Over- and Under-classification of Underlying Cause of Death on Death Certificates From a Small All-autopsied Population of Former Nuclear Workers

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MAIN FINDING

- 240 cases with both death certificates (DC) and full autopsy reports (AR).
- 27.9% underlying causes of death (UCOD) on DCs did not match the ARs.
- Respiratory disease and other causes of death had statistically significant mismatch rates after adjustment.

U.S. Transuranium and Uranium Registries (USTUR)

Mission

- Study actinide biokinetics in the human body
- Study individuals with occupational exposure to actinides
- Obtain, analyze, and maintain information

Participants

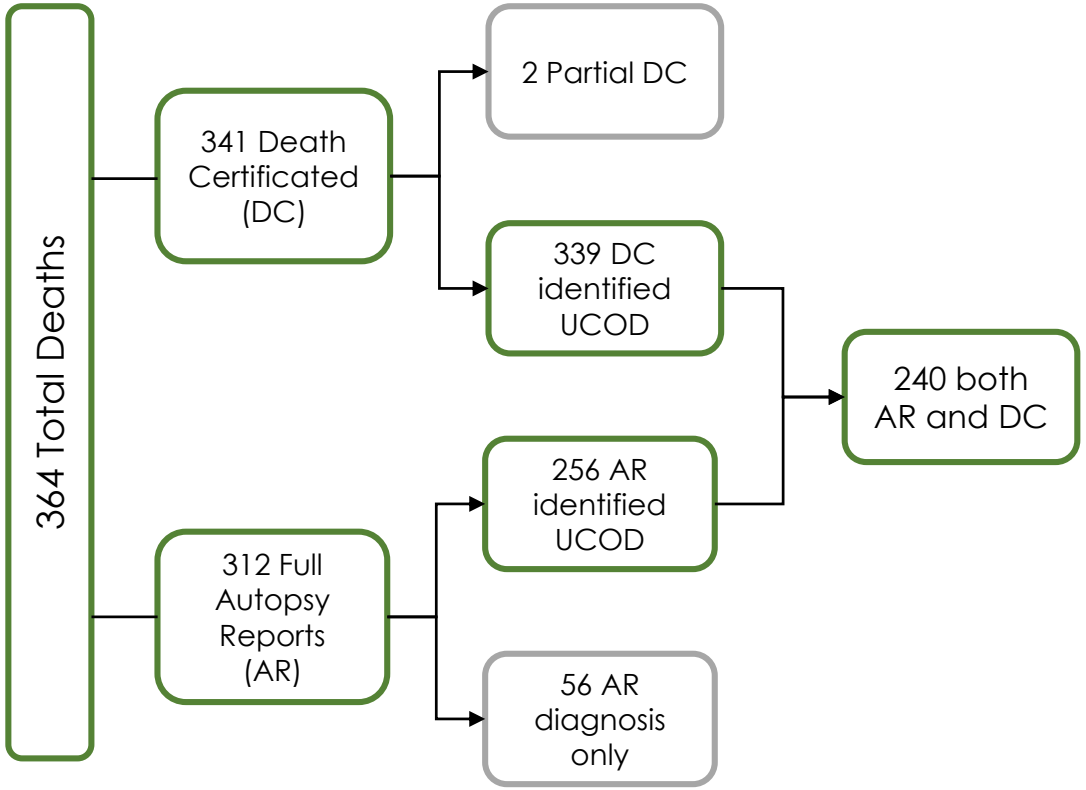
- Occupational exposure history to one or more actinides
- Typically, enrolled years before death or before diagnosis of terminal malignancies or other diseases
- Some enrolled after being diagnosed with advanced cancer

MOTIVATION AND IMPORTANCE

- Types of public health study based on radiation exposure
  - Epidemiological study
  - Radiation risk assessment
  - Radiation-related regulatory standard development for the worker and public
- Death certificate diagnosis may prove incorrect or inadequate compared to autopsy reports
- Small and declining undergoing autopsy proportion of deceased persons
- High autopsy rate in enrolled individuals following USTUR protocol

