## **Supplementary Online Content**

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## **eReferences**

This supplementary material has been provided by the authors to give readers additional information about their work.

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eTable 1. ICD-10 Site Codes Used to Identify Deceased Donors With Primary Brain Tumors in English and Scottish Cancer Registries

Code	Description		
C70	Malignant neoplasm of meninges*		
C70.0	Malignant neoplasm: Cerebral meninges		
C70.9	Malignant neoplasm: Meninges, unspecified*		
C71.X	Malignant neoplasm of brain (unspecified)*		
C71	Malignant neoplasm of brain (all subgroups)		
C72.X	Malignant neoplasm of spinal cord, cranial nerves and other parts of central nervous system*		
C72.8	Malignant neoplasm: Overlapping lesion of brain and other parts of central nervous system*		
C72.9	Malignant neoplasm: Central nervous system, unspecified*		
C75.2	Malignant neoplasm: Craniopharyngeal duct		
C75.3	Malignant neoplasm: Pineal gland		
D32.X	Benign neoplasm of meninges*		
D32.0	Benign neoplasm: Cerebral meninges		
D32.9	Benign neoplasm: Meninges, unspecified*		
D33.X	Benign neoplasm of brain and other parts of central nervous system*		
D33.0	Benign neoplasm: Brain, supratentorial		
D33.1	Benign neoplasm: Brain, infratentorial		
D33.2	Benign neoplasm: Brain, unspecified		
D33.7	Benign neoplasm: Other specified parts of central nervous system*		
D33.9	Benign neoplasm: Central nervous system, unspecified*		
D35.3	Benign neoplasm: Craniopharyngeal duct		
D35.4	Benign neoplasm: Pineal gland		
D42.X	Neoplasm of uncertain or unknown behaviour of meninges*		
D42.0	Neoplasm of uncertain or unknown behaviour: Cerebral meninges		
D42.9	Neoplasm of uncertain or unknown behaviour: Meninges, unspecified*		
D43.X	Neoplasm of uncertain or unknown behaviour of brain and central nervous system*		

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D43.0	Neoplasm of uncertain or unknown behaviour: Brain, supratentorial		
D43.1	Neoplasm of uncertain or unknown behaviour: Brain, infratentorial		
D43.2	Neoplasm of uncertain or unknown behaviour: Brain, unspecified		
D43.7	Neoplasm of uncertain or unknown behaviour: Other parts of central nervous system*		
D43.9	Neoplasm of uncertain or unknown behaviour: Central nervous system, unspecified*		
D44.4	Neoplasm of uncertain or unknown behaviour: Craniopharyngeal duct		
D44.5	Neoplasm of uncertain or unknown behaviour: Pineal gland		
C80	Malignant neoplasm without specification of site (all subtypes)*		
XXX	[site code missing]*		
"V" -::£:	(3/8 · 'C · ' ·   1 / C ·		

<sup>&</sup>quot;X" signifies missing character (i.e., unknown subtype)
\* Manual review to confirm site

ICD-10, International classification of diseases (10<sup>th</sup> revision, 2016 edition)

eTable 2. ICD-O Morphology Codes in Deceased Donors With Brain Tumors Requiring Manual Review

