Redistribution of ill-defined deaths: the Scottish Burden of Disease approach

COST Action CA18218–European Burden of Disease Network workshop on Ill-defined deaths, European Public Health Conference, November 11th 2022, Berlin.

I Grant, E Fletcher G McCartney M Thrower G Wyper D Stockton

Public Health Scotland

Contents

1. Mortality data in Scotland

2. What do ill-defined deaths look like in Scotland?

3. Distribution of ill-defined deaths in Scotland

4. Strengths and limitations of Scottish approach

Structure of mortality data in Scotland

Medical Certificate of Cause of Death

Death registered within 8 days

National Records of Scotland

Clinical coding applied

Public Health Scotland

Mortality records available for analysis

- Completed by a clinician
- Part 1: the underlying cause of death PLUS any disease or condition which led directly to death
- Part 2: Other significant diseases

- Demographic information
- 1 x underlying cause of death
- 10 x secondary/contributory causes of death (maximum)
- Linkable to secondary care and other clinical records

Ill-defined deaths in Scotland

- Between 10-12% of all deaths classed as ill-defined
- Over 75's account for 65% of IDDs
- ~ 50% of IDDs are due to the following conditions:

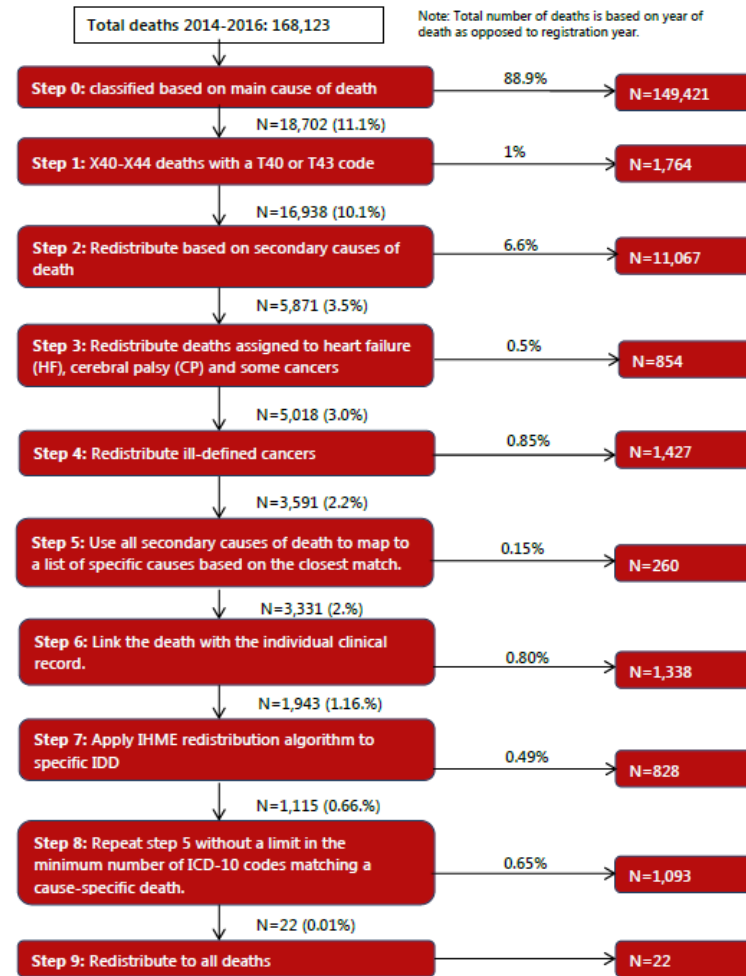| Description |
| --- |
| Malignant neoplasm of other and ill-defined sites |
| Heart failure and other ill-defined cardiovascular conditions |
| Other specified respiratory disorders |
| Streptococcal, severe and other sepsis related infections |
| Pneumonitis due to solids and liquids |
| Other and unspecified diseases* |

65% of burden in Scotland due to YLL therefore crucial robust redistribution processes

* Including unspecified bacterial and infectious diseases, endocrine, nutritional and metabolic diseases; and mental and behavioural disorders.