CASE SECLECTION

UCOD = Underlying Cause of Death



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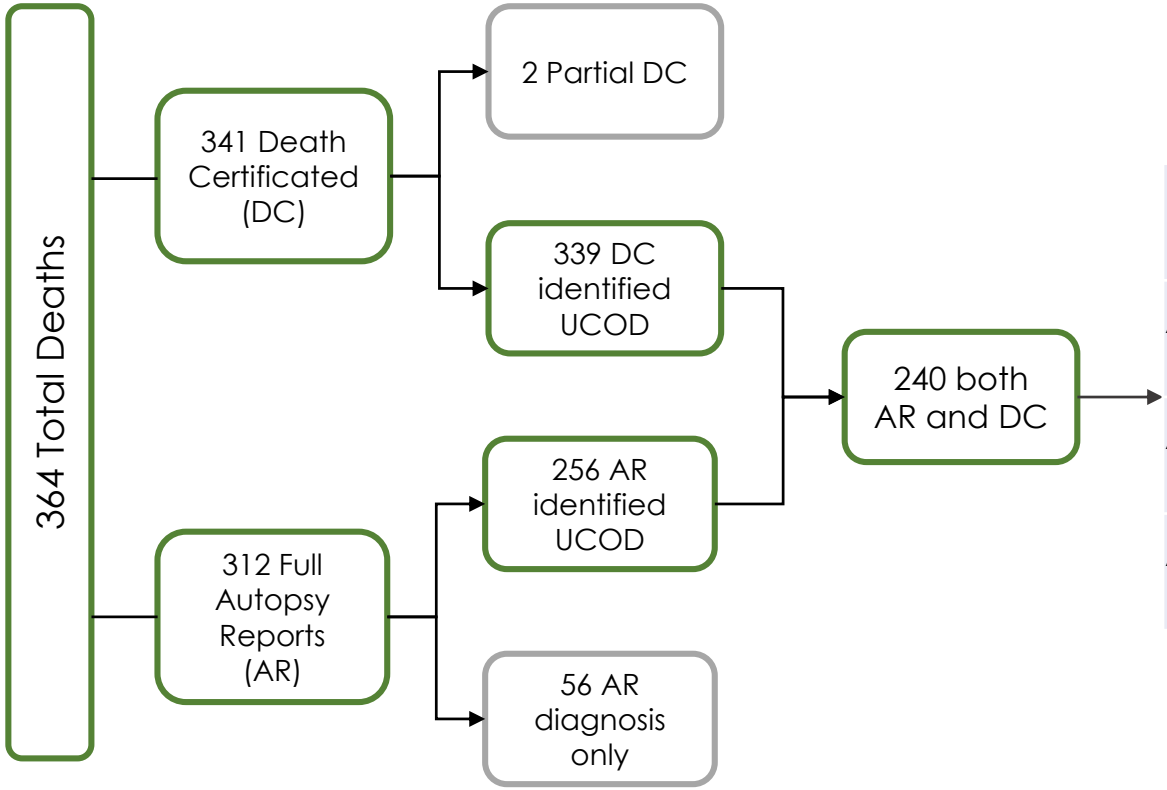

Fields on Standard Death Certificate

Status	Knew autopsy performed	Used autopsy findings	Cases
Autopsy Used	Yes	Yes	52
Autopsy Not Used	No	-	55
	Yes	No	26
Autopsy Use Uncertain	Yes	Missing / Blank	95
	Missing / Blank	Missing / Blank	12

