

# Value-Based Prioritization: A method for choosing meaningful work\*

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## Abstract

*A method is proposed to use value theory to select and quantitatively prioritize actions to accomplish a goal. Actions are relatively ranked based on some quantitative measurement(s) as called for by the value theory. This ranking is transformed by a set of functions which scale up and down each action's relative score based on other relevant measurements and subjective opinions. The resulting list provides a prioritized relative ranking of actions that should be pursued in a particular order. This method is applied to the example of choosing meaningful work using an example value system based on the goal to reduce human suffering.*

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\*<https://github.com/freeradical13/ValueBasedPrioritization>

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# 1. Background

Why should a particular goal be pursued (“Why”)? Given a goal, what actions should be pursued to best accomplish that goal (“What”)? Given an action, how should that action be pursued (“How”)?

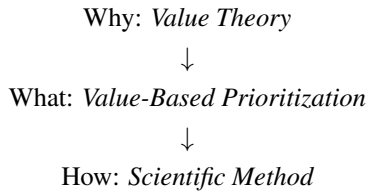
## 1.1. Existing research

To exemplify these questions, the issue of choosing meaningful work is selected. One field that investigates the question of meaningful work is psychology, largely in specialties such as positive and vocational psychology.

Although there are significant efforts to establish the importance of a meaningful life (Allan et al., 2015; Baumeister, 1991; Baumeister et al., 2013; Frankl, 1985; Heintzelman and King, 2013; Martela and Steger, 2016; Park and George, 2013) and meaningful work (Dik et al., 2009; Oades et al., 2017; Steger, 2013; Steger and Dik, 2009), calling (Dik and Duffy, 2012), or purpose (George and Park, 2013), and surveying perceptions of meaningful work (Steger et al., 2006), efforts to provide methods of choosing such meaningful work are largely confined to techniques such as evaluations of psychological profiles for signature strengths (Seligman, 2006), career counseling (Dik et al., 2009) or therapy (Wong, 2010), and job search training (Zikic and Saks, 2009). These approaches are important prerequisites but their less quantitative and less explicit nature make them difficult to evaluate, generalize, and improve.

## 2. Value-Based Prioritization

This article proposes that value theory usually best scopes “Why” and “What” and the scientific method usually best answers “How”. A method called Value-Based Prioritization is developed to answer the “What” question:



### 2.1. Why a Goal?

“Why a Goal?” is usually best scoped using value systems because they are evaluative by nature (Schroeder, 2016). Comparing value systems is left as an (lifelong) exercise for the reader<sup>i</sup>.

### 2.2. What Actions?

“What Actions?” is usually best scoped by prioritizing actions because actions usually have differing effect sizes and time is limited. It follows from the value system used to answer “Why” that the same value system is used primarily to evaluate the priority of each action.

Value-Based Prioritization builds a quantitative prioritization model based on predicted effect sizes. Raw prioritization scores are further scaled by contextual factors such as implementation time, cost, risk, and other judgments.

### 2.3. How to do an Action?

Given answers to “Why?” and “What?”, how to implement actions is usually best answered with the scientific method (Andersen and Hepburn, 2016; Markie, 2017): observations are made and rational thought is used to generate hypotheses, hypotheses are tested with experiments, and successful experiments lead to theories and results.

### 2.4. Method

A *value system*  $V$  (1) generates a *goal*  $G(t)$  (2) (for some time  $t$ ) and a set of *mutually exclusive potential actions*  $A(t)$ :

$$A(t) = \{A_1(t), \dots, A_N(t)\}, \quad N > 1 \quad (3)$$

An action’s *estimated relative accomplishment amount*  $B(A(t))$  is an action’s expected *relative* (i.e. with respect to other actions) contribution towards accomplishing  $G(t)$ :

$$B(A(t)) = \mathbb{R}, \quad 0 \leq \mathbb{R} \leq 1 \quad (4)$$

Thus,  $G(t)$  is fully accomplished if all actions are accomplished:

$$G(t) = \sum_{i=1}^N B(A_i(t)) = 1 \quad (5)$$

A *value-based prioritization score*  $C(A(t))$  is the result of the product of a set of *value-based prioritization scale functions*  $S = \{S_1, \dots, S_N\}$  (6) multiplied by (4):

$$C(A(t)) = B(A(t)) \cdot \prod_{j=1}^N S_j(A(t)), \quad 0 \leq S_j(A(t)) \leq 1 \quad (7)$$

Example scale functions include implementation time, cost, risk, and other judgments. Ideally, scale functions should be defined before running the model to reduce bias. The set  $S$  always includes the element  $S_1(A(t)) = 1$ .

A *value-based prioritization* (VBP)  $Z(t)$  is a sequence of actions ordered by prioritization score (7) in descending order:

$$Z(t) = (A_1(t), \dots, A_N(t)), \quad C(A_1(t)) \geq \dots \geq C(A_N(t)) \quad (8)$$

The first  $k$  actions in  $Z(t)$  should be executed in descending priority/proportion where  $k$  (9) is chosen based on factors such as available concurrency, time, resources, etc.

### 2.5. Modeled Value-Based Prioritization

Historical data may be used to predict actions’ estimated relative accomplishment amounts (4) at a future time  $t_F$  (10).

<sup>i</sup>Example value systems include intuitionism (Huemer, 2007), consequentialism (Sinnott-Armstrong, 2015), evolutionary biology (Fitz-Patrick, 2016), religion (Hare, 2014), epicureanism (Konstan, 2018), stoicism (Baltzly, 2018), political liberalism (Wenar, 2017), anarcho-capitalism (Huemer, 2013), communitarianism (Bell, 2016), objectivism (Badhwar and Long, 2017), etc.

If each action has historical data  $D(A)$ :

$$D(A) = ((t_1, D(A, t_1)), \dots, (t_N, D(A, t_N))) \quad (11)$$

Then, a set of *comparable prediction models* (or forecasting models) (De Gooijer and Hyndman, 2006; Hyndman and Athanasopoulos, 2018; Tashman and Leach, 1991; Taylor and Letham, 2018; Wit et al., 2012)  $R(D(A))$  is applied to each  $D(A)$ ; for example, exponential smoothing (Hyndman et al., 2008; Hyndman and Athanasopoulos, 2018)<sup>ii</sup>, a generalized additive model (GAM) (Taylor and Letham, 2018), ARIMA (Hyndman and Athanasopoulos, 2018)<sup>iii</sup>, linear regression (Hyndman and Athanasopoulos, 2018)<sup>iv</sup>, machine learning (Makridakis et al., 2018), seasonal algorithms such as TBATS (Hyndman and Athanasopoulos, 2018)<sup>v</sup>, poisson log-bilinear regression (Mathers and Loncar, 2006), etc.<sup>vi</sup>:

$$R(D(A)) = \{R_1(D(A)), \dots, R_N(D(A))\} \quad (12)$$

The models are compared using a *model selection* algorithm<sup>vii</sup>  $L(R(D(A)))$  (13); for example, smallest Akaike's Information Criterion (AIC), smallest Corrected AIC (AICc), smallest Bayesian Information Criterion (BIC), smallest cross-validation, largest adjusted coefficient of determination ( $R^2$ ), etc.<sup>viii</sup>

For each action,  $L(R(D(A)))$  produces the *best fitting model*  $M(A(t))$ , or a model that's an average of multiple models (Clemen, 1989)<sup>ix</sup>.