Code	Description(s)	Possible grades	Reason for review	Application of term (when data incomplete)
8000/0	Neoplasm, benign	Any		Used for tumours described as "benign", without type (e.g., "brain tumour, appears benign")
8000/1	Neoplasm, uncertain whether benign or malignant	Any		Used for tumours without behaviour or type described (e.g., "primary brain tumour, could be low or high grade")
8000/3	Neoplasm, malignant	Any		Used for tumours described as "malignant / high grade / aggressive", without type
8001/0	Tumor cells, benign	Any		
8001/1	Tumor cells, uncertain whether benign or malignant	Any		Recoded as "Neoplasm", used as above
8001/3	Tumor cells, malignant	Any		Recoded as Neoplasiii , used as above
8010/3	Carcinoma, NOS	Any		
9362/3	Pineoblastoma, Pineal parenchymal tumor of intermediate differentiation	II, III, IV		
9380/3	Glioma, malignant	Any		Used for tumours described as "high grade / aggressive glioma" without definitive histology, or "gliomatosis"
9380/3	Glioma, NOS	Any		Used for tumours described as "low / unknown grade glioma", without definitive histology
9382/3	Oligoastrocytoma NOS, Anaplastic oligoastrocytoma	II or III		
9395/3	Papillary tumor of pineal region	II or III		
9400/3	Astrocytoma, NOS	Any	If grade not II	Used for tumours described as "astrocytoma" of any grade/behaviour, without definitive histology
9505/1	Ganglioglioma, NOS	1	Change in coding	
9505/3	Ganglioglioma, anaplastic	III	for neuroglial cell	
9506/1	Central neurocytoma	II	tumours	
9540/0	Neurofibroma, NOS	1		
9540/3	Malignant peripheral nerve sheath tumor [multiple subtypes]	II, III or IV		
9550/0	Plexiform neurofibroma	1		[exclude if confirmed cranial / paraspinal nerve tumours]
9560/0	Schwannoma, NOS	1	Inconsistent with ICD-10 site code	
9560/1	Melanotic schwannoma	1	for brain	[ [exclude ii committed cramar/ paraspinal nerve tumours]
9560/3	Neurilemoma, malignant	1	io. brain	
9571/0	Perineurioma, NOS	I, II or III		
9571/3	Perineurioma, malignant	I. II or III	1	

ICD-O, International classification of diseases for oncology (version 3.2)

**eTable 3.** *OPCS-4* Codes to Identify Neurosurgical Procedures in Deceased Donors With Brain Tumors

Codes f	or any neurosurgical procedure (all subtypes included)			
A01	Major excision of tissue of brain			
A02	Excision of lesion of tissue of brain			
A03	Stereotactic ablation of tissue of brain			
A04	Open biopsy of lesion of tissue of brain			
A05	Drainage of lesion of tissue of brain			
A06	Other excision of lesion of tissue of brain			
A07	Other open operations on tissue of brain			
A08	Other biopsy of lesion of tissue of brain			
A09	Neurostimulation of brain			
A10	Other operations on tissue of brain			
A11	Operations on tissue of brain			
A12	Creation of connection from ventricle of brain			
A13	Attention to component of connection from ventricle of brain			
A14	Other operations on connection from ventricle of brain			
A16	Other open operations on ventricle of brain			
A17	Therapeutic endoscopic operations on ventricle of brain			
A18	Diagnostic endoscopic examination of ventricle of brain			
A20	Other operations on ventricle of brain			
A22	Operations on subarachnoid space of brain			
A38	Extirpation of lesion of meninges of brain			
A39	Repair of dura			
A40	Drainage of extradural space			
A41	Drainage of subdural space			
A42	Other operations on meninges of brain			
A43	Other extirpation of lesion of meninges of brain			
V01	Plastic repair of cranium			
V02	Other plastic repair of cranium			
V03	Opening of cranium			
V04	Reshaping of cranium			
V05	Other operations on cranium			
Y46	Open approach to contents of cranium			
Y47	Burrhole approach to contents of cranium			
Codes	or tumour resection			
A012	Total lobectomy of brain			
A013	Partial lobectomy of brain			
A018	Other specified major excision of tissue of brain			
A019	Unspecified major excision of tissue of brain			
A021	Excision of lesion of tissue of frontal lobe of brain			
A022	Excision of lesion of tissue of temporal lobe of brain			
A023	Excision of lesion of tissue of parietal lobe of brain			
A024	Excision of lesion of tissue of occipital lobe of brain			
A025	Excision of lesion of tissue of cerebellum			
A026	Excision of lesion of tissue of brain stem			