Scotland IDD algorithm

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

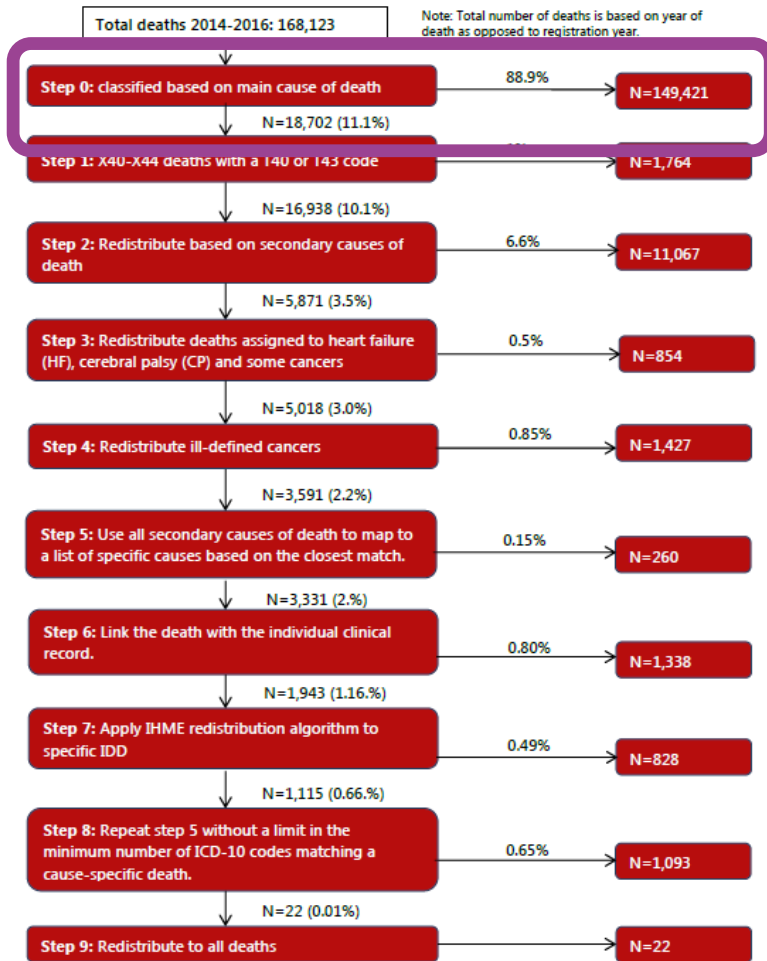| Step	% redistributed	N
Step 0: classified based on main cause of death	88.9%	N=149,421
N=18,702 (11.1%)		
Step 1: X40-X44 deaths with a T40 or T43 code	1%	N=1,764
N=16,938 (10.1%)		
Step 2: Redistribute based on secondary causes of death	6.6%	N=11,067
N=5,871 (3.5%)		
Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers	0.5%	N=854
N=5,018 (3.0%)		
Step 4: Redistribute ill-defined cancers	0.85%	N=1,427
N=3,591 (2.2%)		
Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match.	0.15%	N=260
N=3,331 (2.%)		
Step 6: Link the death with the individual clinical record.	0.80%	N=1,338
N=1,943 (1.16.%)		
Step 7: Apply IHME redistribution algorithm to specific IDD	0.49%	N=828
N=1,115 (0.66.%)		
Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death.	0.65%	N=1,093
N=22 (0.01%)		
Step 9: Redistribute to all deaths		N=22

- Ten-step process
- Hierarchical
- Redistributed at patient-level
- Scotland-specific *plus* adapted IHME methodology
- Clinically reviewed
- **Overall aim:** *to exploit as much of the available clinical information as possible*

Scotland IDD algorithm – step 0

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

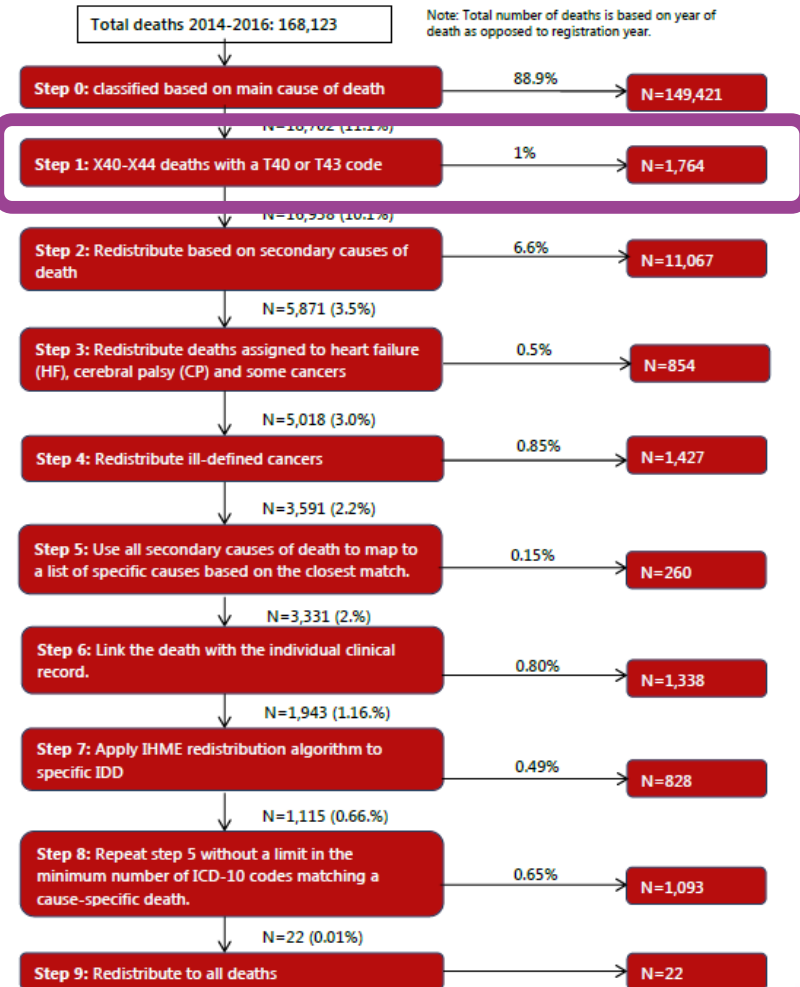| Step	%	N
Step 0: classified based on main cause of death	88.9%	N=149,421
N=18,702 (11.1%)		
Step 1: X40-X44 deaths with a I40 or I43 code		N=1,764
N=16,938 (10.1%)		
Step 2: Redistribute based on secondary causes of death	6.6%	N=11,067
N=5,871 (3.5%)		
Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers	0.5%	N=854
N=5,018 (3.0%)		
Step 4: Redistribute ill-defined cancers	0.85%	N=1,427
N=3,591 (2.2%)		
Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match.	0.15%	N=260
N=3,331 (2.0%)		
Step 6: Link the death with the individual clinical record.	0.80%	N=1,338
N=1,943 (1.16.%)		
Step 7: Apply IHME redistribution algorithm to specific IDD	0.49%	N=828
N=1,115 (0.66.%)		
Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death.	0.65%	N=1,093
N=22 (0.01%)		
Step 9: Redistribute to all deaths		N=22