Each action's  $M(A(t_F))$  is used to predict  $B(A(t_F))$ .

Finally, *modeled value-based prioritization* (MVB)  $Z(t_F)$  is simply (8) with  $t_F$ :

$$\begin{aligned} Z(t_F) &= (A_1(t_F), \dots, A_N(t_F)), \\ C(A_1(t_F)) &\geq \dots \geq C(A_N(t_F)) \end{aligned} \quad (14)$$

### 3. Choosing meaningful work

#### 3.1. Method

The following example applies modeled value-based prioritization (14) to the goal of choosing meaningful work. Every aspect is an example and should be reconsidered.

First, outline the parameters:

- (1)  $V$  = a value system which answers "Why work?" with "To reduce human suffering" which is defined as maximal human suffering: death (more precisely, something like the lack of a potential of life). Alternatives include morbidity and disease burden using Quality-Adjusted Life Years (QALYs) (Lopez et al., 2006; Weinstein et al., 2009), non-human suffering (Huemer, 2019), cost effectiveness (GiveWell.org, 2011; Jamison et al., 2017; Neumann et al., 2018), economic impact (U.N. WHO, 2009), existential

risks (Bostrom, 2013), pre-birth potential (Zane et al., 2015), working to give (MacAskill, 2015), etc.

- (2)  $G(t)$  = eliminate human death.
- (3)  $A(t)$  = the set of actions which would eliminate human death.
- (9)  $k = 1$  for a single person (or 2 to hedge the failure of the first action or to add a volunteer activity).
- (10)  $t_F = 10$  years; an average amount of time under normal conditions to integrate into a new career to work on some subset of  $A(t)$  (including learning, certification, building experience, networking, etc.).
- (11)  $D(A)$  = time-series data on human death by underlying cause<sup>x</sup>.
- (12)  $R(D(A))$  = exponential smoothing functions using Holt's linear trend method as aggregate models<sup>xi,xii,xiii</sup> ( $ETS(A, M, N)$  and  $ETS(A, M_d, N)$  were tested but had bad failure modes, particularly with outliers):

$$\begin{aligned} \{ETS(A, A, N), ETS(A, A_d, N)\}, \\ \phi = 0.98 \end{aligned}$$

Commonly used alternative models in all-cause mortality forecasting include poisson log-bilinear regressions<sup>xiv</sup>.

- (13)  $L(R(D(A)))$  = lowest AICc.

$A(t)$  is a set of actions which would eliminate the groups of Underlying Causes of Death (UCOD) as classified by the International Classification of Diseases (ICD) (U.N. WHO, 2010, 2016a,b)<sup>xv</sup>.

This example starts by looking at the longterm comparable leading causes of death for the United States (NBER, 2018; U.S. CDC, 1998, 2001, 2017; U.S. Census Bureau, 1999)<sup>xvi,xvii</sup>:

$$\begin{aligned} A(t) &= \{ \\ A_1(t) &= \text{Eliminate: Heart disease,} \\ A_2(t) &= \text{Eliminate: Cancer,} \\ &\dots \\ &\} \end{aligned}$$

Review the list of actions and hypothesize scale functions. Examples:

- $S_1(A_i) = 1$

Required scale function.

<sup>x</sup><https://www.who.int/topics/mortality/en/>

<sup>xi</sup><https://otexts.com/fpp2/holt.html>

<sup>xii</sup><https://otexts.com/fpp2/ets.html>

<sup>xiii</sup>[https://www.statsmodels.org/dev/examples/notebooks/generated/exponential\\_smoothing.html](https://www.statsmodels.org/dev/examples/notebooks/generated/exponential_smoothing.html)

<sup>xiv</sup>See Appendix note 4.

<sup>xv</sup>For a discussion of chapters, sub-chapters, and codes, see pages 13-17 of ICD-10 Volume 2 (U.N. WHO, 2010). For a discussion of the definition of underlying cause of death, see page 31 of ICD-10 Volume 2 (U.N. WHO, 2010).

<sup>xvi</sup>See Appendix command 1.

<sup>xvii</sup>See Appendix note 1 on how the data was generated.

<sup>ii</sup><https://otexts.com/fpp2/expsmooth.html>

<sup>iii</sup><https://otexts.com/fpp2/arima.html>

<sup>iv</sup><https://otexts.com/fpp2/regression.html>

<sup>v</sup><https://otexts.com/fpp2/advanced.html>

<sup>vi</sup>See also: Breiman et al. (2001); Donoho (2017); Shmueli et al. (2010)

<sup>vii</sup><https://otexts.com/fpp2/selecting-predictors.html>

<sup>viii</sup>See also: Aho et al. (2014)

<sup>ix</sup><https://otexts.com/fpp2/combinations.html>

- $S_2(A_i) = \left(1 - \frac{\text{AverageAge}(A_i(t_{\max-5:t_{\max}}))}{\text{MaxAge}(A(t))}\right)$

Scale towards younger people because they have more to lose: one minus the ratio of the average age (NBER, 2018) over the last 5 years compared to the maximum age of all deaths.

- $S_3(A_i) = \left(\frac{(f(A_i) - \min(f(A(t)))) \cdot (b-a)}{\max(f(A(t)) - \min(f(A(t))))}\right) + a,$

$$f(A_i) = M'(A_i(t_F)), a = 0.5, b = 1$$

Scale down by up to half by the relative rate of change of an action's predicted rate of death: Take the derivative of  $M(A_i(t))$  and evaluate it with the predicted value and min-max normalize into  $[0.5, 1]$  relative to other actions.

- $S_4(A_i) = \begin{cases} 0.1 & \text{if political/cultural} \\ 1 & \text{otherwise} \end{cases}$

Essentially remove actions that are primarily political and/or cultural (Huemmer, 2012).

The list does not include common scale functions such as implementation time, cost, risk, playing into strengths, piquing interest, market demand, return on investment, ramp-up time, interest, etc. because they are either considered irrelevant for this example<sup>xviii</sup> or moot after applying  $S_4$ . The inverse of existing investment might be interesting to consider.

Create a table listing all actions as rows and all manually calculated scale functions as columns<sup>xix,xx</sup>:

Action	$S_1$	...	$S_N$
$A_1$	0.1		1
$A_2$	1		0.25
...			
$A_N$	0.99		0.9

Table 1: Theoretical manually calculated scale function table

For example, see Table 2:

Action (Eliminate: ...)	$S_4$
Homicide	0.1

Table 2: Example manually calculated scale function table for the longterm comparable leading causes of death for the United States

Outside of the manually calculated scale function table, use obfuscated action names when developing the model to avoid introducing bias.

$D(A)$  for each action is the time-series data of number of deaths per year per some number of population (the

<sup>xviii</sup>The irrelevance of some common scale functions rests on the privilege of having the flexibility to pursue options independent of immediate primal concerns.

<sup>xix</sup>For the longterm comparable leading causes of death for the United States, this is only  $S_4(A_i)$ .

<sup>xx</sup>See Appendix command 2.

