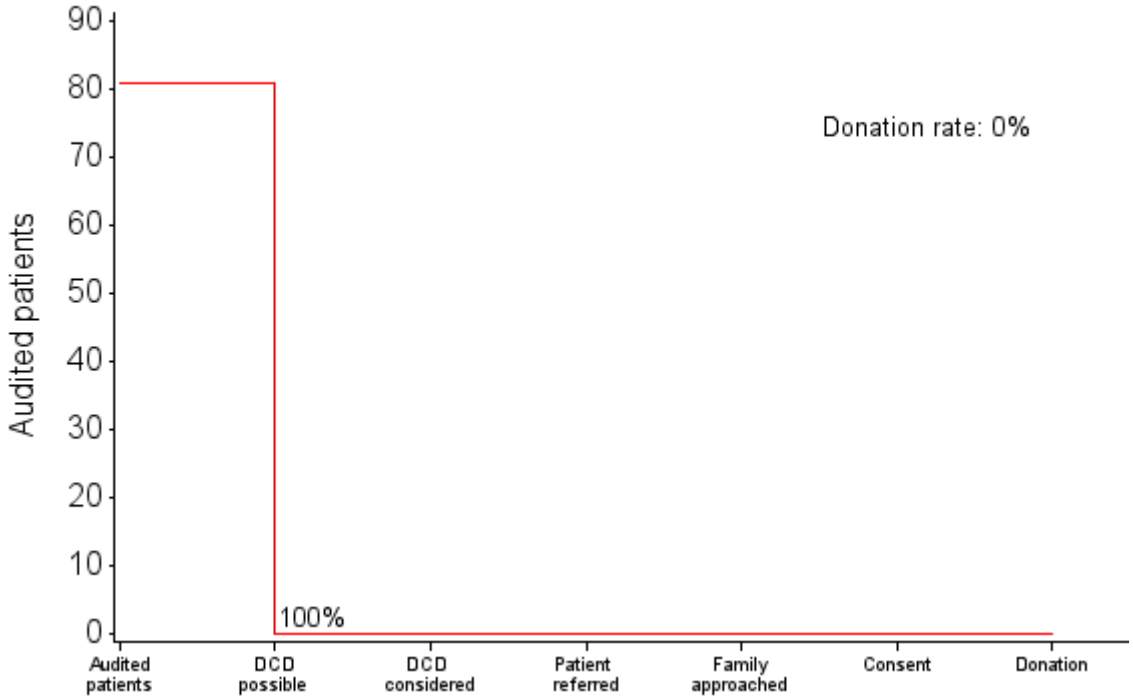

LATVIA, DBD pathway
Audited patients
20
18
16
14
12
10
8
6
4
2
0
0%
25%
33%
0%
0%
0%
50%
0%
Donation rate: 25%
Audited patients
Intubated
BD suspected
BD tests performed
BD confirmed
Patient referred
Family approached
Consent
Donation

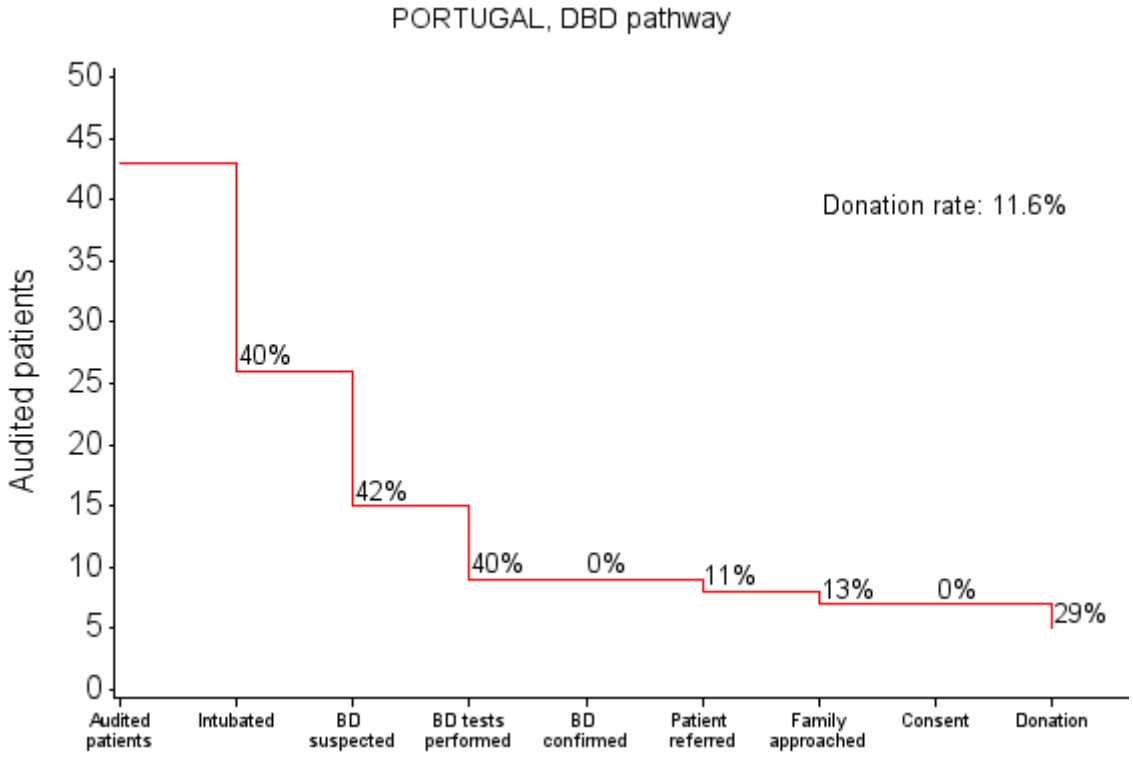

LATVIA, DCD pathway
Audited patients
20
18
16
14
12
10
8
6
4
2
0
100%
Donation rate: 0%
Audited patients
DCD possible
DCD considered
Patient referred
Family approached
Consent
Donation