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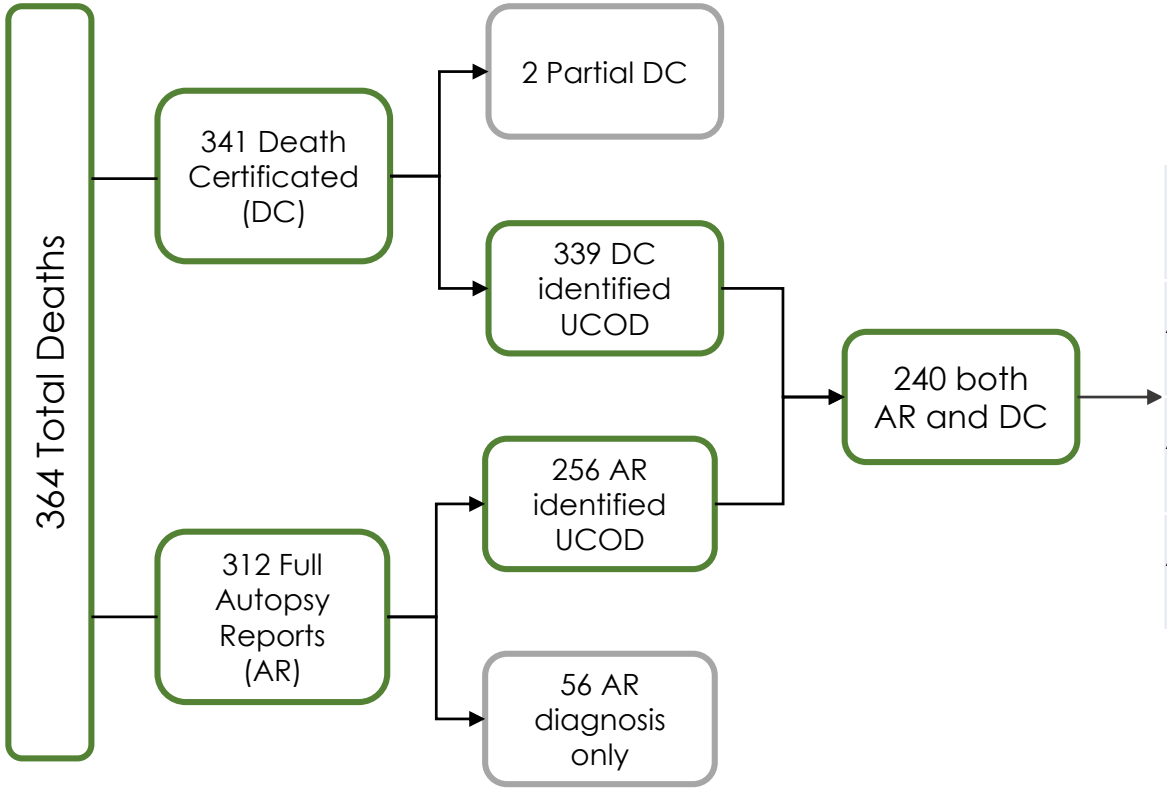

