



**Definitions of End Stage Renal Disease for  
UK Biobank Phase 1 Outcomes Adjudication**

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## **Definitions of End Stage Renal Disease, UK Biobank phase 1 outcomes adjudication**

### **Definitions & Abbreviations:**

<b>ESRD</b>	<b>End Stage Renal Disease</b>
<b>CKD</b>	<b>Chronic Kidney Disease</b>
<b>AKI</b>	<b>Acute Kidney Injury</b>
<b>RRT</b>	<b>Renal Replacement Therapy</b>
<b>DPV</b>	<b>Derived Phenotypic Variable</b>
<b>HES APC</b>	<b>Hospital Episode Statistics - Admitted Patient Care (England)</b>
<b>SMR01</b>	<b>Scottish Morbidity Records – General / Acute Inpatient and Day Case Admissions (Scotland)</b>
<b>PEDW</b>	<b>Patient Episode Database for Wales</b>
<b>EHR</b>	<b>Electronic Health Records</b>
<b>Finished Consultant Episode</b>	<b>The basic counting unit for statistics of admitted care Hospital EHR data (= a row of data in the data extracts provided) is a finished consultant episode (FCE).</b>
<b>Code date</b>	<b>The start date of the FCE is taken as the code date.</b>
<b>ICD 9</b>	<b>International Classification of Diseases, Version 9 (SMR only)</b>
<b>ICD 10</b>	<b>International Classification of Diseases, Version 10</b>
<b>OPCS 4</b>	<b>Office of Population Censuses and Surveys Classification of Surgical Operations and Procedures - Version 4</b>
<b>Prevalent Case</b>	<b>First known hospitalisation with a relevant diagnostic code prior to recruitment, or self-reported event at recruitment.</b>
<b>Incident Case</b>	<b>First known hospitalisation with a relevant diagnostic code post recruitment, or cause-specific death, in those without indication of prevalent event as defined above.</b>

## **Background:**

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 epidemiologists may want to study separately. We have therefore devised an algorithm that identifies RRT in UK Biobank participants, and then selects the subset of participants with other diagnoses or procedures, which indicate 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 by this algorithm have previously been used to successfully identify people with treated ESRD.<sup>1</sup>

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

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

The use of self-report code dates is discussed in Appendix 3.

## **A. END STAGE RENAL DISEASE**

### **(1) ESRD prior to baseline assessment ('prevalent ESRD')**

**(a) ESRD detected by hospital admission EHR (with or without self-report):** ESRD identified by the algorithm steps outlined in Appendix 1 in HES APC, SMR01 or PEDW linked records where

- The assigned case date from hospital admission EHR is prior to the date of baseline assessment.

**OR**

- The participant has self-reported the condition at the baseline assessment, but the assigned case date from hospital admission EHR is post the date of baseline assessment.

**(b) ESRD by self-report only:** The participant has self-reported ESRD, but without evidence of ESRD from linked HES APC, SMR01 or PEDW data (as defined above).

**Setting the date of prevalent ESRD diagnosis:**

- If a participant is identified in both hospital admission and self-report, the earliest recorded date regardless of source is used.
- If a participant is identified in both hospital admission and self-report, but the self-reported date is missing, the algorithm assigned case date is used unless it is post the date of baseline assessment, in which case the default missing date is used.
- If a participant is identified in hospital admission only, the algorithm assigned case date is used.
- If the participant has self-report code(s) only, the earliest self-reported date is used.
- Missing dates are set to 1/1/1900.

### **(2) ESRD following baseline assessment ('incident ESRD')**

**Excluding those with ESRD detected prior to baseline assessment:**

**(a) ESRD detected by hospital admission EHR:** ESRD identified by the algorithm steps outlined in Appendix 1 in HES APC, SMR01 or PEDW linked records with an assigned case date after the date of baseline assessment.

**(b) ESRD detected by death register only:** No incident ESRD detected by hospital admission EHR, but one of the ICD 10 codes listed in Table 2 in a death record, in the underlying cause or any other position.

**Setting the date of incident ESRD diagnosis:**

- If a participant is identified in both hospital admission and death register records, the earliest recorded date regardless of source is used.
- If a participant is identified in hospital admission only, the algorithm assigned case date is used.
- If the ICD code is recorded in death register only, the date of death is used.

## **Appendix 1**

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

### **End Stage Renal Disease Detected in Hospital Admission EHR**

The algorithm detects cases of ESRD in hospital admissions data by using ICD 10 and OPCS4 codes to 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. 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.