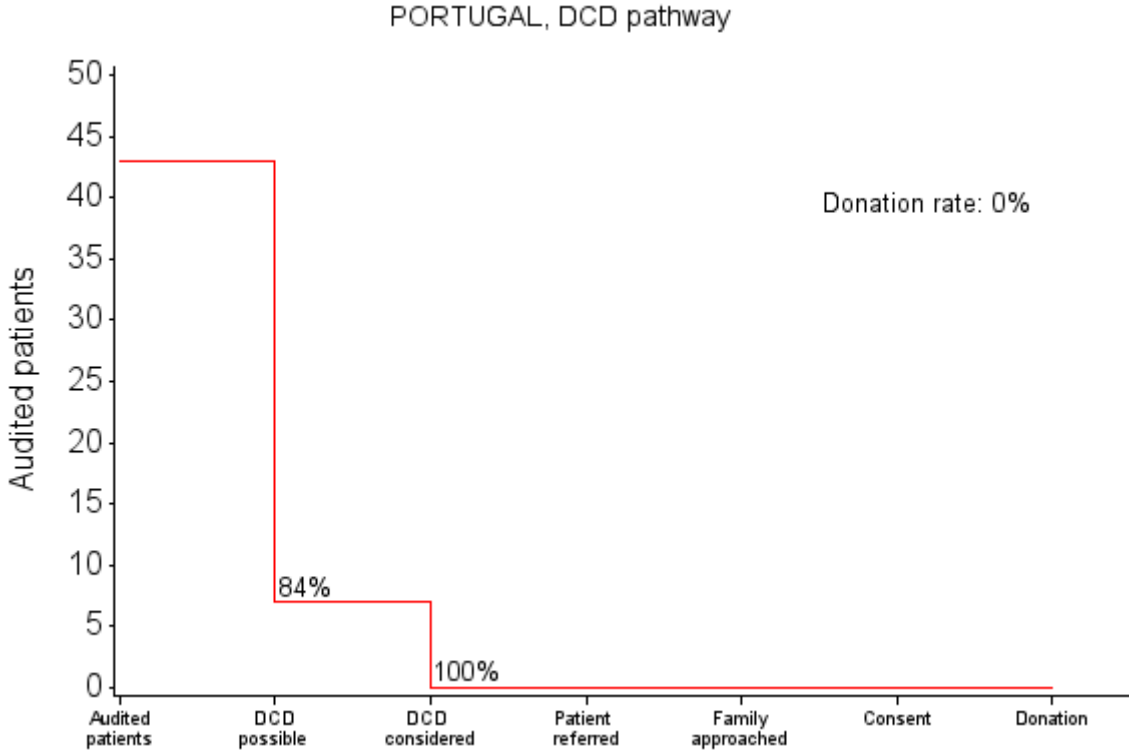
LITHUANIA, DBD pathway



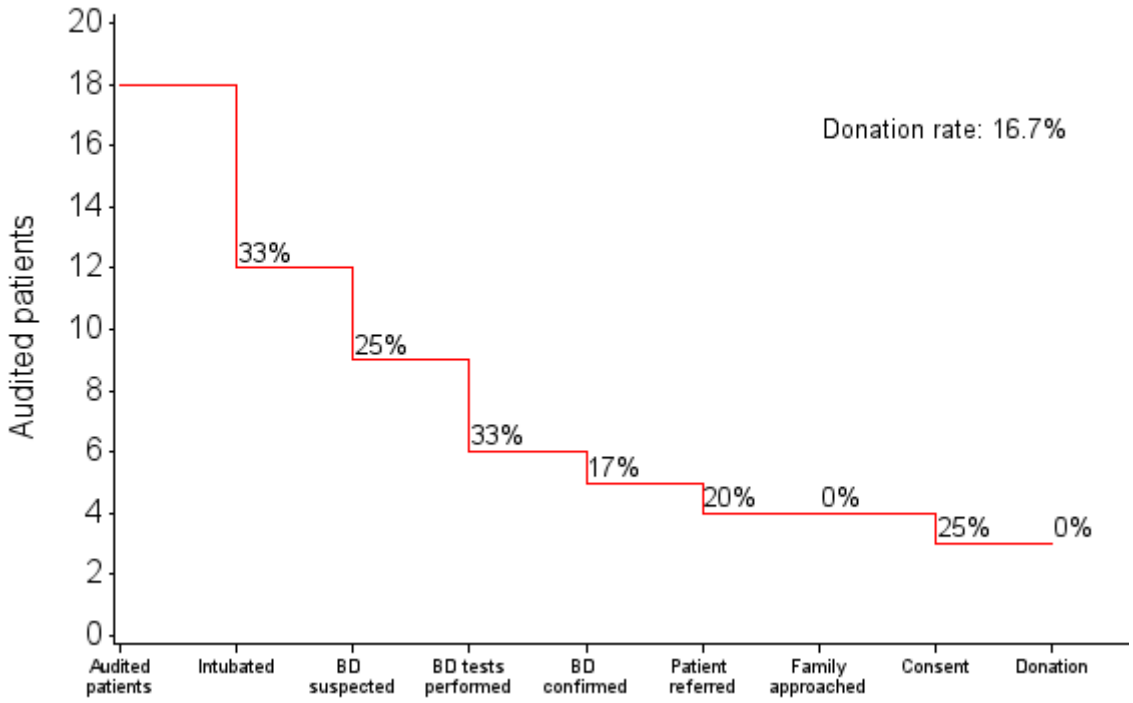
LITHUANIA, DCD pathway



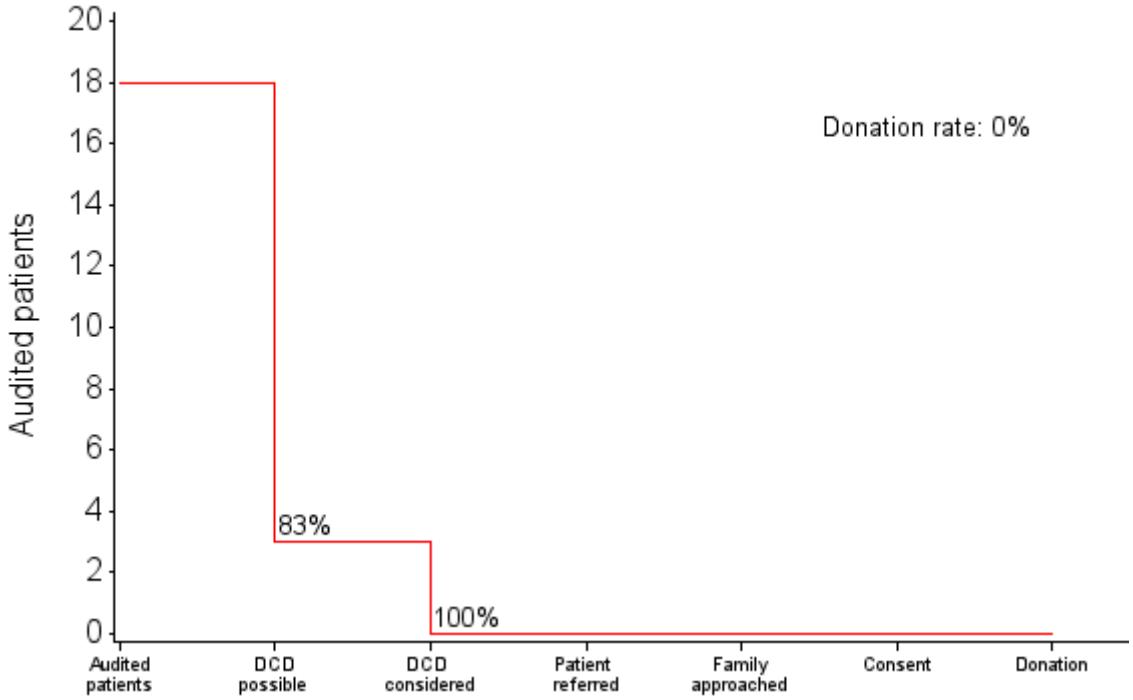

PORTUGAL, DBD pathway
Audited patients
50
45
40
35
30
25
20
15
10
5
0
Donation rate: 11.6%
40%
42%
40%
0%
11%
13%
0%
29%
Audited patients
Intubated
BD suspected
BD tests performed
BD confirmed
Patient referred
Family approached
Consent
Donation