Cause-specific deaths

- Removing non-IDD deaths from process
- Deaths mapped to GBD causes based on <u>primary cause of death only</u>
- Remaining deaths which can't be mapped are ill-defined and enter the redistribution process (~12%)

Scotland IDD algorithm – step 1

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

Step 0: classified based on main cause of death — 88.9% → N=149,421

N=18,702 (11.1%)

Step 1: X40-X44 deaths with a T40 or T43 code — 1% → N=1,764

N=16,938 (10.1%)

Step 2: Redistribute based on secondary causes of death — 6.6% → N=11,067

N=5,871 (3.5%)

Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers — 0.5% → N=854

N=5,018 (3.0%)

Step 4: Redistribute ill-defined cancers — 0.85% → N=1,427

N=3,591 (2.2%)

Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. — 0.15% → N=260

N=3,331 (2%)

Step 6: Link the death with the individual clinical record. — 0.80% → N=1,338

N=1,943 (1.16.%)

Step 7: Apply IHME redistribution algorithm to specific IDD — 0.49% → N=828

N=1,115 (0.66.%)

Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. — 0.65% → N=1,093

N=22 (0.01%)

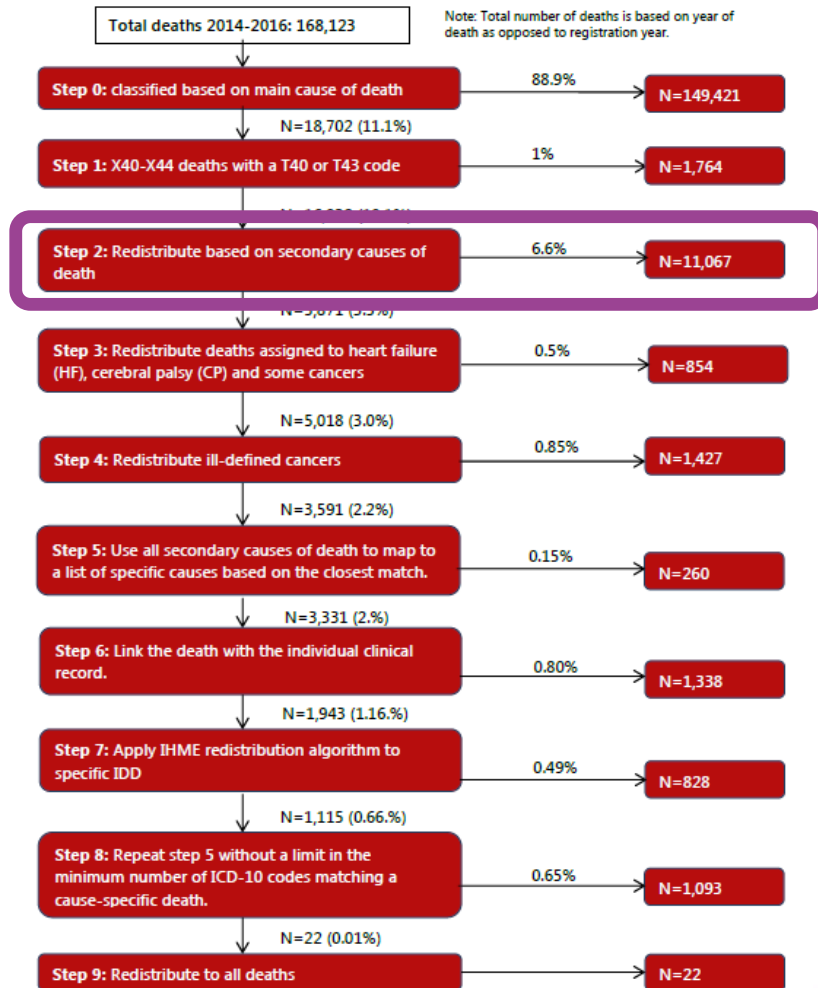Step 9: Redistribute to all deaths — N=22

Redistribute drug-related deaths

- Scotland has specific local rules on identifying drug-related deaths
- Redistribute the death to drug-related death where:
    - Underlying cause of death accidental poisoning AND
    - Contributory cause of death mentions specific drug type
- 9.4% of IDDs redistributed at this step

Scotland IDD algorithm – step 2 (1)

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

Step 0: classified based on main cause of death — 88.9% — N=149,421

N=18,702 (11.1%)

Step 1: X40-X44 deaths with a T40 or T43 code — 1% — N=1,764

Step 2: Redistribute based on secondary causes of death — 6.6% — N=11,067

Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers — 0.5% — N=854

N=5,018 (3.0%)

Step 4: Redistribute ill-defined cancers — 0.85% — N=1,427

N=3,591 (2.2%)

Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. — 0.15% — N=260

N=3,331 (2.%)