The full process for implementing this algorithm in hospital admissions data is outlined in steps 1 to 4 below.

#### **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**

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

**ICD 10 Codes (Continued)**

<b>Code Type</b>	<b>ICD 10 Code</b>	<b>ICD 10 Text</b>	<b>RRT</b>	<b>RRT MAINTENANCE</b>	<b>CKD 5 INDICATOR</b>
ICD 10 Code	Y62.2	Failure of sterile precautions during surgical and medical care - During kidney dialysis or other perfusion	ü		
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	ü		
ICD 10 Code	Z49.0	Preparatory care for dialysis	ü		
ICD 10 Code	Z49.1	Extracorporeal dialysis	ü		
ICD 10 Code	Z49.2	Other dialysis	ü	ü	
ICD 10 Code	Z94.0	Kidney transplant status	ü	ü	ü
ICD 10 Code	Z99.2	Dependence on renal dialysis	ü		

**OPCS 4 Codes**

<b>Code Type</b>	<b>OPCS 4 Code</b>	<b>OPCS 4 Text</b>	<b>RRT</b>	<b>RRT MAINTENANCE</b>	<b>CKD 5 INDICATOR</b>
OPCS 4 Code	L74.1	Insertion of arteriovenous prosthesis			ü
OPCS 4 Code	L74.2	Creation of arteriovenous fistula NEC			ü
OPCS 4 Code	L74.3	Attention to arteriovenous shunt			ü
OPCS 4 Code	L74.4	Banding of arteriovenous fistula			ü
OPCS 4 Code	L74.5	Thrombectomy of arteriovenous fistula			ü
OPCS 4 Code	L74.6	Creation of graft fistula for dialysis			ü
OPCS 4 Code	L74.8	Other specified arteriovenous shunt			ü
OPCS 4 Code	L74.9	Unspecified arteriovenous shunt			ü
OPCS 4 Code	M01.2	Allotransplantation of kidney from live donor	ü	ü	ü
OPCS 4 Code	M01.3	Allotransplantation of kidney from cadaver NEC	ü	ü	ü
OPCS 4 Code	M01.4	Allotransplantation of kidney from cadaver heart beating	ü	ü	ü
OPCS 4 Code	M01.5	Allotransplantation of kidney from cadaver heart non-beating	ü	ü	ü
OPCS 4 Code	M01.8	Other specified transplantation of kidney	ü	ü	ü
OPCS 4 Code	M01.9	Unspecified transplantation of kidney	ü	ü	ü
OPCS 4 Code	M02.3	Bilateral nephrectomy			ü
OPCS 4 Code	M08.4	Exploration of transplanted kidney	ü	ü	ü

*OPCS 4 Codes Continued Overleaf*

**OPCS 4 Codes (Continued)**

<b>Code Type</b>	<b>OPCS 4 Code</b>	<b>OPCS 4 Text</b>	<b>RRT</b>	<b>RRT MAINTENANCE</b>	<b>CKD 5 INDICATOR</b>
OPCS 4 Code	M17.2	Pre-transplantation of kidney work-up – recipient			ü
OPCS 4 Code	M17.4	Post-transplantation of kidney examination – recipient	ü	ü	ü
OPCS 4 Code	M17.8	Other specified interventions associated with transplantation of kidney	ü	ü	ü
OPCS 4 Code	M17.9	Unspecified interventions associated with transplantation of kidney	ü	ü	ü
OPCS 4 Code	X40.1	Renal dialysis	ü		
OPCS 4 Code	X40.2	Peritoneal dialysis NEC	ü	ü	ü
OPCS 4 Code	X40.3	Haemodialysis NEC	ü		
OPCS 4 Code	X40.4	Haemofiltration	ü		
OPCS 4 Code	X40.5	Automated peritoneal dialysis	ü	ü	ü
OPCS 4 Code	X40.6	Continuous ambulatory peritoneal dialysis	ü	ü	ü
OPCS 4 Code	X40.7	Haemoperfusion	ü		
OPCS 4 Code	X40.8	Other specified compensation for renal failure	ü		
OPCS 4 Code	X40.9	Unspecified compensation for renal failure	ü		
OPCS 4 Code	X41.1	Insertion of ambulatory peritoneal dialysis catheter	ü	ü	ü
OPCS 4 Code	X41.2	Removal of ambulatory peritoneal dialysis catheter	ü	ü	ü
OPCS 4 Code	X41.8	Other specified placement of ambulatory apparatus for compensation for renal failure	ü		
OPCS 4 Code	X41.9	Unspecified placement of ambulatory apparatus for compensation for renal failure	ü		
OPCS 4 Code	X42.1	Insertion of temporary peritoneal dialysis catheter	ü		
OPCS 4 Code	X42.8	Other specified placement of other apparatus for compensation for renal failure	ü		
OPCS 4 Code	X42.9	Unspecified placement of other apparatus for compensation for renal failure	ü		
OPCS 4 Code	X43.1	Extracorporeal albumin haemodialysis	ü		

## 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, <b>OR</b> (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 fulfills 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 by hospital admission EHRs.