A027	Evaision of transcrapial dermaid ovet			
A027	Excision of transcranial dermoid cyst  Other specified excision of lesion of tissue of brain			
A028	Unspecified excision of lesion of tissue of brain			
A029 A068	Other specified other excision of lesion of tissue of brain			
A069	Unspecified other excision of lesion of tissue of brain			
A171				
	Endoscopic extirpation of lesion of ventricle of brain			
A381	Extirpation of lesion of meninges of cortex of brain			
A382	Extirpation of lesion of meninges of sphenoidal ridge of cranium			
A383	Extirpation of lesion of meninges of subfrontal region of brain			
A384	Extirpation of lesion of meninges of parasagittal region of brain			
A385	Extirpation of lesion of falx cerebri			
A386	Extirpation of lesion of tentorium cerebelli			
A388	Other specified extirpation of lesion of meninges of brain			
A389	Unspecified extirpation of lesion of meninges of brain			
A431	Extirpation of lesion of meninges of skull base			
A432	Extirpation of lesion of meninges of skull clivus			
A438	Other specified other extirpation of lesion of meninges of brain			
A439	Unspecified other extirpation of lesion of meninges of brain			
V051	Extirpation of lesion of cranium			
V052	Biopsy of lesion of cranium			
X532	Excision of lesion of unspecified organ			
X533	Destruction of lesion of unspecified organ			
X538	Other specified extirpation of unspecified organ			
X539	Unspecified extirpation of unspecified organ			
Y065	Gamma wave excision of lesion of organ NOC			
Y066	Vacuum excision of lesion of organ NOC			
Y067	Radiofrequency excision of lesion of organ NOC			
Y068	Other specified excision of lesion of organ NOC			
Y069	Unspecified excision of lesion of organ NOC			
	for tumour biopsy			
A041	Open biopsy of lesion of tissue of frontal lobe of brain			
A042	Open biopsy of lesion of tissue of temporal lobe of brain			
A043	Open biopsy of lesion of tissue of parietal lobe of brain			
A044	Open biopsy of lesion of tissue of occipital lobe of brain			
A045	Open biopsy of lesion of tissue of cerebellum			
A046	Open biopsy of lesion of tissue of brain stem			
A048	Other specified open biopsy of lesion of tissue of brain			
A049	Unspecified open biopsy of lesion of tissue of brain			
A081	Biopsy of lesion of tissue of frontal lobe of brain NEC			
A082	Biopsy of lesion of tissue of temporal lobe of brain NEC			
A083	Biopsy of lesion of tissue of parietal lobe of brain NEC			
A084	Biopsy of lesion of tissue of occipital lobe of brain NEC			
A085	Biopsy of lesion of tissue of cerebellum NEC			
A086	Biopsy of lesion of tissue of brain stem NEC			
A088	Other specified other biopsy of lesion of tissue of brain			
A089	Unspecified other biopsy of lesion of tissue of brain			

A181	Diagnostic endoscopic examination of ventricle of brain and biopsy of lesion of ventricle of brain				
A422	Biopsy of lesion of meninges of brain				
Y201	Stereotactic biopsy of lesion of organ NOC				
Y202	Stereotactic biopsy of organ NOC				
Y203	Biopsy of lesion of organ NOC				
Y204	Fine needle aspiration NOC				
Y205	Percutaneous biopsy NOC				
Y206	Plugged biopsy NOC				
Y207	Vacuum biopsy of lesion of organ NOC				
Y208	Other specified biopsy of organ NOC				
Y209	Unspecified biopsy of organ NOC				
Codes 1	or external ventricular drain insertion				
A128	Other specified creation of connection from ventricle of brain				
A129	Unspecified creation of connection from ventricle of brain				
A201	Drainage of ventricle of brain NEC				
A203	Monitoring of pressure in ventricle of brain				
A221	Drainage of subarachnoid space of brain				
Codes f	or ventriculo-systemic shunt				
A122	Creation of ventriculovascular shunt				
A123	Creation of ventriculopleural shunt				
A124	Creation of ventriculoperitoneal shunt				
A131	Maintenance of proximal catheter of cerebroventricular shunt				
A132	Maintenance of distal catheter of cerebroventricular shunt				
A133	Insertion of antisyphon device into cerebroventricular shunt				
A134	Renewal of valve of cerebroventricular shunt				
A141	Renewal of cerebroventricular shunt				
A142	Revision of cerebroventricular shunt NEC				
A143	Removal of cerebroventricular shunt				
A144	Irrigation of cerebroventricular shunt				
A145	Attention to cerebroventricular shunt NEC				
	ffice of Population Censuses and Surveys Classification of Interventions and Procedures (version 4.9). <sup>1</sup> swith codes starting 'V', 'X' or 'Y' (italicised) assumed to relate to brain tumour if within 7 days of diagnosis				