Step 6: Link the death with the individual clinical record. — 0.80% — N=1,338

N=1,943 (1.16.%)

Step 7: Apply IHME redistribution algorithm to specific IDD — 0.49% — N=828

N=1,115 (0.66.%)

Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. — 0.65% — N=1,093

N=22 (0.01%)

Step 9: Redistribute to all deaths — N=22

Redistribute based on contributory causes of deaths

- Maximum of 10 contributory causes of death on each death record
- Distribute IDD to all valid contributory causes of death for that patient
- Maximises clinical information available
- 60% of IDDs redistributed at step 2

Scotland IDD algorithm – step 2 (2)

*Redistribute based on secondary causes of deaths - example*

Primary Cause of Death *(ill defined)*	Secondary causes of death	Distritbution proportion
Patient A		
Heart failure, unspecified (I50.9)	Pneumonia, unspecified (J18.9)	0.5
	Malignant neoplasm of prostate (C61)	0.5
Patient B	Bronchiectasis (J47)	0.5
Delirium, unspecified (F05.9)	Heart failure, unspecified (I50.9)	-
	Atrial fibrillation and flutter (I48)	0.5
	Acute renal failure, unspecified (N17.9)	-

- Distribute IDD equally between all cause-specific secondary causes
- Ill-defined secondary causes are ignored
- Assumes equal weighting between secondary causes of death

Scotland IDD algorithm – step 3 & 4 (1)

Summary of the redistribution steps and the percentage of deaths re-distributed in each step
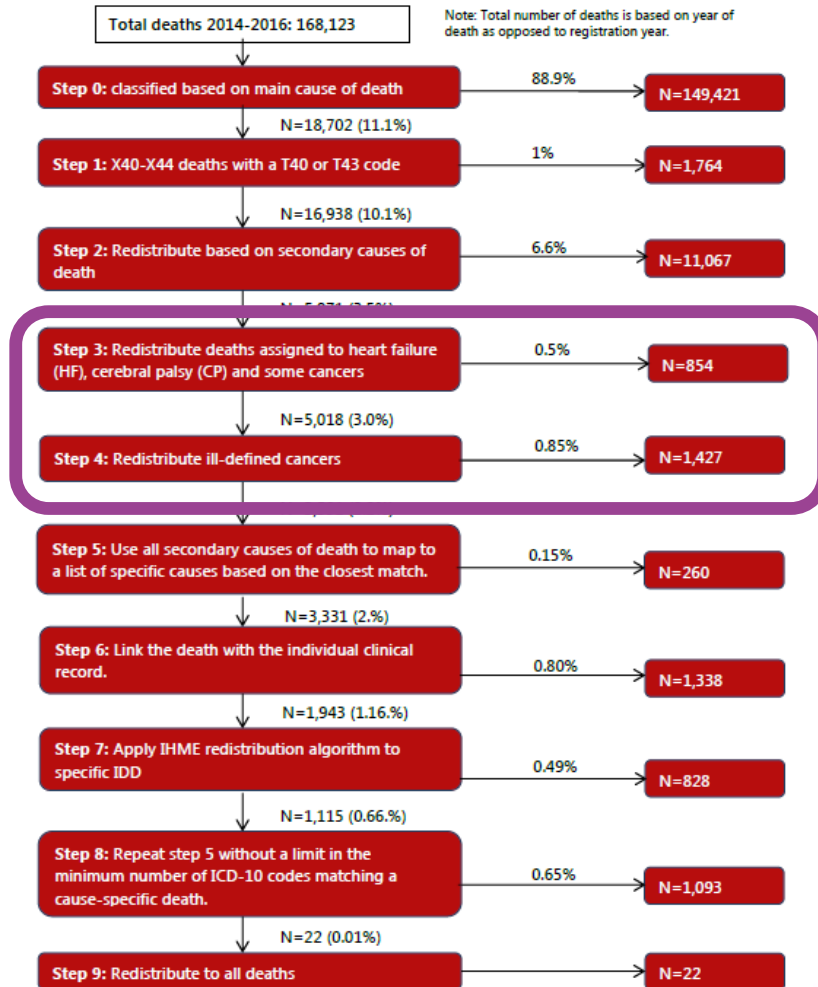
Heart failure, cerebral palsy and ill-defined cancers

- Uses IHME target causes, but with Scotland-specific proportions, not fixed IHME proportions
- 12% of IDDs distributed at this step
- Most heart failure deaths captured previously in step 2

Scotland IDD algorithm – step 3 & 4 (2)

Fixed and age-sex specific distribution proportions

Ill-defined death	Target cause(s)	IHME distribution proportion	Scotland distribution proportion
Malignant neoplasm, overlapping lesion of digestive system (C26.8)	Colorectal cancer	*Fixed*	Age-sex-data specific
	Oesophageal cancer	*Fixed*	Age-sex-data specific
	Stomach cancer	*Fixed*	Age-sex-data specific

How do we calculate the distribution proportions?

