UK Biobank

Definitions of End Stage Renal Disease

Algorithmically-defined outcomes (ADOs)

Version 2.0

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The content of this work and its documentation were originally prepared by
UK Biobank Outcome Adjudication Group (members are named in relevant sections).
This revised document has been produced by UK Biobank's Data Analyst and Scientific teams.

Contents

1. Changes made to the algorithmically-defined outcomes

The UK Biobank Outcome Adjudication Group, in conjunction with clinical experts, developed and validated algorithms based on lists of clinical codes to ascertain a range of health outcomes – referred to as 'algorithmically-defined outcomes' (ADOs) in the Data Showcase.

The original algorithms for the ADO fields in Showcase have now been revised. The new ADOs use a standardised approach to defining health outcomes, which identify the earliest recorded date of a given health outcome irrespective of source (i.e. self-report, hospital admission, death). Another aspect to the new ADOs is that, additional encodings have been assigned to the source of the earliest event, so that for all ADOs except end-stage renal disease, information is provided on whether a code from a hospital or death record is in the primary position (leading cause of admission, or underlying cause of death) or a secondary (contributory) cause of illness or death (see Resource 460 for more details). End-stage renal disease (ESRD) is a special case among the ADO fields in that its definition among hospital records is more complex than for other conditions, as it includes diagnostic and operation/procedural codes (i.e. OPCS 4 codes) as well as having exclusion criteria. Therefore, for this ADO we are not providing encodings for primary and secondary position of hospital and death records, and will simply retain the encoding that says whether the source is hospital or death, or indeed self-report.

This document (Resource 8319) includes details of the revised algorithm, although the code lists used to define ESRD from self-report, hospital and death record data remain the same.

2. Data sources

Currently, the algorithm uses data sources from:

- UKB baseline assessment data (self-reported verbal interview)
- Linked hospital-admission data (HES APC, SMR01, PEDW)
- Death register data.

We will incorporate linked primary care date into these algorithms, once these data on the full cohort are available.

Definitions & Abbreviations

ADO	Algorithmically-defined outcome
AKI	Acute Kidney Injury
CKD	Chronic Kidney Disease
DPV	Derived Phenotypic Variables
EHR	Electronic Health Records
ESRD	End Stage Renal Disease
HES APC	Hospital Episode Statistics - Admitted Patient Care (England)
ICD 9	International Classification of Diseases, Version 9 (SMR only)
ICD 10	International Classification of Diseases, Version 10
PEDW	Patient Episode Database for Wales
RRT	Renal Replacement Therapy
SMR01	Scottish Morbidity Records – General / Acute Inpatient and Day Case Admissions (Scotland)
OPCS 4	Office of Population Censuses and Surveys Classification of Surgical Operations and Procedures - Version 4

3. End-Stage Renal Disease (ESRD) algorithm

(a) The earliest recorded date and its related data source of a condition will be retained per individual participant according to a predefined code list, including the following sources:

i. **Hospital admission HER records:** ESRD identified by the algorithm steps outlined in Appendix 1 using HES APC (England), SMR01 (Scotland) or PEDW (Wales) linked records in the primary or any secondary position, and additional information as described;

ii. **Self-report verified by nurse interview**: The participant has self-reported ESRD at baseline[1] interview and given the date of onset.*

iii. **Death certificate records**: one of the relevant ESRD ICD 10 codes listed in the underlying cause or secondary cause fields.

(b) Data-Coding 300 indicates whether the outcome derives from self-report, or a hospital or death source.

***Note on self-reported dates:** When participants enrolled in the UK Biobank study, they underwent a verbal interview with a research nurse, in which they could 'self-report' medical conditions. The self-report date is taken from the UK Biobank field 20008 ("Interpolated Year when non-cancer illness first diagnosed"). At the verbal interview, UKB nurses were instructed to record either a year or an age at which the diagnosis occurred. Where an age was provided, a best-fit fractional year was then calculated. These have been rounded to one decimal place, and as such should be regarded as a close proxy to the reported date. Some dates of onset are missing. Where this is the case, and the baseline interview was the first data source to record the health outcome, the date of onset will be set to 1/1/1900.