eTable 4. Full Details of Brain Tumors in Deceased Donors

Grade, histology	Count (n=282)
Tumours with definitive grade <sup>a</sup>	
Grade I tumours	
Astrocytic tumours	
Pilocytic astrocytoma	14
Subependymal giant cell astrocytoma	2
Astrocytoma, NOS	1
Meningeal tumours	
Meningioma, NOS	35
Hemangioblastoma	12
Transitional meningioma	7
Meningothelial meningioma	<u>.</u> 4
Fibrous meningioma	<u>.</u> 4
Psammomatous meningioma	
Craniopharyngioma, NOS	6
Subependymoma	2
Pineocytoma	<u>2</u> 1
Dysembryoplastic neuroepithelial tumour	<u></u>
	I
Grade II tumours	
Astrocytic tumours	4.4
Astrocytoma, NOS	14
Fibrillary astrocytoma	3
Gemistocytic astrocytoma, NOS	1
Meningeal tumours	
Meningioma, NOS	2
Atypical meningioma	2
Chordoid meningioma	1
Ependymoma, NOS	8
Oligodendroglioma, NOS	8
Central neurocytoma	5
Oligoastrocytoma, NOS	4
Chordoid glioma	1
Grade III tumours	
Astrocytic tumours	
Astrocytoma, anaplastic, NOS	10
Astrocytoma, NOS	3
Meningeal tumours	
Meningioma, malignant	2
Oligodendroglioma, anaplastic, NOS	6
Anaplastic oligoastrocytoma	3
Ependymoma, anaplastic	2
Gliomatosis cerebri	1
Glioma, malignant <sup>b</sup>	1
Grade IV tumours	
Astrocytic tumours	
Glioblastoma, NOS	45
Astrocytoma, NOS	1
Gliosarcoma	<u>.</u> 1
Embryonal tumours	· · · · · · · · · · · · · · · · · · ·
Medulloblastoma, NOS	5
Desmoplastic nodular medulloblastoma	<u>5</u> 1
Glioma, malignant <sup>b</sup>	<u></u>

Continued

## eTable 4 continued

Grade, histology	Count (n=282)
Tumours without definitive grade	•
Low grade tumours <sup>b</sup>	
Glioma, NOS	4
Meningioma, NOS	4
Neoplasm, benign	3
Astrocytoma, NOS	2
Oligodendroglioma, NOS	1
High grade tumours <sup>c</sup>	
Glioma, malignant	8
Neoplasm, malignant	3
Astrocytoma, NOS	2
Tumours with unknown grade <sup>d</sup>	
Neoplasm, uncertain whether benign or malignant	15
Glioma, malignant	8
Neoplasm, malignant	5
Astrocytoma, NOS	4
Glioma, NOS	1
Gliomatosis cerebri	1

<sup>&</sup>lt;sup>a</sup> WHO Classification of Tumours of the Central Nervous System (2007); preferred terms from International Classification of Diseases for Oncology (version 3.2), except where indicated.

NOS, not otherwise specified; WHO, World Health Organisation

<sup>&</sup>lt;sup>b</sup> No further information available

<sup>&</sup>lt;sup>b</sup> Includes tumours described as "grade I or II", "low grade" or "benign", with ICD-O morphology codes 8000/0 or 8001/0 and no histological information or judged to be low grade after review of clinical details. Five with tissue diagnosis.

<sup>°</sup> Includes tumours described as "grade III or IV", "high grade", "aggressive" or "butterfly glioma", or judged to be high grade after review of clinical details. Four with tissue diagnosis.