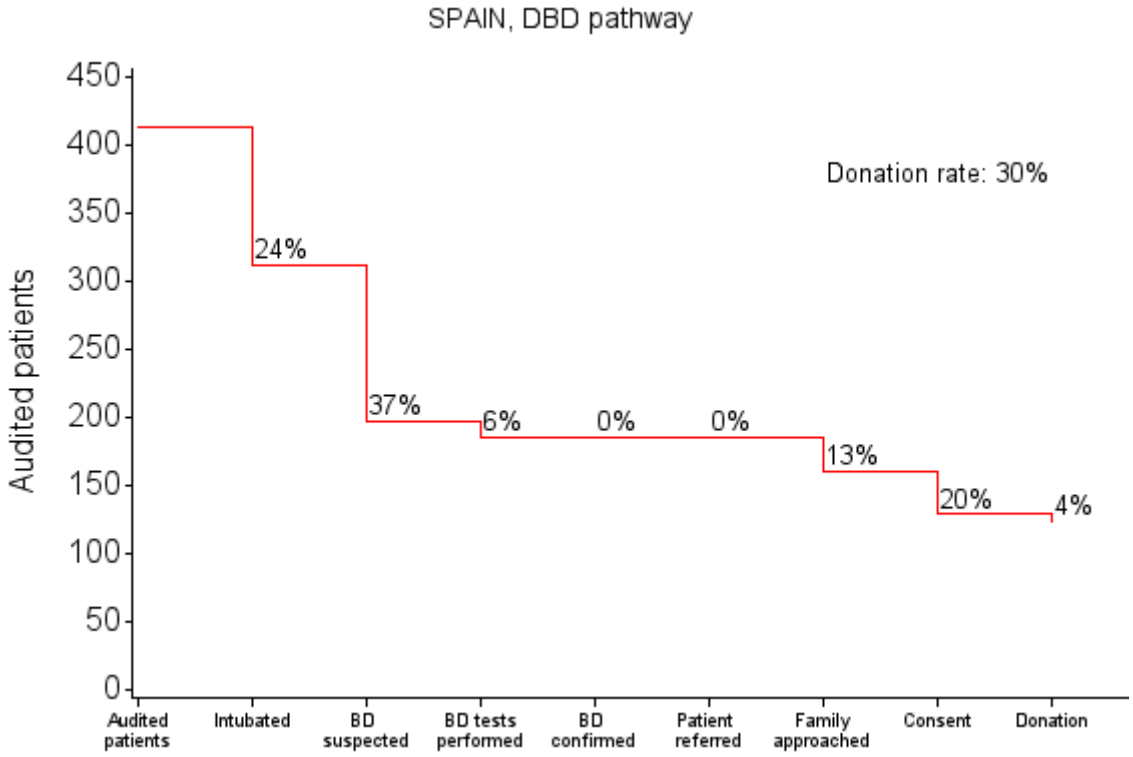

PORTUGAL, DCD pathway
Audited patients
50
45
40
35
30
25
20
15
10
5
0
Donation rate: 0%
84%
100%
Audited patients
DCD possible
DCD considered
Patient referred
Family approached
Consent
Donation