[1] Only self-reports at baseline have been included in the algorithms, as subsequent self-report data are not available for all the cohort and most events will likely be picked up through record linkage.

4. ESRD Definition

End-stage renal disease (ESRD) is treated with renal replacement therapy (RRT), which can be readily identified from hospital admission data. However, RRT is also used to treat acute kidney injury (AKI) which researchers may wish to study separately. We have therefore devised an algorithm that first identifies those who have received RRT, and then selects the subset of participants with other relevant diagnostic or procedural codes specific to ESRD (referred to in this document as indicators of chronic kidney disease [CKD] stage 5). A key assumption of the algorithm is that any peritoneal dialysis or kidney transplantation indicates treated ESRD. The principles used in this algorithm have previously been used to successfully identify people with treated ESRD in a UK cohort.[1]

A summary of the algorithm design is provided in Appendix 1.

The estimated accuracy of the algorithm is discussed in Appendix 2.

References

1. Herrington WG, Smith M, Bankhead C, Matsushita K, Stevens S, Holt T, Hobbs FDR, Coresh J, Woodward M. Body-mass Index and Risk of Advanced Chronic Kidney Disease: Prospective Analyses from a Primary Care Cohort of 1.4 Million Adults in England. PloS One 2017 Mar 8;12(3):e017351

Appendix 1

Data sources on which the algorithm relies are UKB self-report taken from the baseline assessment data (verbal interview); linked hospital admissions data (HES APC, SMR01, PEDW); death register data.

I. End Stage Renal Disease identified from hospital admission data

The algorithm identifies cases of ESRD in hospital admissions data by using ICD 10 and OPCS 4 codes to identify participants who received any RRT (and within this category those who received a kidney transplant or peritoneal dialysis, assumed to be for maintenance RRT), and those with indicators of CKD stage 5. Participants who received a kidney transplant or peritoneal dialysis are assumed to be ESRD cases. In order to exclude cases of AKI, the remaining RRT cases are deemed to be ESRD cases only if they have an associated indicator of CKD stage 5 prior to, or within 365 days of receiving the RRT. The process for implementing the algorithm in hospital admissions data is explained here:

Step 1:

ICD 10 and OPCS 4 codes from hospital admissions are used to create variable categories that identify participants who received any RRT (and within this category those who received a kidney transplant or peritoneal dialysis which was assumed to be for maintenance RRT), and those with indicators of CKD stage 5:

Table 1. Code Lists for RRT, Maintenance RRT and Indicators of CKD Stage 5

ICD 10 Codes					
Code Type	ICD 10 Code	ICD 10 Text	RRT	RRT MAINTENANCE	CKD 5 INDICATOR
ICD 10 Code	E85.3	Secondary systemic amyloidosis	✓		✓
ICD 10 Code	N16.5	Renal tubulo-interstitial disorders in transplant rejection	✓	✓	✓
ICD 10 Code	N18.0	End-stage renal disease			✓
ICD 10 Code	N18.5	Chronic kidney disease, stage 5			✓
ICD 10 Code	Q60.1	Renal agenesis, bilateral			✓
ICD 10 Code	T82.4	Mechanical complication of vascular dialysis catheter	✓		
ICD 10 Code	T86.1	Kidney transplant failure and rejection	✓	✓	✓
ICD 10 Code	Y60.2	Unintentional cut, puncture, perforation or haemorrhage during surgical and medical care - During kidney dialysis or other perfusion	✓		
ICD 10 Code	Y61.2	Foreign object accidentally left in body during surgical and medical care - During kidney dialysis or other perfusion	✓		