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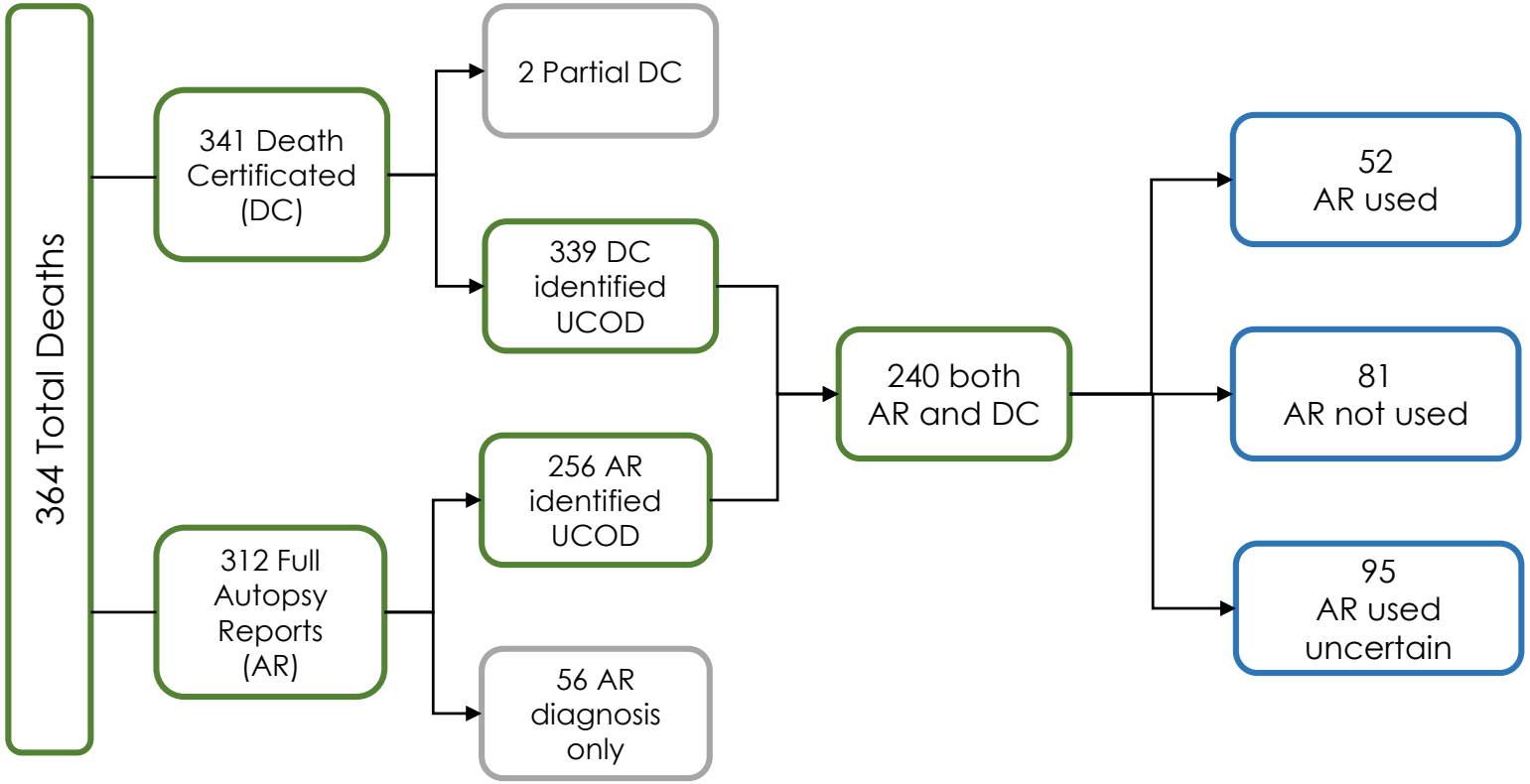

CASE MATCHING

Cause of Death coded independently using International Classification of Diseases, Revision 10 (ICD-10 code)

Status	Code	System	Description
Complete match	I25.0	Circulatory	Chronic ischaemic heart disease: Atherosclerotic cardiovascular disease, so described
	I25.1	Circulatory	Chronic ischaemic heart disease: Atherosclerotic heart disease
Partial match	I21.9	Circulatory	Acute myocardial infarction: Acute myocardial infarction, unspecified
	I25.1	Circulatory	Chronic ischaemic heart disease: Atherosclerotic heart disease
Not match	J43.9	Respiratory	Emphysema: Emphysema, unspecified
	I25.1	Circulatory	Chronic ischaemic heart disease: Atherosclerotic heart disease

METRICS USED

$$Sensitivity = \frac{True\ Positive}{Total\ Cases\ on\ Autopsy\ Reports}$$

$$Positive\ Predictive\ Value\ (PPV) = \frac{True\ Positive}{Total\ Cases\ on\ Death\ Certificates}$$

$$Under - Classification\ Rate = \frac{False\ Negative}{Total\ Cases\ on\ Autopsy\ Reports}$$