<sup>&</sup>lt;sup>d</sup> Includes tumours without definite or suspected grade reported, described as "gliomatosis cerebri" without grade reported, or with ICD-O morphology codes 8000/1, 8001/1, 8000/3 or 8001/3 and no histological information. Six with tissue diagnosis.

eTable 5. Treatment History in Deceased Donors With Brain Tumors

Treatment	At any time	>1 month before donation	<1 month before donation
Any neurosurgical procedure	202 (72%)	98 (35%)	149 (53%)
Resection	140 (50%)	62 (22%)	84 (30%)
Biopsy <sup>a</sup>	70 (25%)	35 (12%)	35 (12%)
External ventricular drain	51 (18)	8 (3%)	46 (16%)
Cerebroventricular shunt <sup>b</sup>	17 (6%)	-	-
Radiotherapy	29 (10%)	26 (9%)	4 (1%)

Values are n (% of donors); some donors had procedures during both time periods (so column 2 ≠ column 3 + column 4)
<sup>a</sup> Excludes biopsy at the time of resection; all donors with a tissue diagnosis before date of donation assumed to have undergone biopsy at time of diagnosis

<sup>&</sup>lt;sup>b</sup> Ventriculo-peritoneal (16), type not specified (1)

eTable 6. Recipient Characteristics According to Donor Type

	Transplants from donors without brain tumours <sup>a</sup>	Transplants from donors with brain tumours <sup>b</sup>	Transplants from donors with high grade brain tumours
Single kidney transplants	(n=19,203)	(n=389)	(n=124)
Recipient age (years)	50 (38 to 59)	48 (36 to 60)	52 (38 to 63)
Highly sensitised (cRF ≥85%)	1,741 (9%)	44 (11%)	12 (10%)
On dialysis at time of transplant	17,110 (89%)	351 (90%)	111 (90%)
Recipient diabetes	1,430 (7%)	27 (7%)	10 (8%)
Previous kidney transplant	2,791 (15%)	68 (17%)	12 (10%)
Wait time (days)	755 (312 to 1,358)	778 (280 to 1,437)	836 (332 to 1,345)
Liver transplants	(n=7,755)	(n=190)	(n=72)
Recipient age (years)	51 (39 to 59)	52 (41 to 60)	51 (40 to 58)
Super-urgent <sup>c</sup>	1,109 (14%)	34 (18%)	8 (11%)
Previous liver transplant	767 (10%)	22 (12%)	7 (10%)
Hepatitis C positive	1,182 (15%)	38 (20%)	15 (21%)
UKELD score <sup>2 d</sup>	55 (51 to 59)	54 (51 to 58)	54 (50 to 59)
Heart transplants	(n=1,762)	(n=69)	(n=26)
Recipient age (years)	47 (27 to 56)	50 (25 to 58)	50 (28 to 58)
Mechanical cardiac support <sup>e</sup>	366 (21%)	15 (22%)	6 (23%)
Urgent <sup>c</sup>	873 (50%)	38 (55%)	13 (50%)
Lung transplants	(n=1,670)	(n=46)	(n=10)
Recipient age (years)	52 (37 to 58)	39 (21 to 51)	37 (24 to 43)
COPD	455 (27%)	8 (17%)	1 (10%)

Values are n (%) or median (IQR). Missing data (n): wait time (19), UKELD score (216), dialysis status (47)

cRF, calculated reaction frequency (reflects the proportion of blood group identical deceased donors that are HLA compatible with the recipient, based on a national reference pool);<sup>3</sup> COPD, chronic obstructive pulmonary disease; UKELD, UK end-stage liver disease.

b Includes donors with high grade tumour (last column)
c According to national criteria, patients with a very limited short-term prognosis are prioritised for organ allocation. 4.5

<sup>&</sup>lt;sup>d</sup>Only calculated for elective transplants

e Defined as the use of a ventricular assist device, total artificial heart or extra-corporeal membrane oxygenation prior to transplant

eTable 7. Characteristics of Utilized and Nonutilized Deceased Donors With Brain **Tumors** 