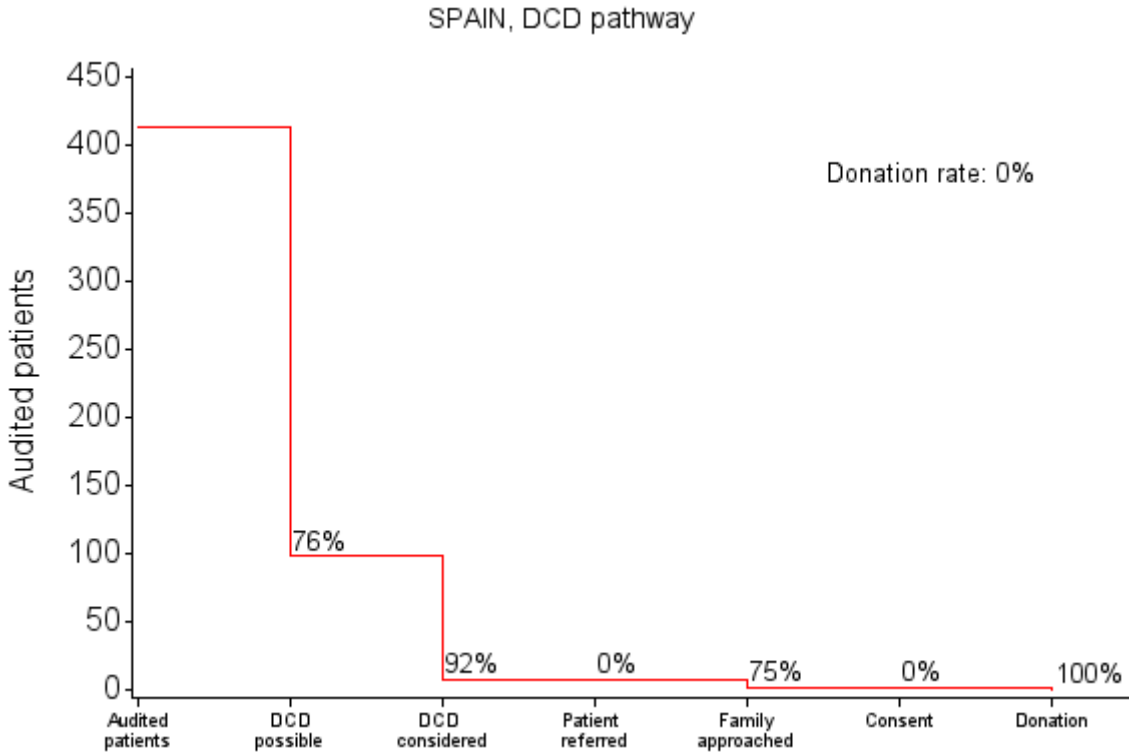
SLOVENIA, DBD pathway



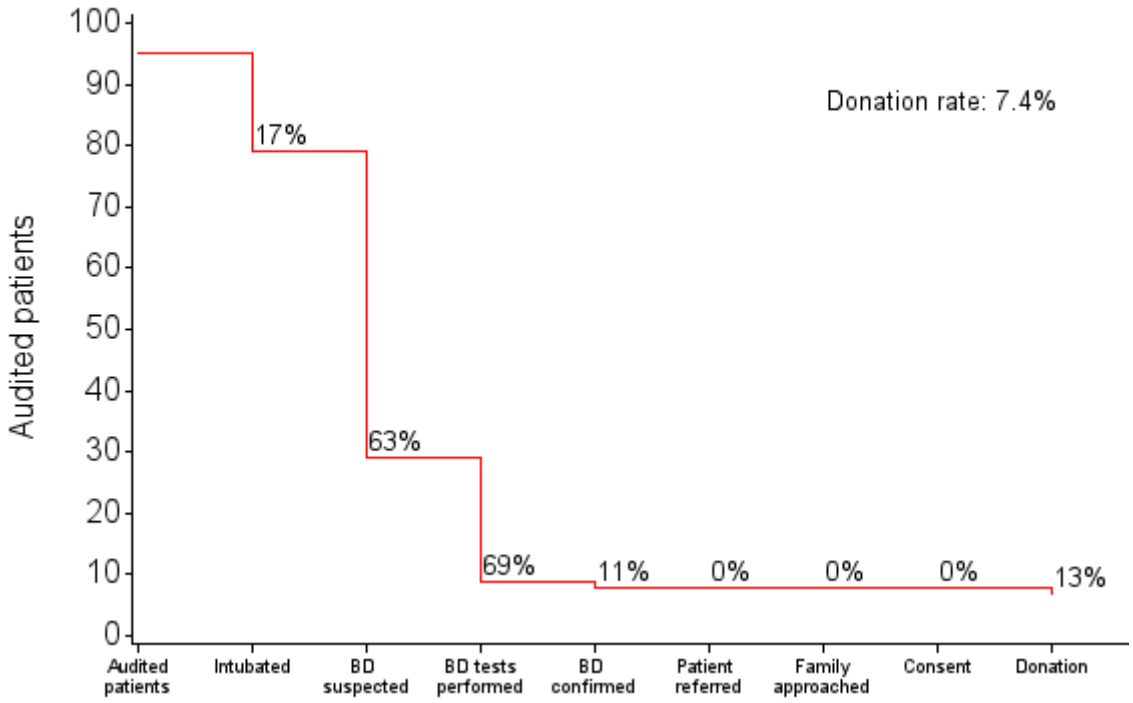
SLOVENIA, DCD pathway



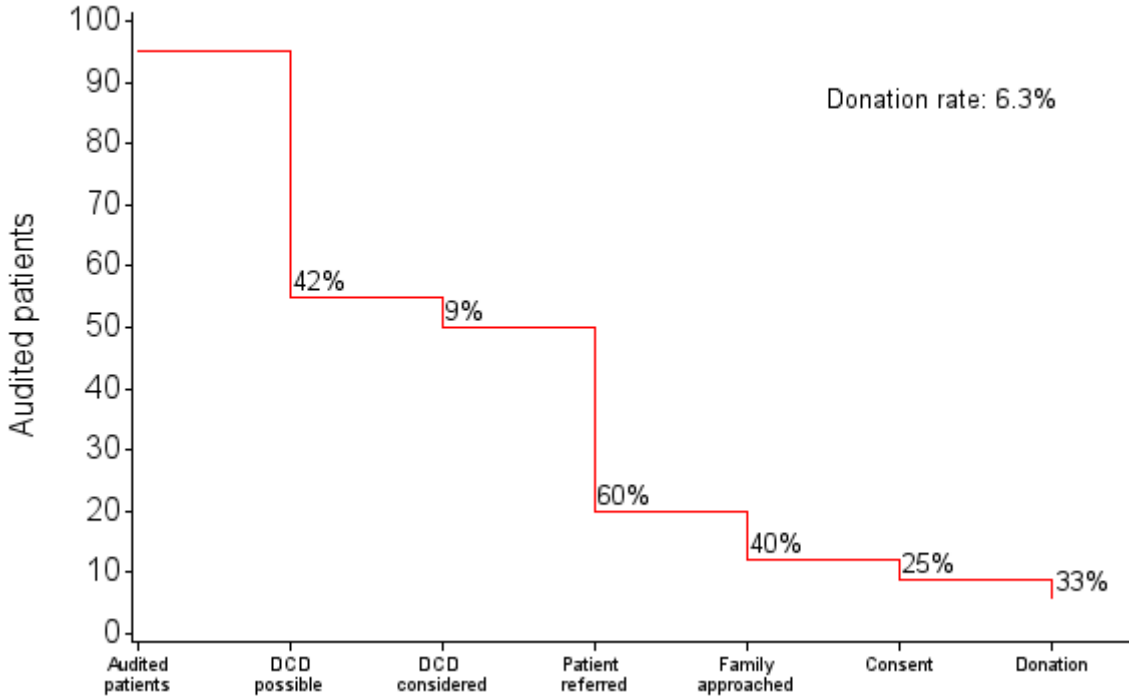

SPAIN, DBD pathway
Audited patients
450
400
350
300
250
200
150
100
50
0
Donation rate: 30%
24%
37%
6%
0%
0%
13%
20%
4%
Audited patients
Intubated
BD suspected
BD tests performed
BD confirmed
Patient referred
Family approached
Consent
Donation

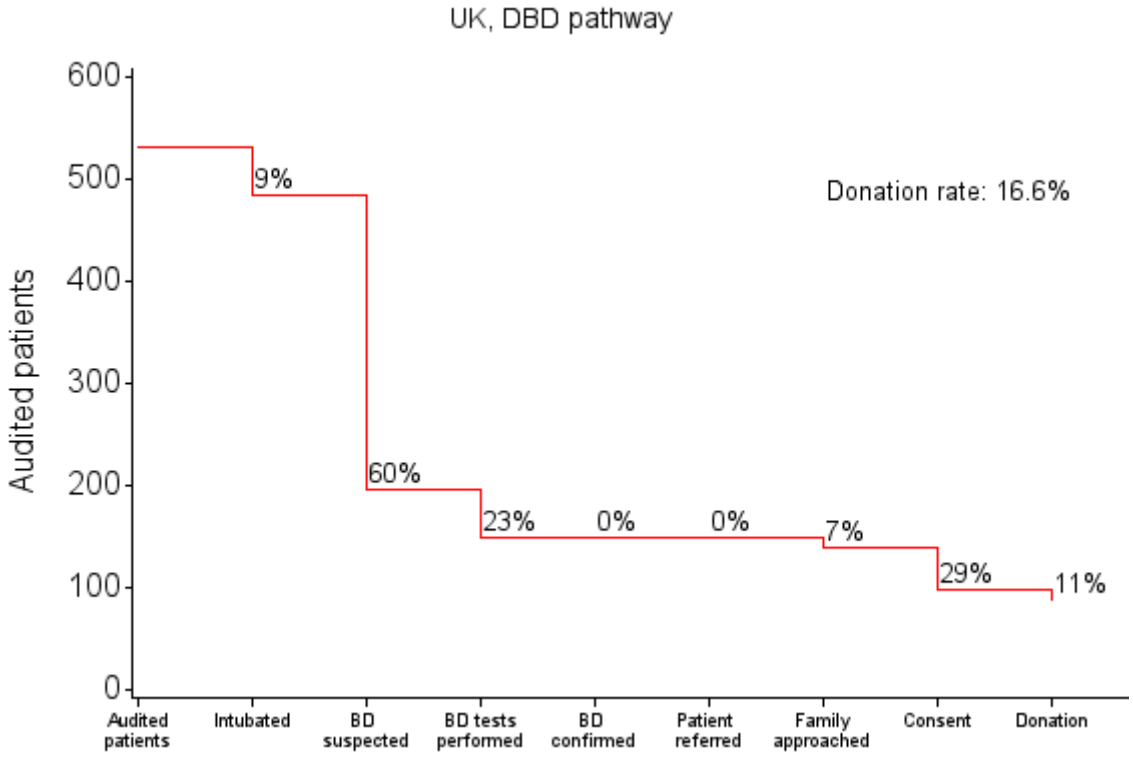

SPAIN, DCD pathway
Audited patients
450
400
350
300
250
200
150
100
50
0
Donation rate: 0%
76%
92%
0%
75%
0%
100%
Audited patients
DCD possible
DCD considered
Patient referred
Family approached
Consent
Donation