ICD 10 Code	Y62.2	Failure of sterile precautions during surgical and medical care - During kidney dialysis or other perfusion	✓		
ICD 10 Code	Y84.1	Other medical procedures as the cause of abnormal reaction of the patient, or of later complication, without mention of misadventure at the time of the procedure - Kidney dialysis	✓		
ICD 10 Code	Z49.0	Preparatory care for dialysis	✓		
ICD 10 Code	Z49.1	Extracorporeal dialysis	✓		
ICD 10 Code	Z49.2	Other dialysis	✓	✓	
ICD 10 Code	Z94.0	Kidney transplant status	✓	✓	✓
ICD 10 Code	Z99.2	Dependence on renal dialysis	✓		
OPCS 4 Codes					
Code Type	OPCS 4 Code	OPCS 4 Text	RRT	RRT MAINTENANCE	CKD 5 INDICATOR
OPCS 4 Code	L74.1	Insertion of arteriovenous prosthesis			✓
OPCS 4 Code	L74.2	Creation of arteriovenous fistula NEC			✓
OPCS 4 Code	L74.3	Attention to arteriovenous shunt			✓
OPCS 4 Code	L74.4	Banding of arteriovenous fistula			✓
OPCS 4 Code	L74.5	Thrombectomy of arteriovenous fistula			✓
OPCS 4 Code	L74.6	Creation of graft fistula for dialysis			✓
OPCS 4 Code	L74.8	Other specified arteriovenous shunt			✓
OPCS 4 Code	L74.9	Unspecified arteriovenous shunt			✓
OPCS 4 Code	M01.2	Allotransplantation of kidney from live donor	✓	✓	✓
OPCS 4 Code	M01.3	Allotransplantation of kidney from cadaver NEC	✓	✓	✓
OPCS 4 Code	M01.4	Allotransplantation of kidney from cadaver heart beating	✓	✓	✓
OPCS 4 Code	M01.5	Allotransplantation of kidney from cadaver heart non-beating	✓	✓	✓
OPCS 4 Code	M01.8	Other specified transplantation of kidney	✓	✓	✓
OPCS 4 Code	M01.9	Unspecified transplantation of kidney	✓	✓	✓
OPCS 4 Code	M02.3	Bilateral nephrectomy			✓
OPCS 4 Code	M08.4	Exploration of transplanted kidney	✓	✓	✓
OPCS 4 Code	M17.2	Pre-transplantation of kidney work-up – recipient			✓
OPCS 4 Code	M17.4	Post-transplantation of kidney examination – recipient	✓	✓	✓
OPCS 4 Code	M17.8	Other specified interventions associated with transplantation of kidney	✓	✓	✓
OPCS 4 Code	M17.9	Unspecified interventions associated with transplantation of kidney	✓	✓	✓
OPCS 4 Code	X40.1	Renal dialysis	✓		

OPCS 4 Code	X40.2	Peritoneal dialysis NEC	✓	✓	✓
OPCS 4 Code	X40.3	Haemodialysis NEC	✓		
OPCS 4 Code	X40.4	Haemofiltration	✓		
OPCS 4 Code	X40.5	Automated peritoneal dialysis	✓	✓	✓
OPCS 4 Code	X40.6	Continuous ambulatory peritoneal dialysis	✓	✓	✓
OPCS 4 Code	X40.7	Haemoperfusion	✓		
OPCS 4 Code	X40.8	Other specified compensation for renal failure	✓		
OPCS 4 Code	X40.9	Unspecified compensation for renal failure	✓		
OPCS 4 Code	X41.1	Insertion of ambulatory peritoneal dialysis catheter	✓	✓	✓
OPCS 4 Code	X41.2	Removal of ambulatory peritoneal dialysis catheter	✓	✓	✓
OPCS 4 Code	X41.8	Other specified placement of ambulatory apparatus for compensation for renal failure	✓		
OPCS 4 Code	X41.9	Unspecified placement of ambulatory apparatus for compensation for renal failure	✓		
OPCS 4 Code	X42.1	Insertion of temporary peritoneal dialysis catheter	✓		
OPCS 4 Code	X42.8	Other specified placement of other apparatus for compensation for renal failure	✓		
OPCS 4 Code	X42.9	Unspecified placement of other apparatus for compensation for renal failure	✓		
OPCS 4 Code	X43.1	Extracorporeal albumin haemodialysis	✓		

Step 2:

ICD 10 and OPCS 4 codes are combined to create the following Derived Phenotypic Variables (DPVs).