Target cause(s)	Males 25-44		Females 85+	
	N of deaths	Distribution Proportions	N of deaths	Distribution Proportions
Colorectal cancer	200	0.500	200	0.500
Oesophageal cancer	50	0.125	0	0
Stomach cancer	150	0.375	200	0.500
Total target cause deaths in strata	*400*	*1*	*400*	*1*

Scotland IDD algorithm – step 5 (1)

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

Step 0: classified based on main cause of death → 88.9% → N=149,421

N=18,702 (11.1%)

Step 1: X40-X44 deaths with a T40 or T43 code → 1% → N=1,764

N=16,938 (10.1%)

Step 2: Redistribute based on secondary causes of death → 6.6% → N=11,067

N=5,871 (3.5%)

Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers → 0.5% → N=854

N=5,018 (3.0%)

Step 4: Redistribute ill-defined cancers → 0.85% → N=1,427

Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. → 0.15% → N=260

Step 6: Link the death with the individual clinical record. → 0.80% → N=1,338

N=1,943 (1.16.%)

Step 7: Apply IHME redistribution algorithm to specific IDD → 0.49% → N=828

N=1,115 (0.66.%)

Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. → 0.65% → N=1,093

N=22 (0.01%)
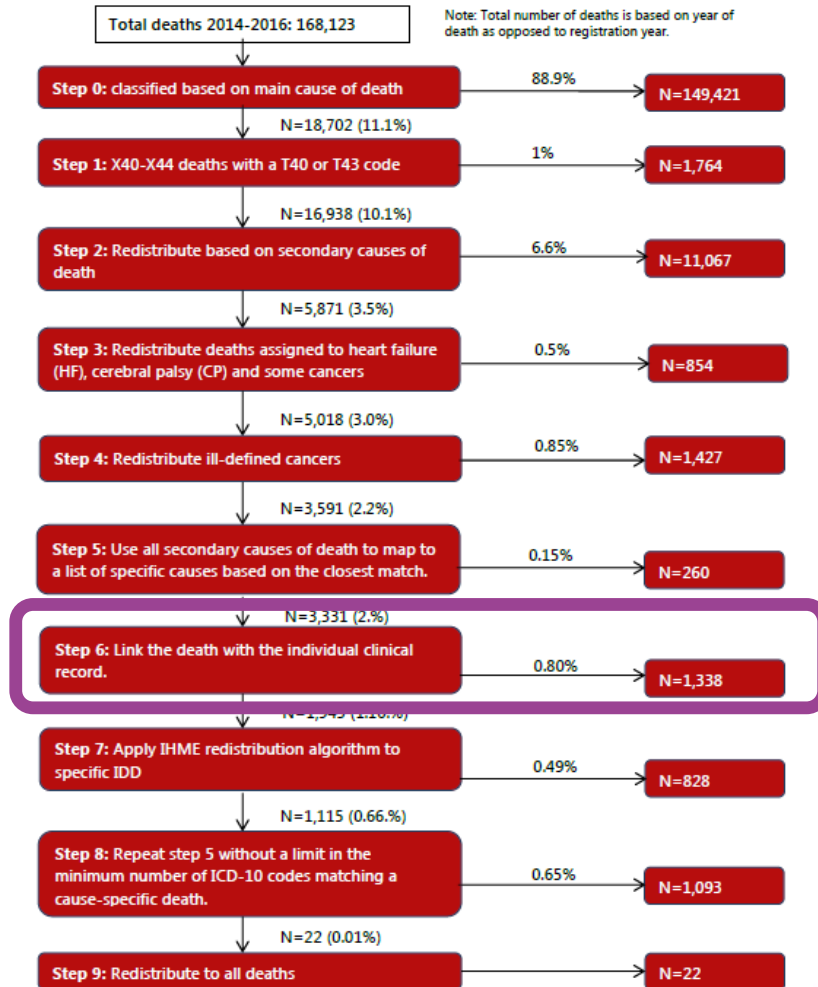
Step 9: Redistribute to all deaths → N=22

Match to similar deaths found in mortality records

- No valid underlying cause of death, nor any valid secondary causes of death
- But still a wealth of information contained on death record
- Create a 'pool' of target codes, using all cause-specific deaths in that age-sex strata
- Attempt to find matches for all contributory causes of death recorded on the IDD
- Minimum of three contributory causes required to match
- 1.4% of IDDs redistributed at this step