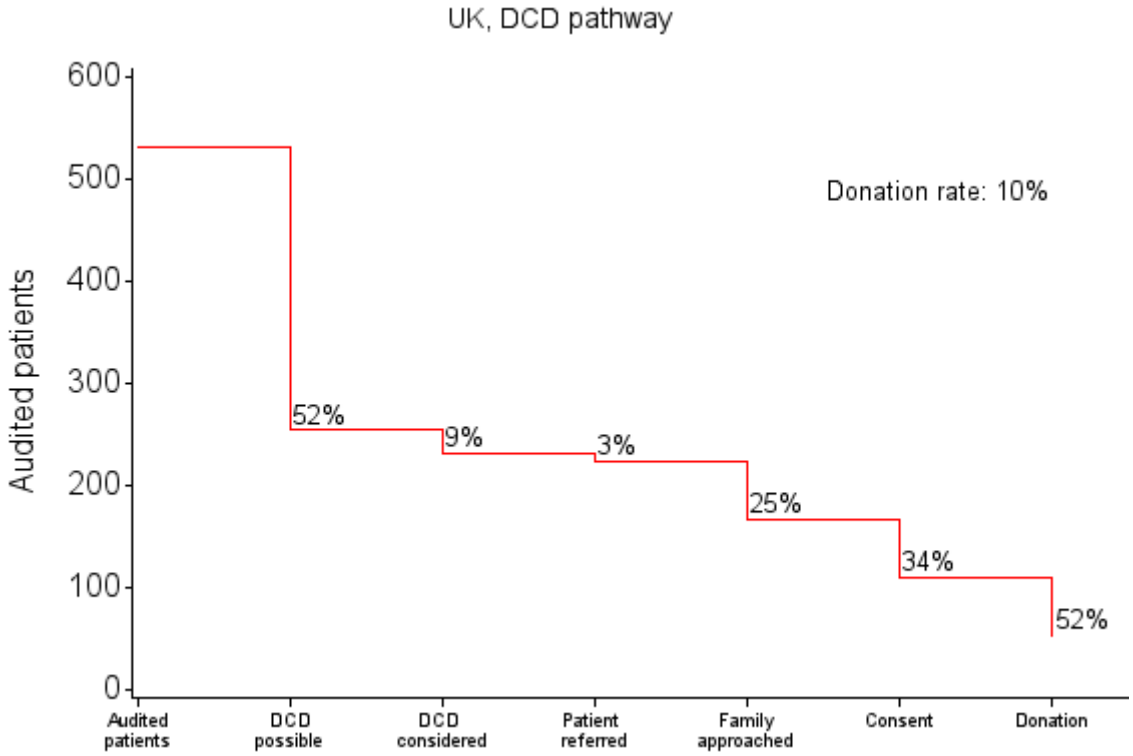
THE NETHERLANDS, DBD pathway



THE NETHERLANDS, DCD pathway




UK, DBD pathway
Audited patients
600
500
400
300
200
100
0
Donation rate: 16.6%
9%
60%
23%
0%
0%
7%
29%
11%
Audited patients
Intubated
BD suspected
BD tests performed
BD confirmed
Patient referred
Family approached
Consent
Donation


UK, DCD pathway
Audited patients
600
500
400
300
200
100
0
Donation rate: 10%
52%
9%
3%
25%
34%
52%
Audited patients
DCD possible
DCD considered
Patient referred
Family approached
Consent
Donation

APPENDIX 6 Full Data from Multivariate Analyses

Results are presented in terms of the odds of donation (or the relevant outcome) relative to a baseline group for each factor. An odds ratio of greater than one indicates a greater chance of donation relative to the baseline group. A p value of <0.05 was used to define statistical significance.

Model 1.

Table 1

Cohort: All patients. N= 1670
Odds-ratios for the donation model for all included factors. 492/1670 patients became donors.

Factor	Level	N	donors	(%)	Odds-ratio	95% CI	P-value
Random effect					-	-	0.7098
Unit	ICU	902	268	29.7	1		
	Other	317	12	3.8	0.11	(0.06 - 0.22)	<.0001
	Neuro ICU	374	121	32.4	1.08	(0.76 - 1.54)	0.6462
	ED	77	1	1.3	0.02	(0.00 - 0.18)	0.0005
Age	0-17 years	44	11	25.0	1.44	(0.63 - 3.28)	0.3778
	18-49	371	139	37.5	2.60	(1.80 - 3.75)	<.0001
	50-59	297	79	26.6	1.61	(1.09 - 2.39)	0.0185
	60-69	385	75	19.5	1.11	(0.76 - 1.63)	0.5840
	70+	573	98	17.1	1		
Sex	Male	1034	324	22.6	1		
	Female	636	168	26.4	1.34	(1.02 - 1.76)	0.0342
Cause of death	Cerebrovascular accidents	927	231	24.9	1		
	Trauma	326	110	33.7	1.20	(0.86 - 1.68)	0.2749
	cerebral damage	305	51	16.7	0.54	(0.34 - 0.84)	0.0071
	cerebral neoplasm	80	6	7.5	0.25	(0.10 - 0.63)	0.0040
	infections	32	4	24.9	0.54	(0.17 - 1.75)	0.2975
Days from brain injury to death	0 days	112	14	12.5	1		
	1-2	664	208	31.3	1.87	(0.96 - 3.61)	0.0637
	3-6	522	119	22.8	1.36	(0.69 - 2.66)	0.3681
	7-10	201	40	19.9	1.20	(0.57 - 2.53)	0.6319
	11+	171	21	12.3	0.60	(0.26 - 1.37)	0.2195
Number of adult beds	1-19	340	83	24.4	1		