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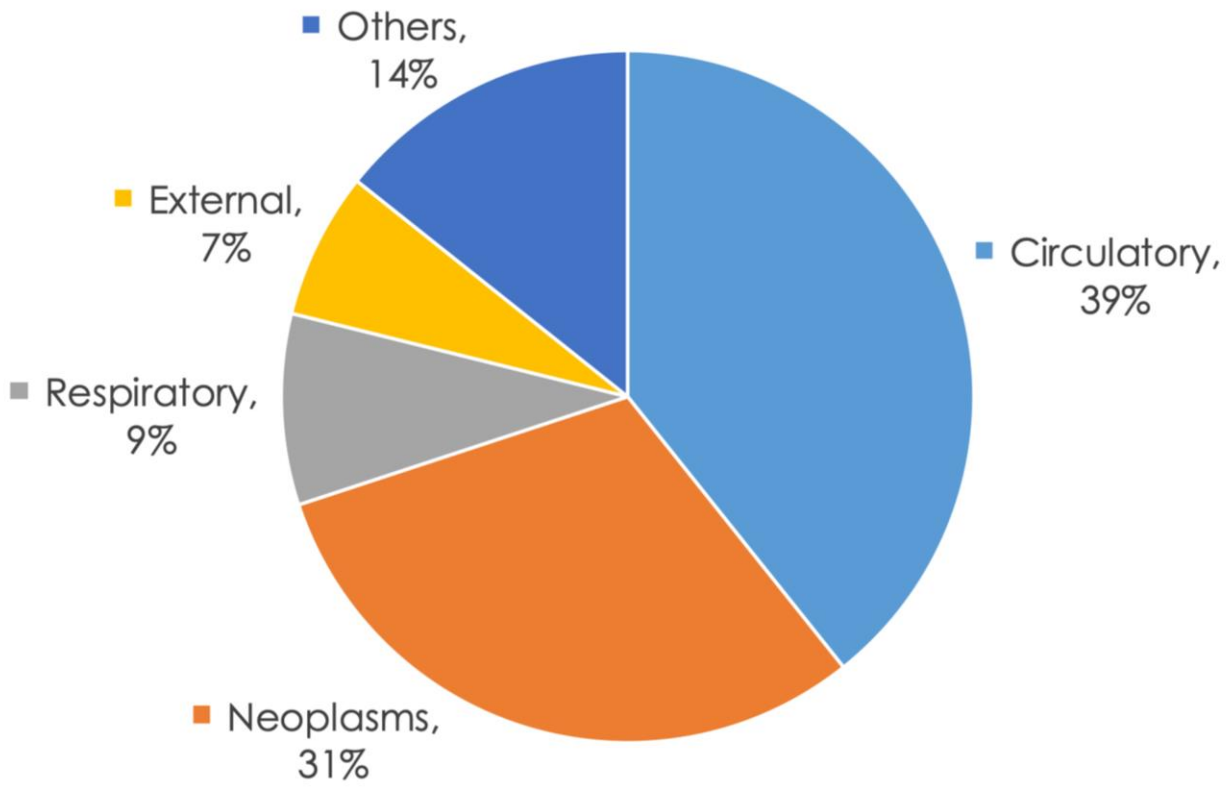
UCOD ON 339 DEATH CERTIFICATES



Diagnosis on Death Certificates vs Autopsy Reports

	Death certificate	Autopsy report underlying cause of death (UCOD)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	Infectious	**0**	0	0	0	0	0	1	1	0	0	0	0	0	0	2
2	Neoplasms	0	**56[37]**	1	0	0	0	5	2	0	0	0	0	0	1	65
3	Blood	0	0	**0**	0	0	0	0	0	1	0	0	0	0	0	1
4	Metabolic	0	1	0	**1[1]**	0	1	1	0	0	0	0	0	0	0	4
5	Mental	0	1	0	0	**0**	2	2	0	0	0	0	0	0	0	5
6	Nervous	0	0	0	0	0	**6[5]**	3	1	0	0	0	0	0	0	10
7	Circulatory	1	2	0	1	0	1	**85[34]**	4	1	0	1	1	1	2	100
8	Respiratory	0	4	0	0	0	1	11	**9[8]**	0	0	0	0	0	0	25
9	Digestive	0	0	0	0	0	0	0	0	**1[0]**	0	0	0	0	0	1
10	Musculoskeletal	0	0	0	0	0	0	1	0	0	**0**	1	0	0	0	2
11	Genitourinary	0	0	0	0	0	0	2	0	0	0	**1[0]**	0	0	0	3
12	Malformations	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0
13	Symptoms	0	2	0	0	0	0	2	0	1	0	0	0	**0**	0	5
14	External	0	1	0	0	1	0	1	0	0	0	0	0	0	**14[3]**	17
	Total	1	67	1	2	1	11	114	17	4	0	3	1	1	17	173
	Mismatch cases	**Match cases** [Complete match]														