“Crude Rate”<sup>xxi</sup>, 100,000 for the U.S. and 1,000,000 for the world). For example, for *Cancer*<sup>xxii</sup>, see Table 3:

Year	Crude Rate
1900	61.612658
1901	63.969191
...	...
2016	185.319100
2017	184.217584

Table 3: Crude rate of deaths per year for *Cancer* for the Longterm comparable leading causes of death for the United States

Run each comparable prediction model  $R_i(D(A))$ . For example, for *Cancer*<sup>xxiii</sup>, see Figure 1:

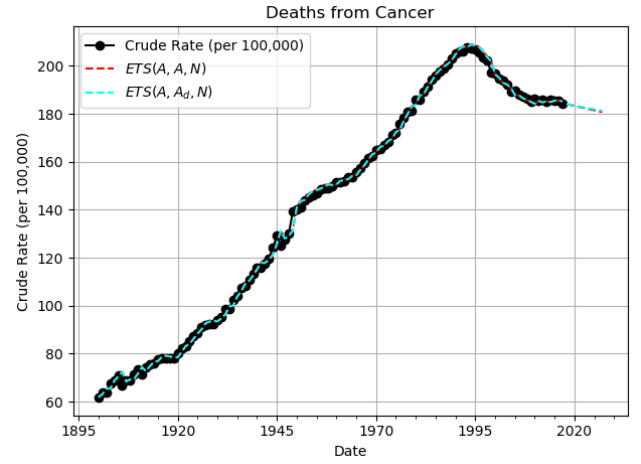


Figure 1: Exponential smoothing functions  $ETS(A, A^*, N)$ ,  $\phi = 0.98$  using Holt's linear trend method for *Cancer* for the Longterm comparable leading causes of death for the United States

Scedasticity, forecast uncertainty, and cross-validation are not considered because it's not clear how to automate processing of such data to tune or choose models.

For each model, calculate AICc and choose the model  $M(A(t_F))$  that has the lowest AICc. For example, see Table 4:

$R_i(D(A))$	AICc	Predicted
<b><math>ETS(A, A, N)</math></b>	<b>128.37</b>	<b>180.73</b>
$ETS(A, A_d, N)$	128.83	181.29

Table 4: Example AICc values of  $R_i(D(A))$  for *Cancer* for the Longterm comparable leading causes of death for the United States

Use each  $M(A(t_F))$ 's predicted value (setting negative values to 0) and generate all of the relative  $B(t_F)$  values along with any scale functions based on the models (e.g. scaling by the relative prediction derivatives using  $S_3$ ). For example, see Table 5:

<sup>xxi</sup><https://wonder.cdc.gov/wonder/help/cmfc.html#Frequently%20Asked%20Questions%20about%20Death%20Rates>

<sup>xxii</sup>See Appendix command 3.

<sup>xxiii</sup>See Appendix command 4.

Action	$B(t_F)$	$S_1$	$S_3$
Name02	0.305	1	0.682
Name18	0.281	1	0.634
...	...	...	...

Table 5: Example  $B(t_F)$  values and model-based scale function values for the Longterm comparable leading causes of death for the United States

Combine the table above with the manually calculated scale functions table (Table 1) and any other calculated scale functions (e.g.  $S_2(A_i)$ ) to create the final table with all scale function values. For example, see Table 6:

Action	$B(t_F)$	$S_1$	$S_2$	$S_3$	$S_4$
Name02	0.305	1	0.386	0.682	1
Name18	0.281	1	0.435	0.634	1
...	...	...	...	...	...

Table 6: Example  $B(t_F)$  values with all scale function values for the Longterm comparable leading causes of death for the United States

Calculate the product of each action's  $B(t_F)$  and its scale function values to produce the final  $Z(t_F)$  table and then sort by the values in descending order and choose the top  $k$  actions.

This analysis is run on various mutually exclusive groupings of causes of death<sup>xxiv</sup>:

<sup>xxiv</sup>See Appendix command 6.

## 3.2. Results

**3.2.1. Longterm comparable leading causes of death for the United States.** Top 5 MVBP results for the longterm comparable leading causes of death for the United States<sup>xxv</sup> in Table 7 and Figures 2-6:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Heart disease	0.080375
2	Cancer	0.077476
3	Chronic respiratory diseases	0.034373
4	Accidents excluding motor vehicles	0.025423
5	Diabetes	0.014776

Table 7:  $Z(t_F)$  table for the Longterm comparable leading causes of death for the United States

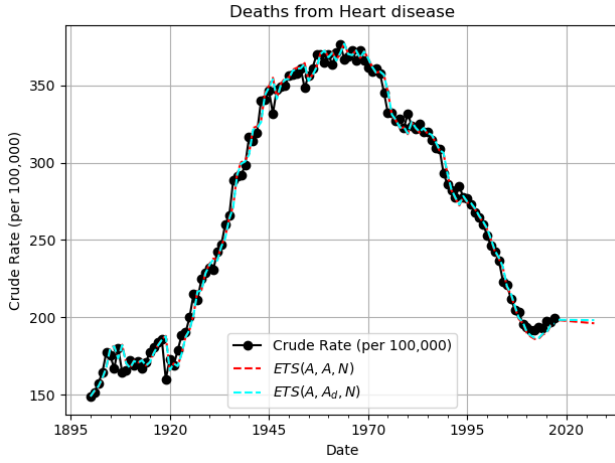


Figure 2: First priority action from the Longterm comparable leading causes of death for the United States: *Heart disease*

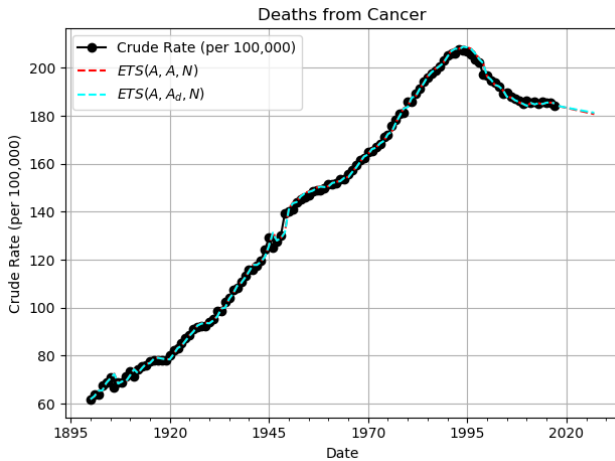


Figure 3: Second priority action from the Longterm comparable leading causes of death for the United States: *Cancer*

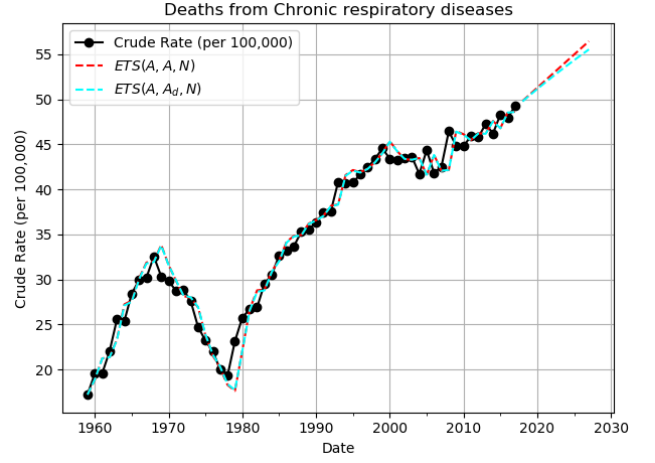


Figure 4: Third priority action from the Longterm comparable leading causes of death for the United States: *Chronic respiratory diseases*