	20-34	487	97	19.9	0.43	(0.28 - 0.64)	<.0001
	35-49	299	83	27.8	0.67	(0.43 - 1.05)	0.0789
	50+	544	139	25.6	1.03	(0.64 - 1.66)	0.9064
Clinical background of KDP	Dr	961	207	21.5	1		
	Nurse	677	181	26.7	0.72	(0.50 - 1.05)	0.0858
	Other	32	14	43.8	2.07	(0.83 - 5.17)	0.1162
Written policy/guideline/protocol for OD process	No	137	23	16.8	1		
	Yes	1533	379	24.7	1.52	(0.85 - 2.74)	0.1582
DCD program	No	363	53	14.6	1		
	Yes	1307	349	26.7	2.26	(1.44 - 3.55)	0.0006
ethical codes of practice	No	282	41	14.5	1		
	Yes	1388	361	26.0	1.55	(1.00 - 2.42)	0.0508
Responsibility for OD	CC doctor only	252	40	15.9	1		
	KDP and CC doctor	1418	362	25.5	2.68	(1.67 - 4.30)	<.0001
Was patient referred for neurosurgery	No	529	72	13.6	1		
	Yes	1141	330	28.9	1.94	(1.30 - 2.91)	0.0016
Discipline of person making intubation/ventilation decision	ICU	560	142	25.4	1		
	Emergency medicine	422	136	32.2	1.28	(0.91 - 1.80)	0.1596
	Other	688	124	18.0	0.88	(0.63 - 1.24)	0.4564

Model 2.

Table 2

Cohort: mechanically ventilated patients only. N=1404
Odds-ratios for the DBD model for all included factors. 328/1404 patients became DBD donors.

Factor	**Level**	**N**	**DBD donors**	**(%)**	**Odds-ratio**	**95% CI**	**P-value**
Random hospital effects					-	-	0.0116
Unit	ICU	888	221	24.9	1		
	Other	109	11	10.1	0.31	(0.14 - 0.66)	0.0030
	Neurological ICU	364	95	26.1	0.95	(0.60 - 1.52)	0.8383
	ED	43	1	2.3	0.04	(0.00 - 0.31)	0.0026

Age	0-17	43	9	20.9	1.50	(0.60 - 3.76)	0.3791
	18-49	363	111	30.6	2.53	(1.68 - 3.80)	<.0001
	50-59	277	62	22.4	1.61	(1.03 - 2.51)	0.0354
	60-69	324	62	19.1	1.12	(0.73 - 1.71)	0.5986
	70+	397	84	21.2	1		
Sex	Male	874	180	20.6	1		
	Female	530	148	27.9	1.67	(1.24 - 2.26)	0.0011
Cause of death	Cerebrovascular accidents	724	202	27.9	1		
	Trauma	314	91	29.0	1.22	(0.85 - 1.76)	0.2725
	cerebral damage	294	28	9.5	0.22	(0.14 - 0.36)	<.0001
	cerebral neoplasm	42	4	9.5	0.21	(0.07 - 0.65)	0.0077
	infections	30	3	10.0	0.39	(0.10 - 1.48)	0.1642
Days from brain injury to death	0	93	13	14.0	1		
	1-2	558	184	33.0	1.48	(0.73 - 3.02)	0.2746
	3-6	450	92	20.4	0.93	(0.45 - 1.92)	0.8318
	7-10	169	25	14.8	0.58	(0.25 - 1.35)	0.2011
	11+	134	14	10.5	0.37	(0.15 - 0.92)	0.0331
Number of adult beds	1-19	328	78	23.8	1		
	20-34	579	111	19.2	0.52	(0.29 - 0.94)	0.0294
	35-49	303	81	26.7	0.92	(0.48 - 1.75)	0.7931
	50+	194	58	29.9	1.59	(0.76 - 3.31)	0.2108
DCD program	No	317	50	15.8	1		
	Yes	1087	278	25.6	1.63	(0.92 - 2.87)	0.0923
Ethical codes of practice	No	216	30	13.9	1		
	Yes	1188	298	25.1	2.30	(1.17 - 4.53)	0.0164
Responsibility for OD	ICU doctor only	186	43	23.1	1		
	KDP and CC doctor	1218	328	23.4	1.89	(0.93 - 3.85)	0.0763

Model 3

Table 3.

Cohort: All patients. N=1670.
Odds-ratios for the model where intubation and ventilation is the outcome.
1404/1670 patients were intubated and mechanically ventilated.

Factor	Level	N	Intubated	%	Odds-ratio	95% CI	P-value
Random effect					-	-	0.0453
Unit	ICU	902	888	98.5	1		
	Other	317	109	34.4	0.01	(0.00 - 0.02)	<.0001
	Neuro ICU	374	364	97.3	0.36	(0.12 - 1.06)	0.0625
	ED	77	43	55.8	0.02	(0.01 - 0.04)	<.0001
Age	0-17	44	43	97.7	21.30	(0.08 - >999)	0.2825
	18-49	371	363	97.8	14.45	(4.88 - 42.82)	<.0001
	50-59	297	277	93.3	2.85	(1.29 - 6.33)	0.0107
	60-69	385	324	84.2	2.33	(1.31 - 4.16)	0.0046
	70+	573	397	69.3	1		
Cause of death	Cerebrovascular accidents	927	724	78.1	1		
	Trauma	326	314	96.3	5.28	(2.20 - 12.66)	0.0003
	cerebral damage	305	294	96.4	3.67	(1.57 - 8.56)	0.0032
	cerebral neoplasm	80	42	52.5	0.14	(0.06 - 0.35)	<.0001
	infections	32	30	93.8	13.75	(1.45 - 130.62)	0.0232
Profession involved in decision about intubation	ICU	560	515	92.0	1		
	Emergency	422	391	92.7	1.26	(0.55 - 2.89)	0.5810
	Other	688	498	72.4	0.37	(0.19 - 0.71)	0.0036
2nd decision maker involved?	No	1256	1088	86.6	1		
	Yes	414	316	76.3	0.41	(0.23 - 0.70)	0.0017
hospital performs organ transplants	No	878	700	79.7	1		
	Yes	792	704	88.9	1.91	(0.86 - 4.24)	0.1086
24 hr access HLA and virology testing	No	522	398	76.2	1		
	Yes	1148	1006	87.6	2.69	(1.15 - 6.27)	0.0228
ethical codes of practice	No	282	216	76.6	1		
	Yes	1388	1188	85.6	2.63	(0.94 - 7.39)	0.0653
national criteria to alert KDP	No	239	225	94.1	1		
	Yes	1431	1179	82.4	0.30	(0.09 - 1.04)	0.0581

Model 4

Table 4

Cohort: Patients were intubated and ventilated and BD was a likely diagnosis. N=730.
Odds-ratios for the model where BD testing is the outcome (intubated and ventilated patients only where BD was a likely diagnosis). 574/730 patients were tested.