Scotland IDD algorithm – step 6

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

Step 0: classified based on main cause of death — 88.9% — N=149,421
N=18,702 (11.1%)
Step 1: X40-X44 deaths with a T40 or T43 code — 1% — N=1,764
N=16,938 (10.1%)
Step 2: Redistribute based on secondary causes of death — 6.6% — N=11,067
N=5,871 (3.5%)
Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers — 0.5% — N=854
N=5,018 (3.0%)
Step 4: Redistribute ill-defined cancers — 0.85% — N=1,427
N=3,591 (2.2%)
Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. — 0.15% — N=260
N=3,331 (2.%)
Step 6: Link the death with the individual clinical record. — 0.80% — N=1,338
N=1,949 (1.16%)
Step 7: Apply IHME redistribution algorithm to specific IDD — 0.49% — N=828
N=1,115 (0.66.%)
Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. — 0.65% — N=1,093
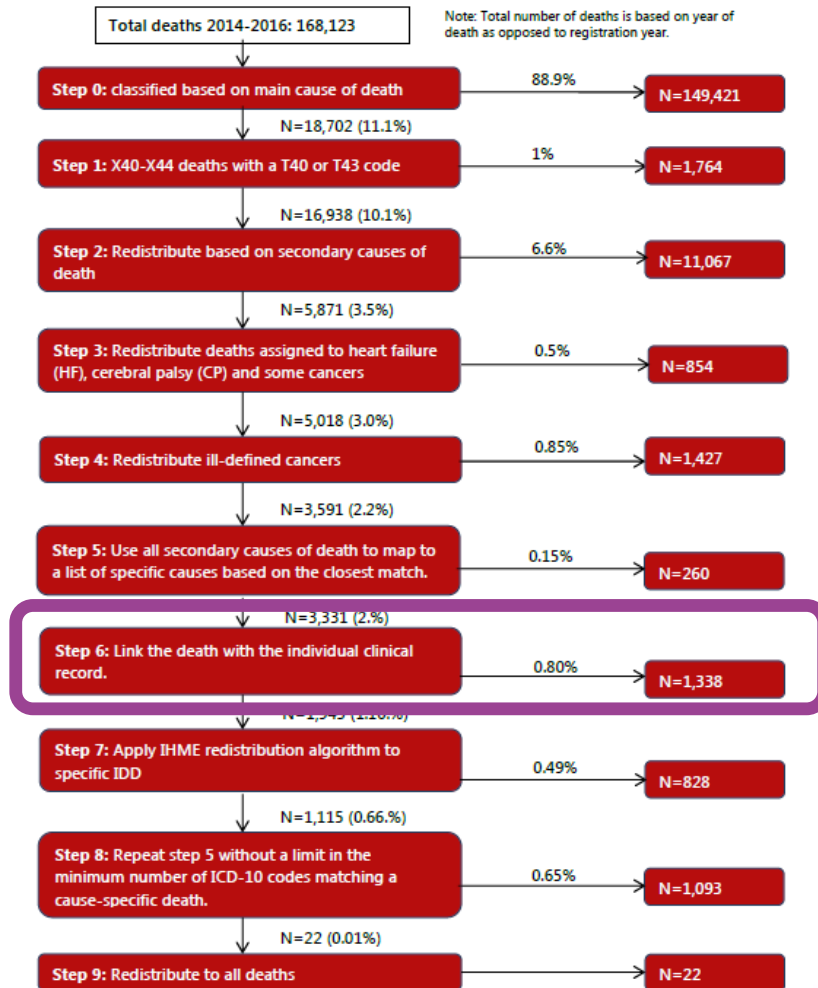N=22 (0.01%)
Step 9: Redistribute to all deaths — N=22

Link to individual clinical records

- Identify any conditions for which the patient was prevalent in the two years prior to death
- Redistribute death to all valid conditions
- ~ 7.4% of IDDs distributed at this step

- Possible bias towards more serious morbidities due to lack of linkage to primary care
- Difficult to implement in countries without strong data linkage capabilities

Scotland IDD algorithm – step 7

Summary of the redistribution steps and the percentage of deaths re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

Step 0: classified based on main cause of death — 88.9% — N=149,421

N=18,702 (11.1%)

Step 1: X40-X44 deaths with a T40 or T43 code — 1% — N=1,764

N=16,938 (10.1%)

Step 2: Redistribute based on secondary causes of death — 6.6% — N=11,067

N=5,871 (3.5%)

Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers — 0.5% — N=854

N=5,018 (3.0%)

Step 4: Redistribute ill-defined cancers — 0.85% — N=1,427

N=3,591 (2.2%)

Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. — 0.15% — N=260

N=3,331 (2.%)

Step 6: Link the death with the individual clinical record. — 0.80% — N=1,338

N=1,949 (1.16%)

Step 7: Apply IHME redistribution algorithm to specific IDD — 0.49% — N=828

N=1,115 (0.66.%)

Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. — 0.65% — N=1,093

N=22 (0.01%)

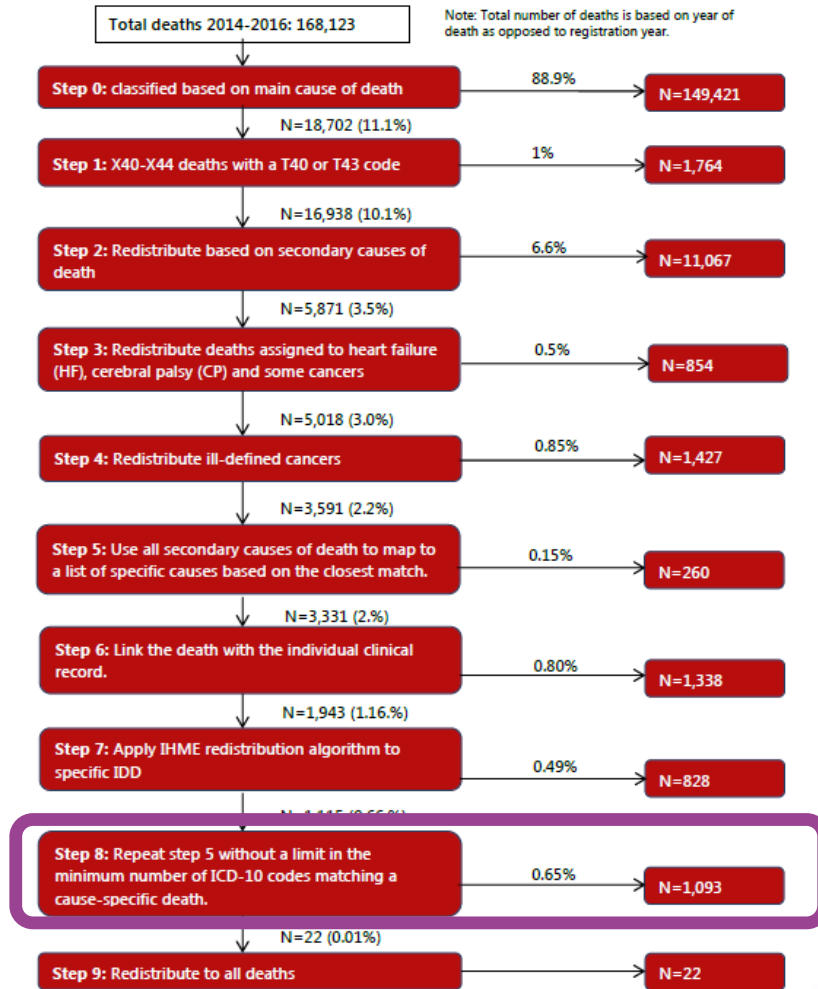Step 9: Redistribute to all deaths — N=22