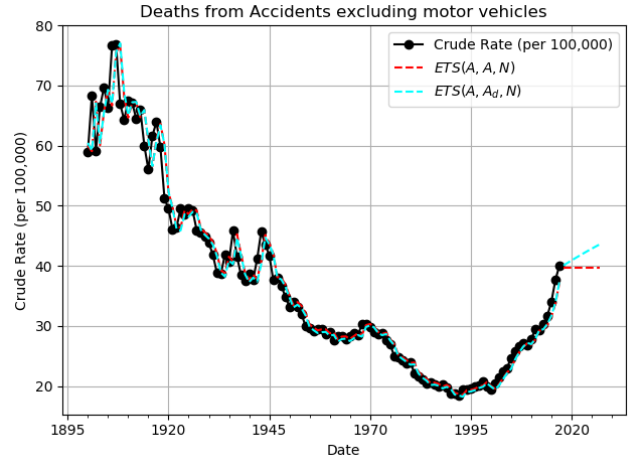


Figure 5: Fourth priority action from the Longterm comparable leading causes of death for the United States: *Accidents excluding motor vehicles*

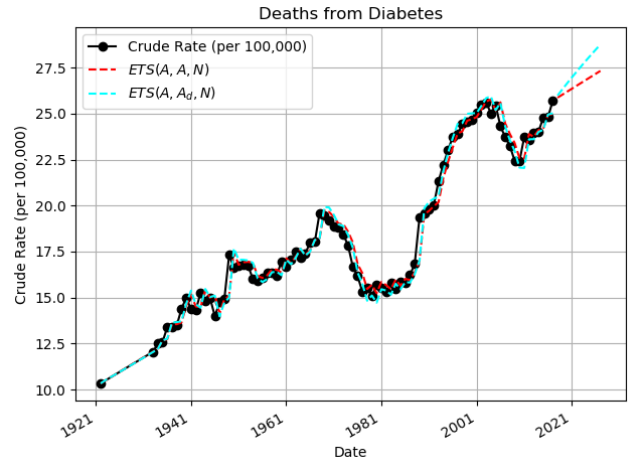


Figure 6: Fifth priority action from the Longterm comparable leading causes of death for the United States: *Diabetes*

<sup>xxv</sup>See Appendix command 5.



**3.2.2. ICD-9 and ICD-10 113 Cause List for the United States.** Top 5 MVBP results for the ICD-9 and ICD-10 113 Cause List for the United States (Anderson et al., 2001; NBER, 2018; U.S. CDC, 2000, 2017)<sup>xxvi,xxvii,xxviii</sup> in Table 8 and Figures 7-11:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Nontransport accidents	0.032929
2	...poisoning ...noxious substances	0.025236
3	Ischemic heart diseases	0.022342
4	Cerebrovascular diseases	0.015068
5	Other chronic lower respiratory diseases	0.013543

Table 8:  $Z(t_F)$  table for the ICD-9 and ICD-10 113 Cause List for the United States

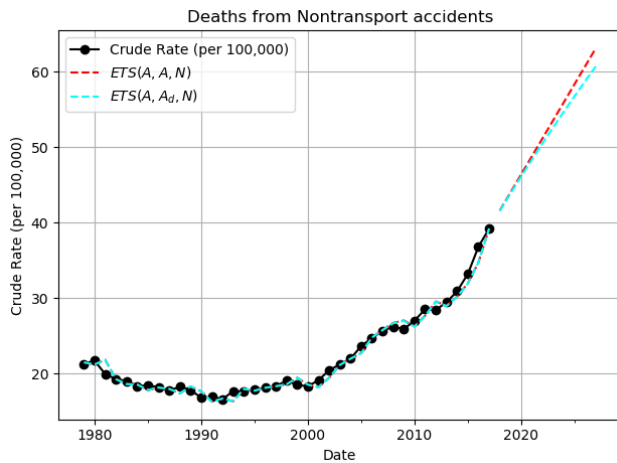


Figure 7: First priority action from the ICD-9 and ICD-10 113 Cause List for the United States: *Nontransport accidents*

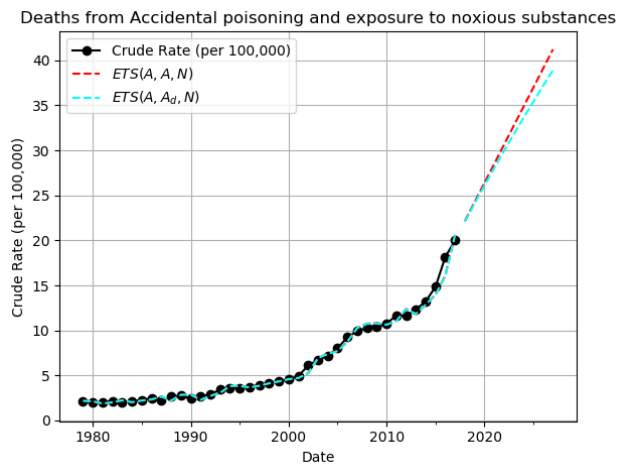


Figure 8: Second priority action from the ICD-9 and ICD-10 113 Cause List for the United States: *Accidental poisoning and exposure to noxious substances*

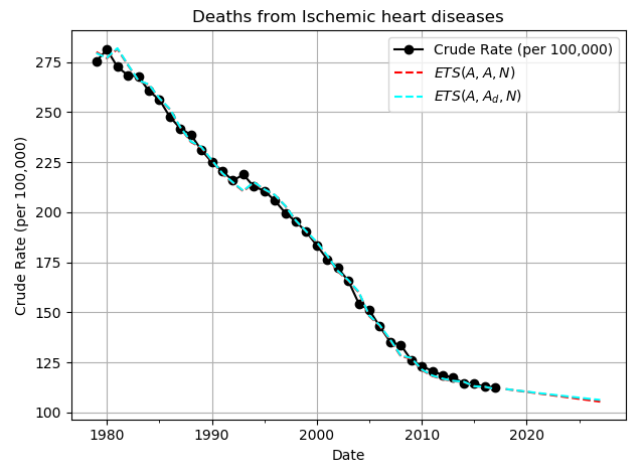


Figure 9: Third priority action from the ICD-9 and ICD-10 113 Cause List for the United States: *Ischemic heart diseases*

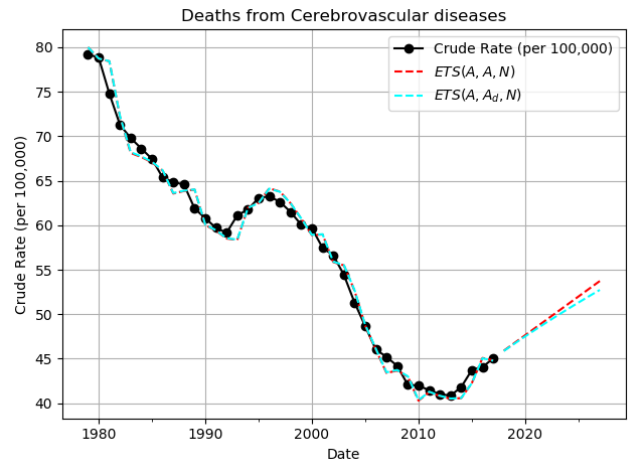


Figure 10: Fourth priority action from the ICD-9 and ICD-10 113 Cause List for the United States: *Cerebrovascular diseases*