TOP 5 CATEGORIES

DC	AR					Total Match [Complete Match]		
	1	2	3	4	5	Total	Not Match False positive	Over-Classification %
Circulatory	85[34]	1	4	2	7	100	15	15.0%
Neoplasms	5	56[37]	2	1	1	65	9	13.8%
Respiratory	11	4	9[8]	0	1	25	16	64.0%
External	1	1	0	14[3]	1	17	3	17.6%
Others	12	4	2	0	9[6]	33	24	72.7%
Total	114	67	17	17	25	240	67	27.9%
Not Match False negative	29	11	8	3	16	67		
Under-Classification %	25.4%	16.4%	47.1%	17.6%	64.0%	27.9%		
Mismatch cases	Match cases [Complete match]							

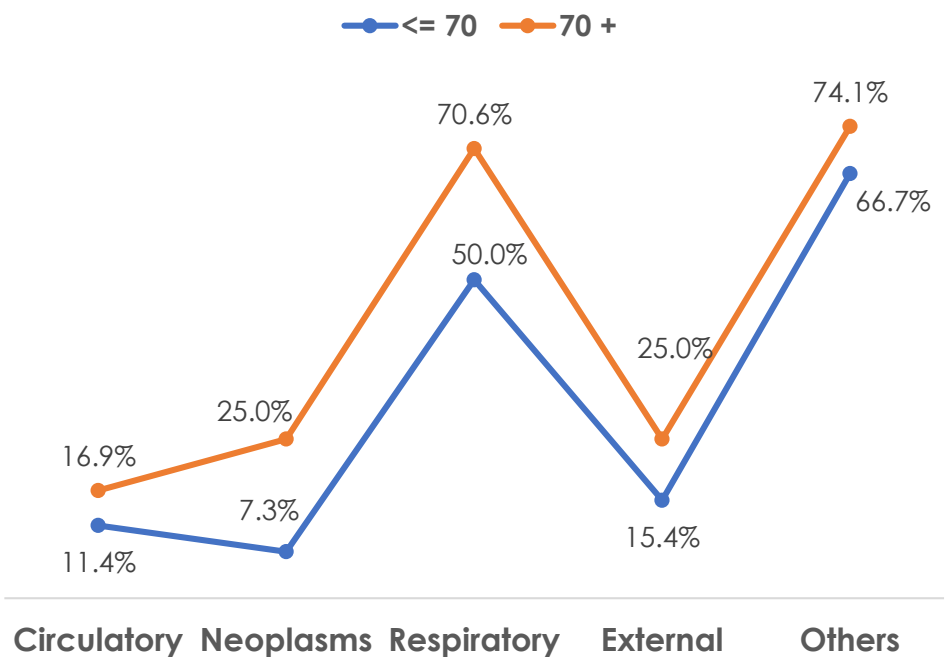
OVER- AND UNDER-CLASSIFICATION RATE: ALL DATA

	Overall		AR not used		AR used		AR use uncertain	
	Over	Under	Over	Under	Over	Under	Over	Under
Circulatory	14.6%	23.4%	29.0%	35.3%	13.0%	13.0%	4.8%	20.0%
Neoplasms	13.1%	15.9%	12.5%	26.3%	15.4%	15.4%	12.5%	9.7%
Respiratory	62.5%	47.1%	60.0%	55.6%	50.0%	33.3%	70.0%	40.0%
External	17.6%	17.6%	0.0%	42.9%	28.6%	0.0%	16.7%	0.0%
Others	70.0%	62.5%	75.0%	58.3%	40.0%	62.5%	80.0%	75.0%
Total Mismatch	**26.8%**		**39.5%**		**21.2%**		**18.9%**	
Total Match	**73.2%**		**60.5%**		**78.8%**		**81.1%**	