## **End Stage Renal Disease Detected from Self-Report and Death Records**

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

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

## **Appendix 2**

We compared the number of cases detected from hospital admission EHRs 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**

<i>Hospital</i>	<i>Self-Report</i>		<i>Total</i>
	<i>0</i>	<i>1</i>	
<i>0</i>	501,600	155	501,755
<i>1</i>	67	383	450
<b><i>Total</i></b>	<b>501,667</b>	<b>538</b>	<b>502,205</b>

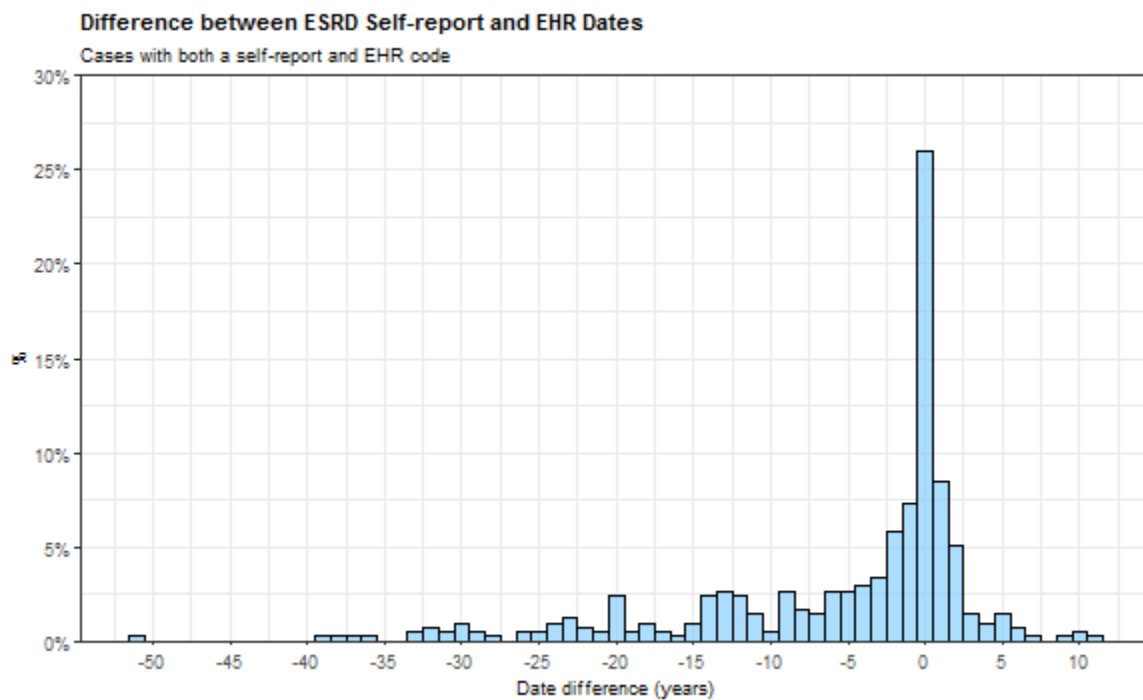
**Kappa statistic: 0.78 (95% CI 0.75-0.80)**

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.

### Appendix 3

The self-report date is taken from the UK Biobank field [20008](#) or [20010](#) (“Interpolated Year when non-cancer illness first diagnosed/operation took place”). At the nurse led interviews, nurses were instructed to record either a year or an age at which the diagnosis/operation occurred. Where an age was provided, a best-fit fractional year was then calculated.

For cases that are detected in both self-report and EHRs this algorithm assigns the earliest date as the event date for the case. The histogram below shows the difference (in years) between self-report and EHR dates for the subset of ESRD cases that are detected in both. Negative values indicate that the self-report date is earlier than the HER date. In the majority of cases (67%), the earliest date is the self-reported date.



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## **References:**

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