	Utilised donors with brain tumours (n=282)	Non-utilised donors with brain tumours (n=83)
Donor characteristics		
Age (years)	42 (33 to 54)	51 (39 to 60)
Female sex	154 (54%)	46 (55%)
DCD	41 (15%)	49 (59%)
BMI (kg/m²)	26 (23 to 28)	26 (23 to 30)
Diabetes	10 (4%)	7 (8%)
Missing data	5 (2%)	12 (14%)
Hypertension	42 (15%)	12 (14%)
Missing data	9 (3%)	14 (17%)
Smoking <sup>a</sup>	69 (24%)	20 (24%)
Missing data	5 (2%)	14 (17%)
Alcohol abuse <sup>a</sup>	10 (4%)	5 (6%)
Missing data	27 (10%)	19 (23%)
Drug abuse <sup>a</sup>	14 (5%)	4 (5%)
Missing data	5 (2%)	13 (16%)
Organ-specific risk indices <sup>b</sup>		
Kidney		
Terminal creatinine (µmol/L)	65 (50 to 83)	57 (45 to 72)
UK KDRI °	0.99 (0.81 to 1.27)	1.03 (0.98 to 1.50)
Liver		
UK DLI <sup>d</sup>	0.97 (0.84 to 1.12)	1.67 (1.02 to 1.99)
Lung donor category		
Optimal	49 (23%)	5 (10%)
Extended criteria	106 (50%)	22 (46%)
Marginal	28 (13%)	9 (19%)
Missing data	31 (14%)	12 (25%)
Tumour characteristics		
Time since diagnosis (days)	8 (2 to 463)	9 (3 to 165)
Histological diagnosis	210 (74%)	61 (73%)
WHO grade <sup>e</sup>		
I	90 (32%)	15 (18%)
II	49 (18%)	9 (11%)
III	28 (9%)	8 (10%)
IV	54 (19%)	36 (43%)
Grade uncertain		
Low grade	14 (5%)	-
High grade	13 (5%)	3 (4%)
Grade unavailable	34 (12%)	12 (14%)
Treatment history		
Resection	140 (50%)	46 (55%)
EVD insertion	51 (18%)	13 (16%)
Cerebroventricular shunt	17 (6%)	5 (6%)
Biopsy <sup>f</sup>	70 (25%)	19 (23%)
Radiotherapy	29 (10%)	13 (16%)

Values are n (%) and median (IQR). Restricted to consented donors where at least one organ was offered for transplantation (n=365).
BMI, body mass index; DCD, donation after circulatory death; EVD, external ventricular drain; UK KDRI, UK kidney donor

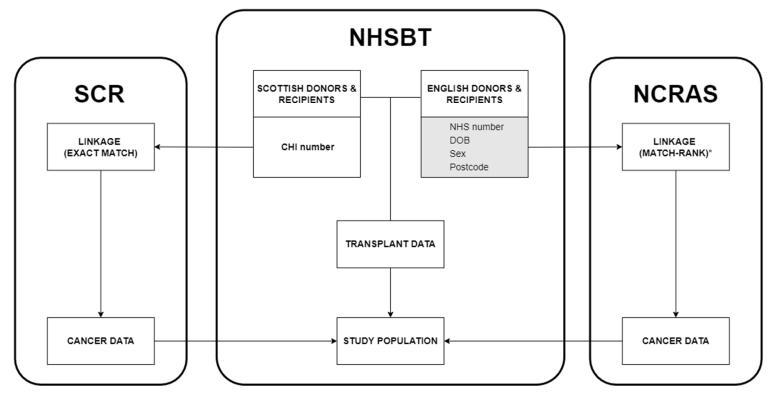
risk index; UK DLI, UK donor liver index.

Missing data (n), where not stated above: BMI (13), terminal creatinine (7), UK KDRI (6), UK DLI (25), basis of diagnosis (8);

time since diagnosis (9).

a Past or current. b Where organ offered. c Excludes donors aged <18 years. d Excludes adjustment for split liver transplantation <sup>e</sup> 2007 classification system. <sup>6</sup> f Excludes biopsy at time of resection.