Apply IHME target cause redistribution

- 35 conditions where we redistribute to IHME target causes
- Again, we redistribute according to the relative proportions seen in the Scottish data
- 4.4% of IDDs distributed at this step

Scotland IDD algorithm – step 8

Summary of the redistribution steps and the percentage of deaths re-distributed in each step
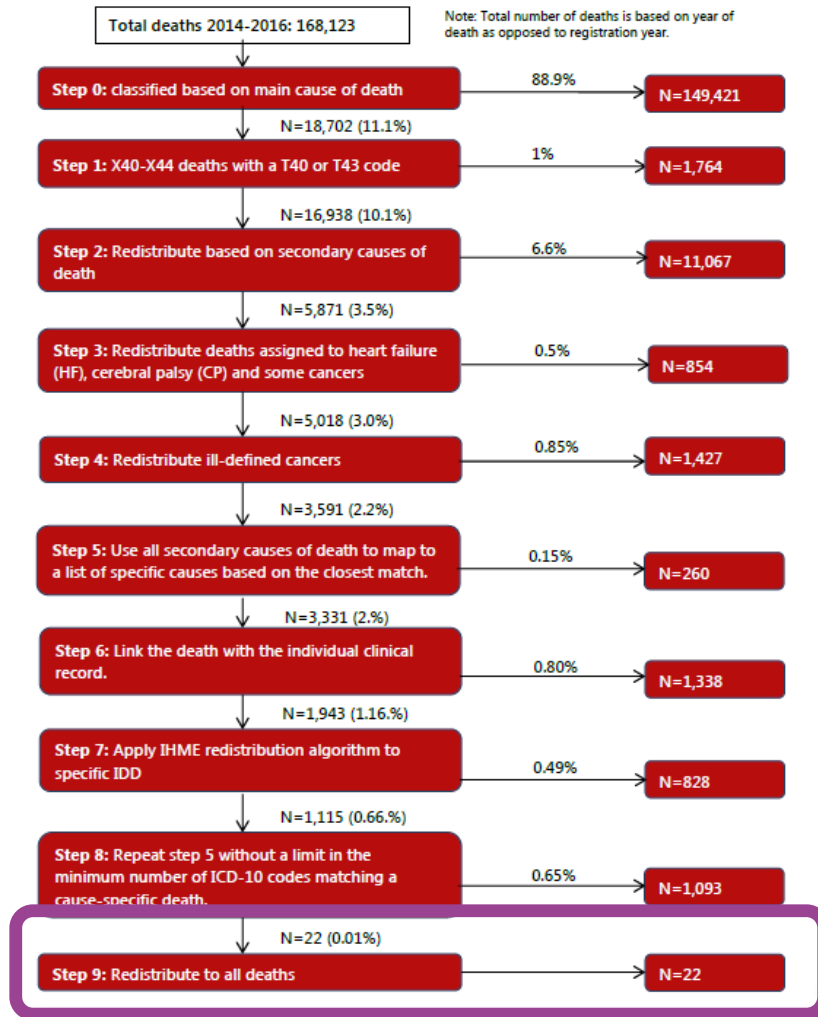
Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of death as opposed to registration year.

Step 0: classified based on main cause of death — 88.9% — N=149,421

N=18,702 (11.1%)

Step 1: X40-X44 deaths with a T40 or T43 code — 1% — N=1,764

N=16,938 (10.1%)

Step 2: Redistribute based on secondary causes of death — 6.6% — N=11,067

N=5,871 (3.5%)

Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers — 0.5% — N=854

N=5,018 (3.0%)

Step 4: Redistribute ill-defined cancers — 0.85% — N=1,427

N=3,591 (2.2%)

Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. — 0.15% — N=260

N=3,331 (2.%)

Step 6: Link the death with the individual clinical record. — 0.80% — N=1,338

N=1,943 (1.16.%)

Step 7: Apply IHME redistribution algorithm to specific IDD — 0.49% — N=828

Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. — 0.65% — N=1,093

N=22 (0.01%)

Step 9: Redistribute to all deaths — N=22

As step 5 with relaxed matching parameters

- Match with cause-specific deaths with the same contributory causes
- Relax parameters so only require two contributory causes to match
- Matching done within same age-sex strata
- Redistribute death to all valid conditions
- 5.8% of IDDs distributed at this step

Scotland IDD algorithm – step 9

Summary of the redistribution steps and the percentage of deaths
re-distributed in each step

Total deaths 2014-2016: 168,123

Note: Total number of deaths is based on year of
death as opposed to registration year.