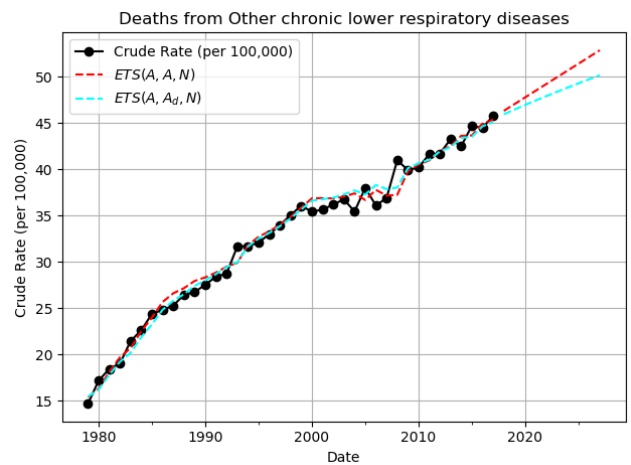


Figure 11: Fifth priority action from the ICD-9 and ICD-10 113 Cause List for the United States: *Other chronic lower respiratory diseases*

<sup>xxvi</sup> [http://ftp.cdc.gov/pub/Health\\_Statistics/NCHS/Datasets/Comparability/icd9\\_i cd10/Comparability\\_Ratio\\_tables.xls](http://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/Comparability/icd9_i cd10/Comparability_Ratio_tables.xls)

<sup>xxvii</sup> <https://wonder.cdc.gov/wonder/help/ucd.html#ICD-10%20113%20Cause%20List>

<sup>xxviii</sup> [https://www.cdc.gov/nchs/data/dvs/Multiple\\_Cause\\_Record\\_Layout\\_2016.pdf](https://www.cdc.gov/nchs/data/dvs/Multiple_Cause_Record_Layout_2016.pdf), page 19; The list actually has 118 mutually exclusive groups instead of 113.

**3.2.3. ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings.** Top 5 MVBP results for the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings in Table 9 and Figures 12-16:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Major cardiovascular diseases	0.131121
2	Accidents (unintentional injuries)	0.050850
3	Malignant neoplasms	0.045513
4	Chronic lower respiratory diseases	0.017207
5	Alzheimer's disease	0.012517

Table 9:  $Z(t_F)$  table for the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings

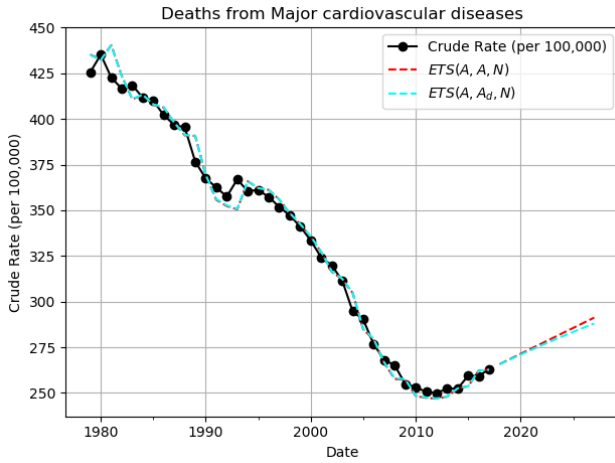


Figure 12: First priority action from the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings: *Major cardiovascular diseases*

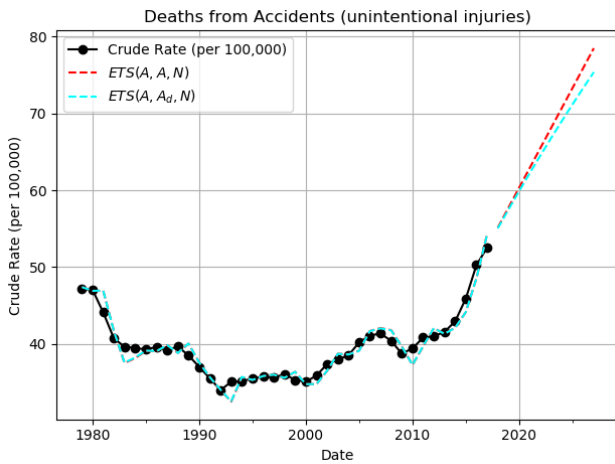


Figure 13: Second priority action from the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings: *Accidents (unintentional injuries)*

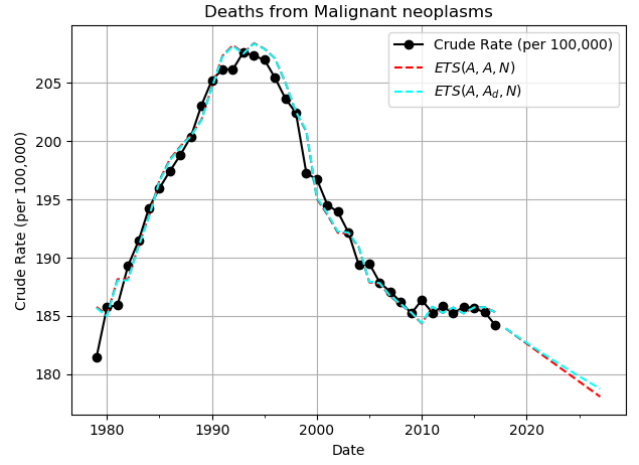


Figure 14: Third priority action from the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings: *Malignant neoplasms*

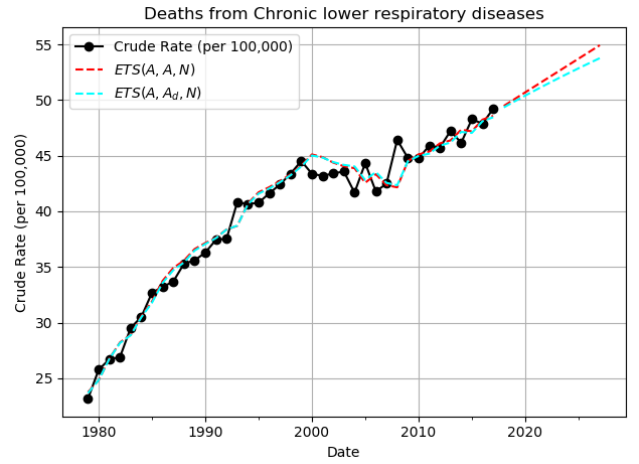


Figure 15: Fourth priority action from the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings: *Chronic lower respiratory diseases*

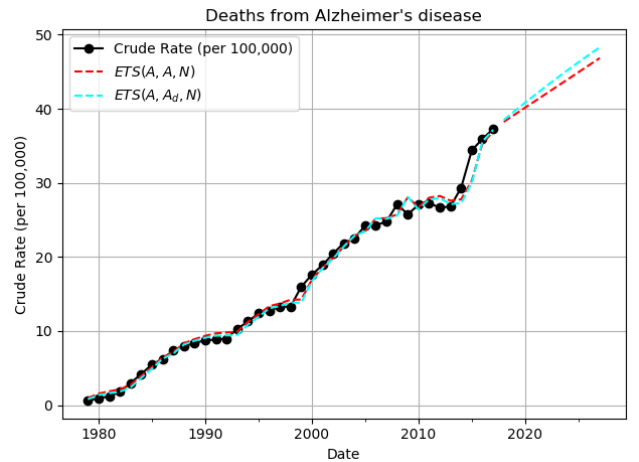


Figure 16: Fifth priority action from the ICD-9 and ICD-10 113 Cause List for the United States with only top-level groupings: *Alzheimer's disease*