Factor	Level	N	Tested	%	Odds-ratio	95% CI	P-value
Random hospital effect					-	-	0.3243
Unit	ICU	471	368	78.1	1		
	Other	38	25	65.8	0.73	(0.23 - 2.29)	0.5888
	Neuro ICU	207	178	86.0	2.47	(1.26 - 4.85)	0.0092
	ED	14	3	21.4	0.07	(0.01 - 0.47)	0.0064
Age	0-17	35	19	54.3	0.41	(0.13 - 1.26)	0.1178
	18-49	225	190	84.4	2.21	(1.05 - 4.66)	0.0368
	50-59	152	111	73.0	0.61	(0.29 - 1.25)	0.1734
	60-69	145	109	75.2	0.85	(0.40 - 1.78)	0.6545
	70+	173	145	83.8	1		
Sex	Male	420	329	78.3	1		
	Female	310	245	79.0	1.56	(0.94 - 2.57)	0.0819
Cause of death	Cerebrovascular accidents	412	348	84.5	1		
	Trauma	187	144	77.0	0.69	(0.38 - 1.24)	0.2136
	cerebral damage	98	64	65.3	0.29	(0.15 - 0.56)	0.0005
	cerebral neoplasm	20	10	50.0	0.08	(0.02 - 0.25)	<.0001
	infections	13	8	61.5	0.33	(0.07 - 1.66)	0.177
Days from brain injury to death	0	52	28	53.9	1		
	1-2	380	302	79.5	2.51	(1.00 - 6.31)	0.0497
	3-6	201	168	83.6	5.54	(2.04 - 15.03)	0.0011
	7-10	49	39	79.6	2.31	(0.68 -	0.1756

						7.80)	
	11+	48	37	77.1	5.39	(1.42 - 20.47)	0.0143
Profession involved in decision about testing	ICU	630	506	80.3	1		
	Other	100	68	68.0	0.44	(0.19 - 1.02)	0.0565
2nd decision maker	No	347	288	74.7	1		
	Yes	383	286	83.0	2.55	(1.53 - 4.26)	0.0005
Hospital performs organ transplants	No	337	264	78.3	1		
	Yes	393	310	78.9	0.49	(0.25 - 0.97)	0.0413
availability of KDP	Full time	451	368	81.6	1		
	Part time	257	185	72.0	1.21	(0.51 - 2.90)	0.6607
	Available when requested	22	21	95.5	3.43	(1.24 - 9.47)	0.0181
Clinical background of KDP	Dr	493	373	75.7	1		
	Nurse	136	120	88.2	0.16	(0.07 - 0.35)	<.0001
	Other	101	81	80.2	0.65	(0.05 - 8.22)	0.7343
Country has DCD program	No	177	116	65.5	1		
	Yes	553	458	82.8	37.01	(12.88 – 106.34	<.0001
Ethical codes of practice	No	94	57	60.6	1		
	Yes	636	517	81.3	30.78	(8.58 – 110.43)	<.0001
guidance on withdrawal or limitation of life sustaining treatment	No	186	127	68.3	1		
	Yes	544	447	82.2	0.17	(0.05 - 0.51)	0.0022

Model Five

Table 5

Cohort: Countries with a DCD programme. Patients whose care was best described by scenarios C and D in question 1 of the patient questionnaire.
N=561.
Odds-ratios for the DCD model for all included factors. 67/561 patients became DCD donors.

Factor	Level	N	DCD donors	%	Odds-ratio	95% CI	P-value
Random hospital effects					-	-	0.2683
Unit	ICU	364	41	11.3	1		
	Other (inc ED)	50	1	2.0	0.19	(0.02 - 1.62)	0.1257
	Neuro ICU	147	25	17.0	1.81	(0.80 - 4.11)	0.1494
Age (0-17 years)	0-17	17	2	11.8	1.28	(0.22 - 7.34)	0.7743
	18-49	105	27	25.7	2.78	(1.27 - 6.09)	0.0121
	50-59	110	14	12.7	1.22	(0.52 - 2.88)	0.6463
	60-69	147	10	6.8	0.77	(0.31 - 1.94)	0.5748
	70+	182	14	7.7	1		
Sex	Male	363	50	13.8	1		
	Female	198	17	8.6	0.58	(0.30 - 1.10)	0.0926
Written criteria to alert KDP	No	115	17	14.8	1		
	Yes	446	50	11.2	0.18	(0.05 - 0.60)	0.0065
24 hr access Trans cranial Doppler	No	244	46	18.9	1		
	Yes	317	21	6.6	0.14	(0.05 - 0.40)	0.0006

Appendix 7 Comparative Data for UK, Spain and Other MS

An attempt was made to produce suitable models for DBD and DCD donation and DBD only donation separately for UK, Spain, and all other countries combined. If basing these on the models built when the full cohort of patients is analysed too many variables cannot be used or need to be modified to ensure the model converges suitably. This causes excessive variation from the full model and the results cannot be compared properly.

Therefore Tables 6-8 provide the raw values for the variables (that is, the information under the headings 'Factor', 'Level', 'N', '[outcome]' and '(%)' in the tables) separately for UK, Spain and all other countries. This allows observation of the differences across countries by factor, to understand how the UK and Spain might influence the model.

UK

Table 6a)

Cohort: All UK patients. N= 531. 146/531 patients became donors.

Factor	Level	N	donors	(%)
Unit	ICU	243	76	31.3
	Other	62	1	1.6
	Neuro ICU	210	69	32.9
	ED	16	0	0
Age	0-17 years	16	5	31.3
	18-49	157	64	40.8
	50-59	113	31	27.4
	60-69	114	21	18.4
	70+	131	25	19.1
Sex	Female	62	218	28.4
	Male	84	313	26.8
Cause of death	Trauma	100	41	41.0
	Cerebrovascular accidents	262	69	26.3
	cerebral damage	151	30	19.9
	cerebral neoplasm	12	4	33.3
	infections	6	2	33.3
Days from brain injury to death	0 days	39	6	15.4
	1-2	203	73	36.0
	3-6	192	43	22.4

	7-10	60	18	30.0
	11+	37	6	16.2
Number of adult beds	1-19	164	44	26.8
	20-34	181	45	24.9
	35-49	100	31	31.0
	50+	86	26	30.2
Clinical background of KDP	Dr	0	0	-
	Nurse	531	146	27.5
	Other	0	0	-
Written policy/guideline/protocol for OD process	No	0	0	-
	Yes	531	146	27.5
DCD program	No	0	0	-
	Yes	531	146	27.5
ethical codes of practice	No	0	0	-
	Yes	531	146	27.5
Responsibility for OD	CC doctor only	0	0	-
	KDP and CC doctor	531	146	27.5
Was patient referred for neurosurgery	No	144	23	16.0
	Yes	387	123	31.8
Discipline of person making intubation/ventilation decision	ICU	150	34	22.7
	Emergency medicine	129	46	35.7
	Other	252	66	26.2

Table 6b)

Cohort: UK mechanically ventilated patients only. N= 484
87/484 patients became DBD donors.