Step 0: classified based on main cause of death — 88.9% — N=149,421

N=18,702 (11.1%)

Step 1: X40-X44 deaths with a T40 or T43 code — 1% — N=1,764

N=16,938 (10.1%)

Step 2: Redistribute based on secondary causes of death — 6.6% — N=11,067

N=5,871 (3.5%)

Step 3: Redistribute deaths assigned to heart failure (HF), cerebral palsy (CP) and some cancers — 0.5% — N=854

N=5,018 (3.0%)

Step 4: Redistribute ill-defined cancers — 0.85% — N=1,427

N=3,591 (2.2%)

Step 5: Use all secondary causes of death to map to a list of specific causes based on the closest match. — 0.15% — N=260

N=3,331 (2.%)

Step 6: Link the death with the individual clinical record. — 0.80% — N=1,338

N=1,943 (1.16.%)

Step 7: Apply IHME redistribution algorithm to specific IDD — 0.49% — N=828

N=1,115 (0.66.%)

Step 8: Repeat step 5 without a limit in the minimum number of ICD-10 codes matching a cause-specific death. — 0.65% — N=1,093

N=22 (0.01%)

Step 9: Redistribute to all deaths — N=22

Redistribute to all cause-specific

- Very small number of IDDs left at this stage
- Redistribute to all cause-specific deaths seen in their age-sex strata
- Redistribute proportionally
- Relax parameters so only require two contributory causes to match
- 0.1% of IDDs redistributed at this step

Summary of process

Step	Description summary	% of IDDs redistributed (% of all deaths)
0	Cause-specific cause of death	n/a (88.9%)
1	Drug-related deaths	9.4% (1.0%)
2	Redistribute based on secondary causes of death	59.2% (6.6%)
3	Redistribute deaths due to heart failure and cerebral palsy	4.6% (0.5%)
4	Redistribute ill-defined cancer deaths	7.6% (0.8%)

Step	Description summary	% of IDDs redistributed (% of all deaths)
5	Match to similar cause-specific deaths	1.4% (0.2%)
6	Link to clinical records	7.4% (0.8%)
7	Redistribute to IHME target conditions	4.4% (0.5%)
8	Step 5 without matching parameters	5.8% (0.7%)
9	Redistribute all cause-specific	0.1% (<0.1%)

Strengths and limitations of Scottish approach

Strengths

- Exploits all available information
- Applies robust, clinically reviewed methodology
- Application of internationally accepted methodology with Scotland-specific proportions

Limitations

- Potential bias due to hierarchical nature
- Potential bias towards more serious morbidities (matching to clinical records)
- Assuming equal weighting between secondary causes (distributing to contributory causes in step 2)

Ill-defined deaths and COVID-19

Aims:

1. Estimate ill-defined deaths redistributed to COVID-19
2. Assess the impact of the redistribution process on augmenting estimates of cause-specific COVID-19 mortality.

Method:

1. Extract 2020 deaths where covid listed as underlying or a contributory cause of death
2. Categorised into covid cause-specific, other cause-specific and ill-defined
3. IDDs redistributed proportionally to the underlying causes of death (step 2 of process)

Results:

1. Of 6,852 deaths:
    1. 6,174 (90%) covid cause-specific
    2. 602 (9%) other cause-specific
    3. 76 (1%) ill-defined
2. Following proportional redistribution, an additional 21 deaths allocated to covid
3. <u>Supplementing covid-19 cause-specific deaths with redistributed IDDs has a negligible impact</u>
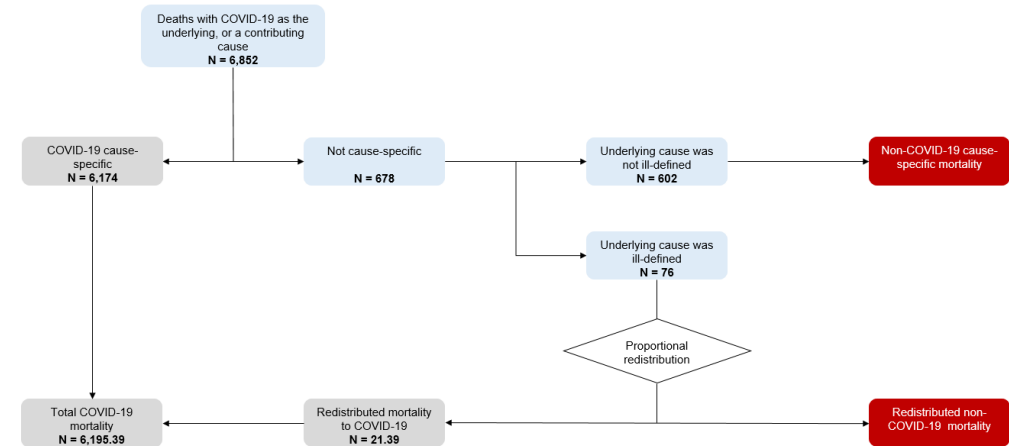
Acknowledgments and further information

SBoD team:

Diane Stockton, Gerry McCartney, Ian Grant, Grant Wyper, Eilidh Fletcher, Maite Thrower

Talk to us:

phs.sbod-team@phs.scot

SCAN ME

https://www.scotpho.org.uk/comparative-health/burden-of-disease/overview/

#ScottishBurdenOfDisease
#BurdenEU