Sensitivity and PPV for AR Not Used Group

Underlying COD Category	Total Match	Not Match false negative	Not Match false positive	Total Cases on AR	Total Cases on DC	Sensitivity for total match	PPV for total match
	(a)+(b)	(c)	(d)	(a)+(b)+(c)	(a)+(b)+(d)	(a+b)/(a+b+c)	(a+b)/(a+b+d)
Circulatory	22	12	9	34	31	64.7%	71.0%
Neoplasms	14	5	2	19	16	73.7%	87.5%
Respiratory	4	5	6	9	10	44.4%	40.0%
External	4	3	0	7	4	57.1%	100.0%
Others	5	7	15	12	20	41.7%	25.0%

MISMATCH RATES BY AGE AND YEAR OF DEATH



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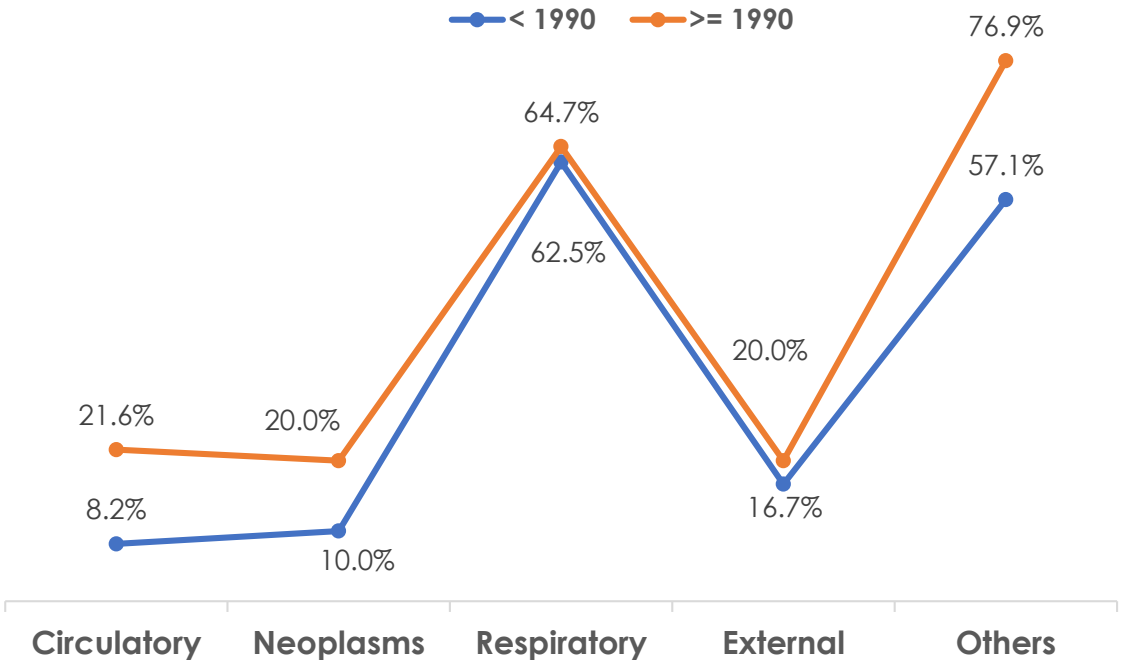

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LOGISTIC REGRESSION RESULTS

- Autopsy not used group – not significant (p=0.543)
- Top 5 disease categories
  - Neoplasms – reference
  - Respiratory diseases – significant (p=0.0001)
  - Other causes – significant (p<0.0001)
  - Circulatory diseases – not significant (p=0.866)
  - External causes – not significant (p=0.565)

DISCUSSION

- Only general inferential conclusion to help determine and assess the cause of death and identify any apparent abnormality
  - Insufficient number of cases
  - Tendency to have factors influencing death in registered population with occupationally exposed to radioactive elements
- Study generated a valuable discussion on the accuracy of using cause of death data on death certificates as a research resource.
  - Especially for respiratory diseases and other causes of death.
  - Diagnosis of autopsy reports remain essential in studies requiring statistical mortality.

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College of Pharmacy
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