Factor	Level	N	DBD donors	(%)
Unit	ICU	240	43	17.9
	Other	23	0	0
	Neurological ICU	208	44	21.2
	ED	13	0	0
Age	0-17	16	3	18.8
	18-49	155	41	26.5
	50-59	106	17	16.0
	60-69	103	13	12.6

	70+	104	13	12.5
Sex	Female	195	45	23.1
	Male	289	42	14.5
Cause of death	Trauma	98	26	26.5
	Cerebrovascular accidents	223	45	20.2
	cerebral damage	146	12	8.2
	cerebral neoplasm	11	2	18.2
	infections	6	2	33.3
Days from brain injury to death	0	35	6	17.1
	1-2	187	52	27.8
	3-6	178	21	11.8
	7-10	56	6	10.7
	11+	28	2	7.1
Number of adult beds	1-19	143	31	21.7
	20-34	256	48	18.8
	35-49	85	8	9.4
	50+	0	0	-
DCD program	No	0	0	-
	Yes	484	87	18.0
Ethical codes of practice	No	0	0	-
	Yes	484	87	18.0
Responsibility for OD	ICU doctor only	0	0	-
	KDP and CC doctor	484	87	18.0

Spain

Table 7a)

Cohort: All Spain patients. N= 413. 126/413 patients became donors.

Factor	Level	N	donors	(%)
Unit	ICU	235	101	43.0
	Other	110	6	5.5
	Neuro ICU	40	19	47.5
	ED	28	0	0
Age	0-17 years	11	4	36.4
	18-49	59	24	40.7
	50-59	48	20	41.7
	60-69	100	28	28.0
	70+	195	50	25.6
Sex	Female	144	51	35.4
	Male	269	75	27.9
Cause of death	Trauma	61	26	42.6
	Cerebrovascular accidents	253	90	35.6
	cerebral damage	54	9	16.7
	cerebral neoplasm	36	1	2.8
	infections	9	0	0
Days from brain injury to death	0 days	17	4	23.5
	1-2	185	79	42.7
	3-6	108	27	25.0
	7-10	56	12	21.4
	11+	47	4	8.5
Number of adult beds	1-19	51	15	29.4
	20-34	77	12	15.6
	35-49	153	56	36.6
	50+	132	43	32.6
Clinical background of KDP	Dr	363	104	28.7
	Nurse	50	22	44.0
	Other	0	0	-
Written policy/guideline/protocol for OD process	No	0	0	-
	Yes	413	126	30.5
DCD program	No	0	0	-
	Yes	413	126	30.5
ethical codes of practice	No	0	0	-
	Yes	413	126	30.5

Responsibility for OD	CC doctor only	0	0	-
	KDP and CC doctor	413	126	30.5
Was patient referred for neurosurgery	No	149	127	14.8
	Yes	264	160	39.4
Discipline of person making intubation/ventilation decision	ICU	155	52	33.6
	Emergency medicine	143	57	39.9
	Other	115	17	14.8

Table 7b)

Cohort: Spain mechanically ventilated patients only. N= 312
125/312 patients became DBD donors.

Factor	**Level**	**N**	**DBD donors**	**(%)**
Unit	ICU	230	100	43.5
	Other	34	6	17.7
	Neurological ICU	39	19	48.7
	ED	9	0	0
Age	0-17	10	4	40.0
	18-49	55	24	43.6
	50-59	42	20	47.6
	60-69	84	28	33.3
	70+	121	49	40.5
Sex	Female	108	51	47.2
	Male	204	74	36.3
Cause of death	Trauma	54	26	48.2
	Cerebrovascular accidents	188	90	47.9
	cerebral damage	51	8	15.7
	cerebral neoplasm	11	1	9.1
	infections	8	0	0
Days from brain injury to death	0	11	4	36.4
	1-2	147	79	53.7
	3-6	79	27	34.2
	7-10	43	11	25.6
	11+	32	4	12.5
Number of adult beds	1-19	34	15	44.1
	20-34	51	12	23.5
	35-49	131	56	42.8

	50+	96	42		43.8
DCD program	No	0	0		0
	Yes	312	125		40.1
Ethical codes of practice	No	0	0		0
	Yes	312	125		40.1
Responsibility for OD	ICU doctor only	0	0		0
	KDP and CC doctor	312	125		40.1

Table 8 a)

Cohort: All non-UK and non-Spain patients. N=726. 130/726 patients became donors.

Factor	**Level**	**N**	**donors**	**(%)**
Unit	ICU	424	91	21.5
	Other	145	5	3.5
	Neuro ICU	124	33	26.6
	ED	33	1	3.0
Age	0-17 years	17	2	11.8
	18-49	155	51	32.9
	50-59	136	28	20.6
	60-69	171	26	15.2
	70+	247	23	9.3
Sex	Female	274	55	20.1
	Male	452	75	16.6
Cause of death	Trauma	165	43	26.1
	Cerebrovascular accidents	412	72	17.5
	cerebral damage	100	12	12.0
	cerebral neoplasm	32	1	3.1
	infections	17	2	11.8
Days from brain injury to death	0 days	56	4	7.1

	1-2	276	56	20.3
	3-6	222	49	22.1
	7-10	85	10	11.8
	11+	87	11	12.6
Number of adult beds	1-19	182	37	20.3
	20-34	312	57	18.3
	35-49	105	20	19.1
	50+	127	16	12.6
Clinical background of KDP	Dr	598	103	17.2
	Nurse	96	13	13.5
	Other	32	14	43.8
Written policy/guideline/protocol for OD process	No	49	8	16.3
	Yes	677	122	18.0
DCD program	No	363	53	14.6
	Yes	363	77	21.2
ethical codes of practice	No	282	41	14.5
	Yes	444	89	20.1
Responsibility for OD	CC doctor only	252	40	15.9
	KDP and CC doctor	474	90	19.0
Was patient referred for neurosurgery	No	236	27	11.4
	Yes	490	103	21.0
Discipline of person making intubation/ventilation decision	ICU	255	56	22.0
	Emergency medicine	150	33	22.0
	Other	321	41	12.8

Table 8 b)

Cohort: Non-UK and non-Spain mechanically ventilated patients only N= 608
116/608 patients became DBD donors.

Factor	Level	N	DBD donors	(%)
Unit	ICU	418	78	18.7
	Other	52	5	9.6
	Neurological ICU	117	32	27.4
	ED	21	1	4.8
Age	0-17	17	2	11.8
	18-49	153	46	30.1
	50-59	129	25	19.4
	60-69	137	21	15.3
	70+	172	22	12.8
Sex	Female	227	52	22.9
	Male	381	64	16.8
Cause of death	Trauma	162	39	24.1
	Cerebrovascular accidents	313	67	21.4
	cerebral damage	97	8	8.3
	cerebral neoplasm	20	1	5.0
	infections	16	1	6.3
Days from brain injury to death	0	47	3	6.4
	1-2	224	53	23.7
	3-6	193	44	22.8
	7-10	70	8	11.4
	11+	74	8	10.8
Number of adult beds	1-19	151	32	21.2

	20-34	272	51	18.8
	35-49	87	17	19.5
	50+	98	16	16.3
DCD program	No	317	50	15.8
	Yes	291	66	22.7
Ethical codes of practice	No	202	37	13.9
	Yes	406	79	21.9
Responsibility for OD	ICU doctor only	186	43	18.3
	KDP and CC doctor	422	73	19.5