**3.2.4. ICD-10 Chapters for the United States.** Top 5 MVBP results for the ICD-10 Chapters for the United States (U.S. CDC, 2017)<sup>xxix</sup> in Table 10 and Figures 17-21:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Diseases of the circulatory system	0.101677
2	External causes of morbidity ...	0.060121
3	Neoplasms	0.039507
4	Diseases of the nervous system	0.037175
5	Diseases of the respiratory system	0.026494

Table 10:  $Z(t_F)$  table for the ICD-10 Chapters for the United States

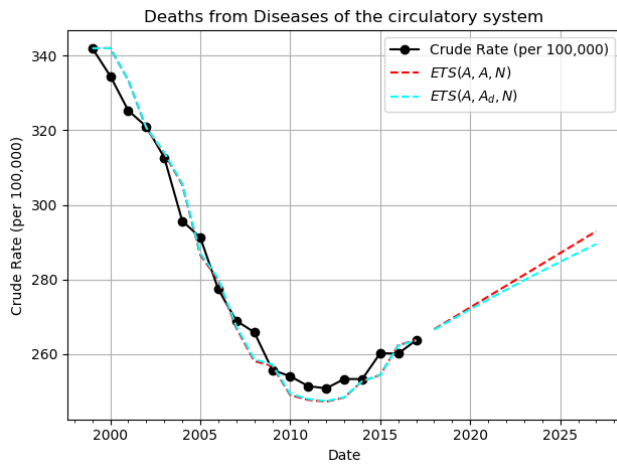


Figure 17: First priority action from the ICD-10 Chapters for the United States: *Diseases of the circulatory system*

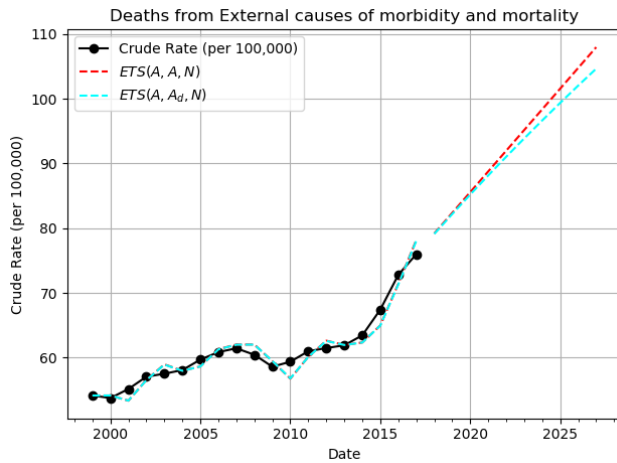


Figure 18: Second priority action from the ICD-10 Chapters for the United States: *External causes of morbidity and mortality*

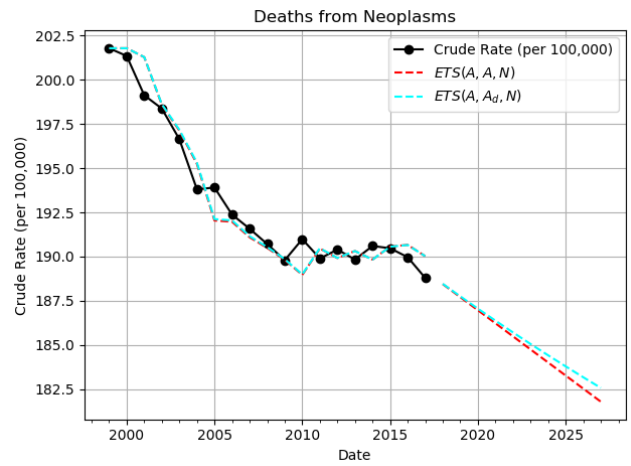


Figure 19: Third priority action from the ICD-10 Chapters for the United States: *Neoplasms*

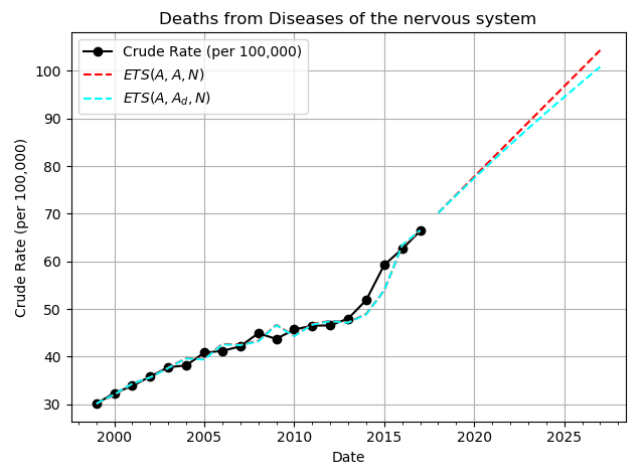


Figure 20: Fourth priority action from the ICD-10 Chapters for the United States: *Diseases of the nervous system*

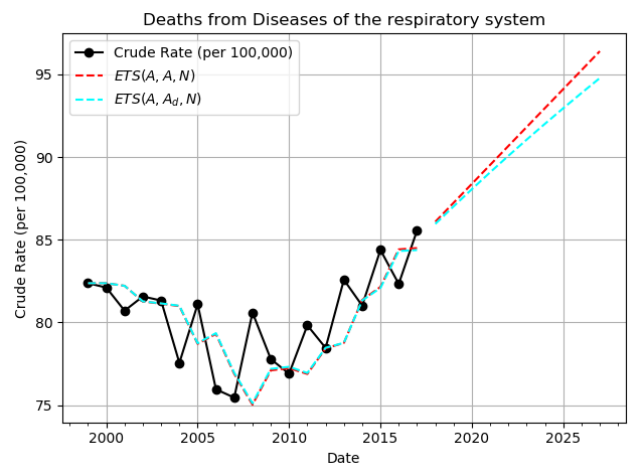


Figure 21: Fifth priority action from the ICD-10 Chapters for the United States: *Diseases of the respiratory system*

<sup>xxix</sup>Group Results By "Year" And By "ICD Chapter"; Check "Export Results"; Uncheck "Show Totals"

**3.2.5. ICD-10 Sub-Chapters for the United States.** Top 5 MVBP results for the ICD-10 Sub-Chapters for the United States (U.S. CDC, 2017)<sup>xxx</sup> in Table 11 and Figures 22-26:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Malignant neoplasms	0.042786
2	Other external causes of accidental injury	0.036444
3	Other forms of heart disease	0.023138
4	Ischaemic heart diseases	0.022449
5	Other ... diseases of the nervous system	0.016669