DPV Category	Description	Rules
DPV_COMPOSITE_ANY_RRT	Any renal replacement therapy (RRT: dialysis or transplantation), i.e. includes both acute or maintenance RRT	Any participant with RRT =1 should be considered DPV_COMPOSITE_ANY_RRT=1. For this outcome, first and any subsequent records need to be recorded with all the relevant dates.
DPV_COMPOSITE_ESRD_TX_OR_PD	CKD stage 5 treated by transplantation or peritoneal dialysis	Any participant with MAINTENANCE_RRT=1 should be considered DPV_COMPOSITE_ESRD_TX_OR_PD=1. Use the earliest date of these records as the date.
DPV_COMPOSITE_CKD5_INDICATOR	Any CKD stage 5 indicator	Any participant with CKD5_INDICATOR=1; should be considered DPV_COMPOSITE_ CKD5_INDICATOR = 1. For this outcome, first and any subsequent records need to be recorded with all the relevant dates.

Step 3:

Participants without evidence of a CKD stage indicator are excluded (i.e. those with acute kidney injury are excluded).

DPV Category	Description	Rules
DPV_COMPOSITE_ESRD_ONRRT	CKD stage 5 treated with renal replacement therapy identified using CKD stage 5 indicators	A record of DPV_COMPOSITE_ANY_RRT = 1 with (a) a record in DPV_COMPOSITE_CKD5_INDICATOR = 1 before the record in DPV_COMPOSITE_ANY_RRT=1, OR (b) a record in DPV_COMPOSITE_CKD5_INDICATOR = 1 on or within 365 days of the record in DPV_COMPOSITE_ANY_RRT = 1. - Use the earliest date of a record in DPV_COMPOSITE_ANY_RRT = 1 that fulfils one of these criteria as the date.
DPV_COMPOSITE_ESRD_ONRRT_COMBINED	Combined CKD stage 5 treated with RRT	Any participant with DPV_COMPOSITE_ESRD_TX_OR_PD = 1 or DPV_COMPOSITE_ESRD_ONRRT = 1. Use the earliest date of these records as the assigned case date.

Step 4:

Any participant with DPV_COMPOSITE_ESRD_ONRRT_COMBINED=1 after implementation of the above algorithm steps is deemed to be an ESRD case detected in hospital admission data.

II. End Stage Renal Disease Detected from Self-Report and Death Records

Table 2. Code Lists for ESRD in Self-Report and Death Records

UK Biobank Self Report Codes			
Code Type	Code	Biobank Code Text	ESRD
UK Biobank Self Report	Field 20002 Code 1193	Renal failure requiring dialysis	✓
UK Biobank Self Report	Field 20004 Code 1195	Renal/kidney transplant	✓
UK Biobank Self Report	Field 20004 Code 1580	Dialysis access surgery	✓
UK Biobank Self Report	Field 20004 Code 1581	Haemodialysis access/fistula surgery	✓
UK Biobank Self Report	Field 20004 Code 1582	Peritoneal dialysis (capd) access surgery	✓
ICD 10 Codes			
Code Type	ICD 10 Code	ICD 10 Text	ESRD
ICD 10 Code	N18.0	End-stage renal disease	✓
ICD 10 Code	N18.5	Chronic kidney disease, stage 5	✓

***Acknowledgments**: Code list generated by Charlie Harper, Will Herrington and Cathie Sudlow on behalf of UK Biobank Outcome Adjudication Group.*

Appendix 2

We compared the number of cases detected from hospital admission data prior to the baseline recruitment date, with the self-reported ESRD at baseline, in all UK Biobank participants and found a good level of agreement:

Comparison of Probable Self-Report ESRD and Prevalent Inpatient Cases

Hospital	*Self-Report*		*Total*
	0	1	
0	501,600	155	501,755
1	67	383	450
Total	501,667	538	502,205

Kappa statistic: 0.78 (95% CI 0.75-0.80)

It is probable that self-reported condition code 1193, “Renal failure requiring dialysis”, will include some participants that have suffered Acute Kidney Injury (AKI) rather than ESRD. The validation of the algorithm against the self-reported cases of RRT was carried out including and excluding code 1193. The kappa statistic was higher when code 1193 was included (0.78), than when excluded (0.75) and so it was decided to keep this code in the self-reported ESRD category.

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