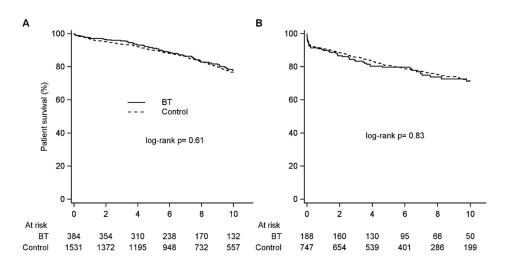
eFigure 1. Data Linkage Process

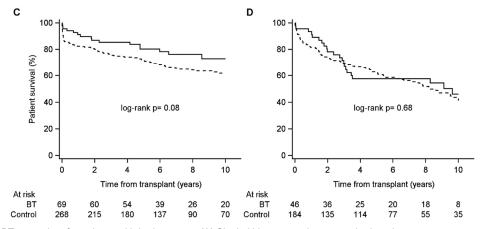


Data linkage performed by Public Health Scotland Electronic Data Research and Innovation Service (UKTR-SCR) and NCRAS (UKTR-NCRAS).

CHI, community health index; DOB, date of birth; NCRAS, National Cancer Registration and Analysis Service; NHS, National Health Service; SCR, Scottish Cancer Registry; NHSBT, National Health Service Blood and Transplant. Shaded box, "pseudonymisation at source" applied (prevents sharing of identifiable data on individuals without cancer). \*Quality of matching graded according to standard criteria.<sup>7</sup>

eFigure 2. Patient Survival in Transplants From Deceased Donors With Brain Tumors and Matched Controls

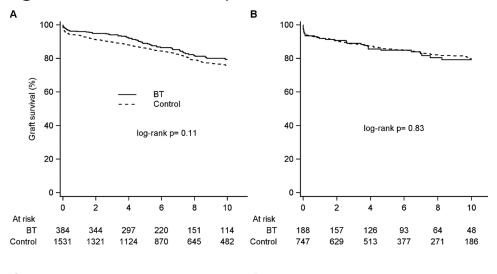


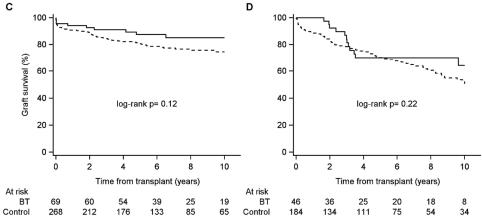


BT, transplant from donor with brain tumour. (A) Single kidney transplants, matched on donor age, sex, type and terminal creatinine, recipient age, sex and graft number, calendar period (no matches for one case [excluded]; insufficient matches for four cases, eight controls missing). (B) Liver transplants, matched on donor age, sex and type, recipient age, sex and urgency, calendar period (no matches for one case [excluded]; insufficient matches for three cases, five controls missing). (C) Cardiac transplants, matched on donor age, sex and type, recipient age, sex and urgency, calendar period (no

matches for one case [excluded], insufficient matches for two cases, six controls missing). (D) Lung transplants, matched on donor and recipient age and sex. Data censored at last follow-up or 10 years. Transplants without outcome data excluded.

eFigure 3. Graft Survival in Transplants From Deceased Donors With Brain Tumors and Matched Controls





BT, transplant from donor with brain tumour. (A) Single kidney transplants, matched on donor age, sex, type and terminal creatinine, recipient age, sex and graft number, calendar period (no matches for one case [excluded]; insufficient matches for four cases, eight controls missing). (B) Liver transplants, matched on donor age, sex and type, recipient age, sex and urgency, calendar period (no matches

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for one case [excluded]; insufficient matches for three cases, five controls missing). (C) Cardiac transplants, matched on donor age, sex and type, recipient age, sex and urgency, calendar period (no matches for one case [excluded], insufficient matches for three cases, six controls missing). (D) Lung transplants, matched on donor and recipient age and sex. Graft failure defined as re-transplantation (or resumption of long-term dialysis in kidney recipients), censored at death, last follow-up or 10 years. Transplants without outcome data excluded.

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