Table 11:  $Z(t_F)$  table for the ICD-10 Sub-Chapters for the United States

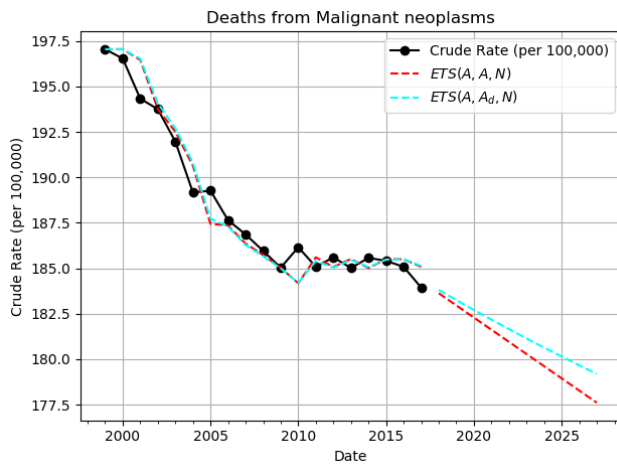


Figure 22: First priority action from the ICD-10 Sub-Chapters for the United States: *Malignant neoplasms*

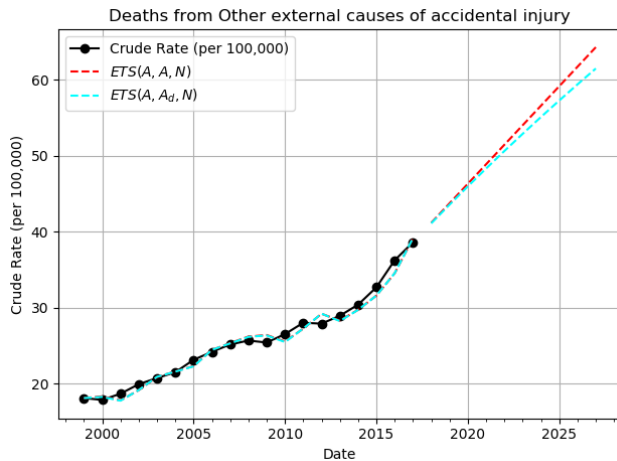


Figure 23: Second priority action from the ICD-10 Sub-Chapters for the United States: *Other external causes of accidental injury*

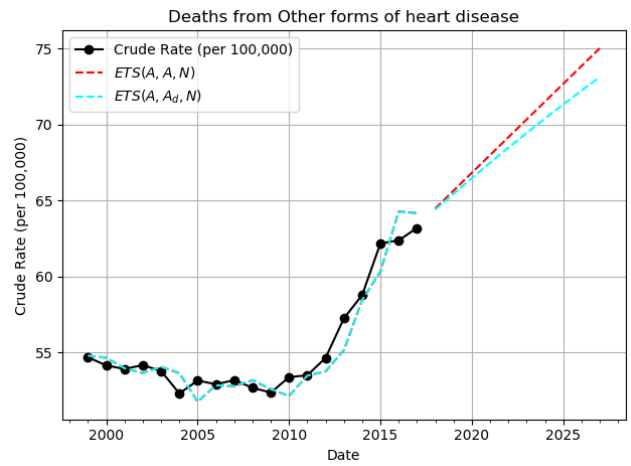


Figure 24: Third priority action from the ICD-10 Sub-Chapters for the United States: *Other forms of heart disease*

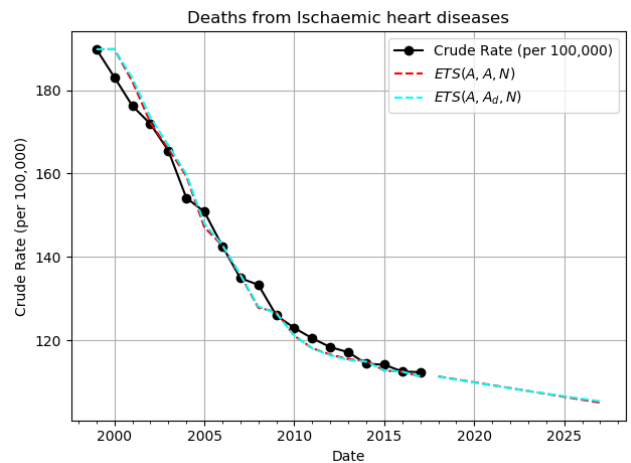


Figure 25: Fourth priority action from the ICD-10 Sub-Chapters for the United States: *Ischaemic heart diseases*

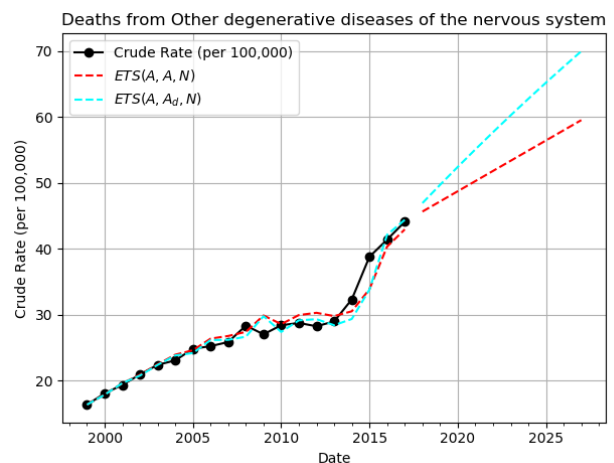


Figure 26: Fifth priority action from the ICD-10 Sub-Chapters for the United States: *Other degenerative diseases of the nervous system*

<sup>xxx</sup>Group Results By "Year" And By "ICD Sub-Chapter"; Check "Export Results"; Uncheck "Show Totals"

**3.2.6. ICD-10 Minimally grouped (5,264) causes of death for the United States.** Top 5 MVBP results for the minimally grouped (5,264) causes of death for the United States (U.S. CDC, 2017)<sup>xxxi,xxxii</sup> in Table 12 and Figures 27-31:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Alzheimer disease, unspecified (G30.9)	0.013730
2	Atherosclerotic heart disease (I25.1)	0.012711
3	Accidental poisoning ... (X42)	0.012563
4	... pulmonary disease, unspecified (J44.9)	0.011704
5	Cerebral infarction, unspecified (I63.9)	0.007563

Table 12:  $Z(t_F)$  table for the Minimally grouped (5,264) causes of death for the United States

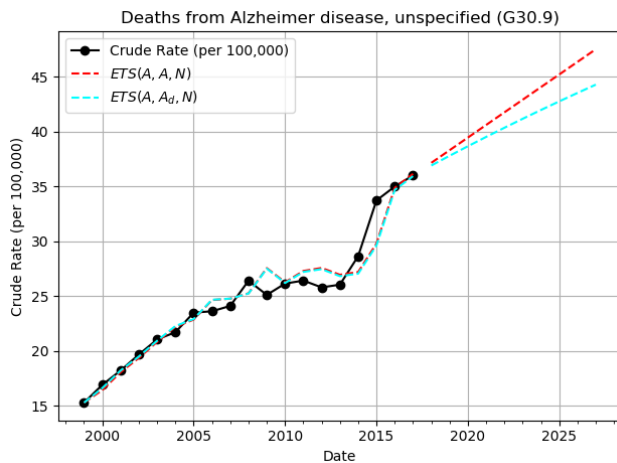


Figure 27: First priority action from the Minimally grouped (5,264) causes of death for the United States: *Alzheimer disease, unspecified (G30.9)*

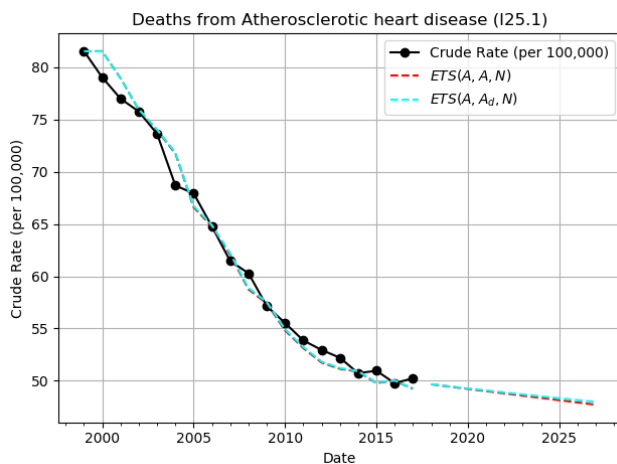


Figure 28: Second priority action from the Minimally grouped (5,264) causes of death for the United States: *Atherosclerotic heart disease (I25.1)*

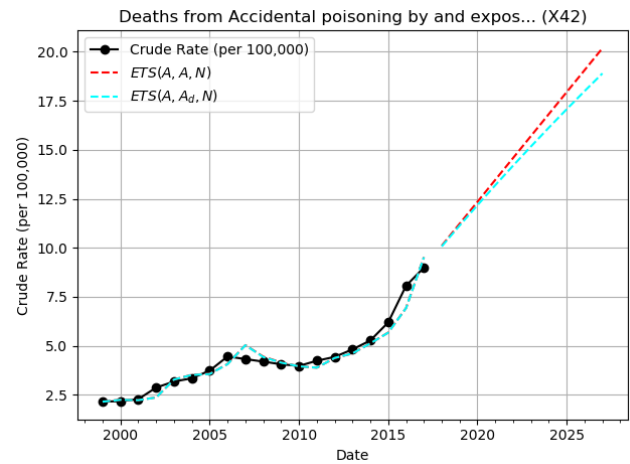


Figure 29: Third priority action from the Minimally grouped (5,264) causes of death for the United States: *Accidental poisoning by and exposure to narcotics and psychodysleptics [hallucinogens] not elsewhere classified (X42)*

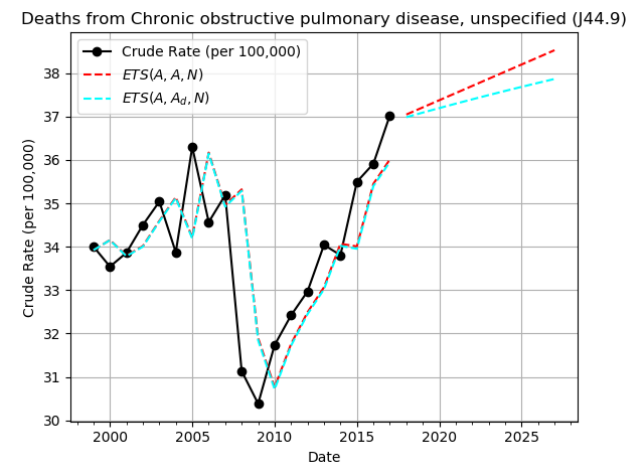


Figure 30: Fourth priority action from the Minimally grouped (5,264) causes of death for the United States: *Chronic obstructive pulmonary disease, unspecified (J44.9)*

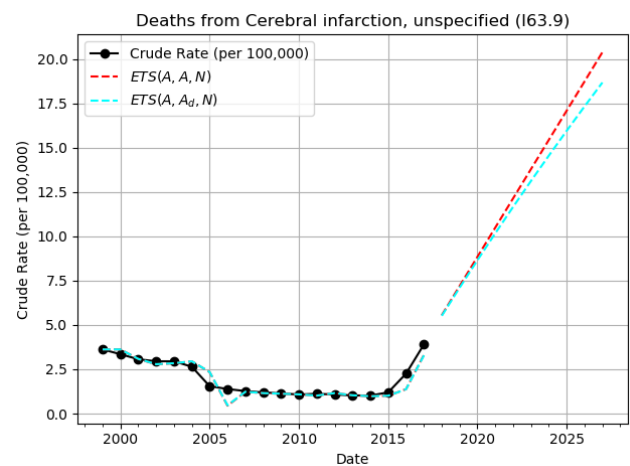


Figure 31: Fifth priority action from the Minimally grouped (5,264) causes of death for the United States: *Cerebral infarction, unspecified (I63.9)*

<sup>xxxi</sup> Group Results By “Year” And By “Cause of death”; Check “Export Results”; Uncheck “Show Totals”

<sup>xxxii</sup> Without  $S_4$  due to the sheer number of causes.

**3.2.7. ICD-10 Minimally grouped (11,316) causes of death for the World.** Top 5 MVBP results for the minimally grouped (11,316) causes of death for the World (U.N. WHO, 2016a, 2019)<sup>xxxiii,xxxiv,xxxv</sup> in Table 13 and Figures 32-36:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	...neoplasm of bronchus ... (C34.9)	0.026866
2	Unspecified dementia (F03)	0.024561
3	Acute myocardial infarction ... (I21.9)	0.022585
4	Other ill-defined ... (R99)	0.019871
5	Heart failure, unspecified (I50.9)	0.018749

Table 13:  $Z(t_F)$  table for the Minimally grouped (11,316) causes of death for the World

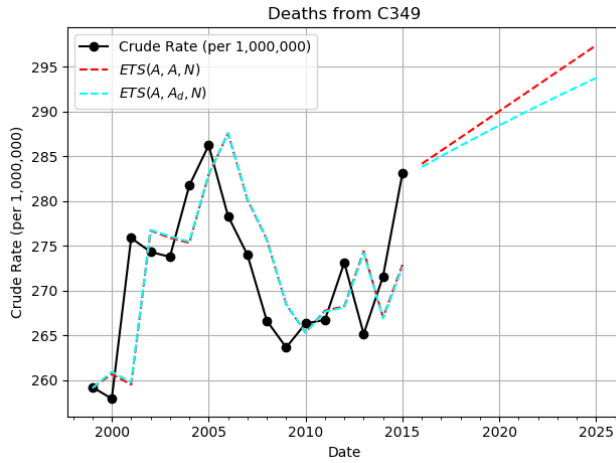


Figure 32: First priority action from the Minimally grouped (11,316) causes of death for the World: *Malignant neoplasm of bronchus and lung, unspecified (C34.9)*

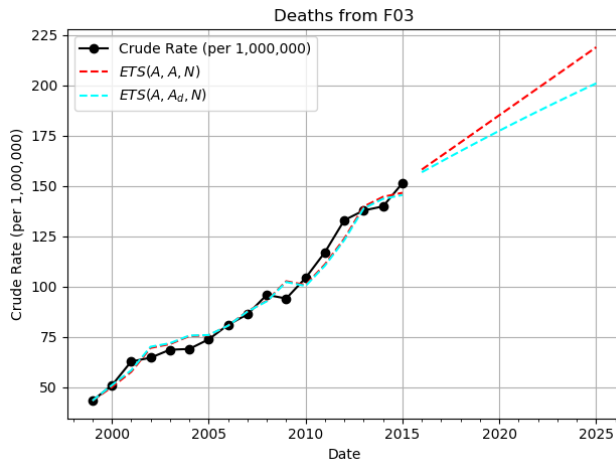


Figure 33: Second priority action from the Minimally grouped (11,316) causes of death for the World: *Unspecified dementia (F03)*

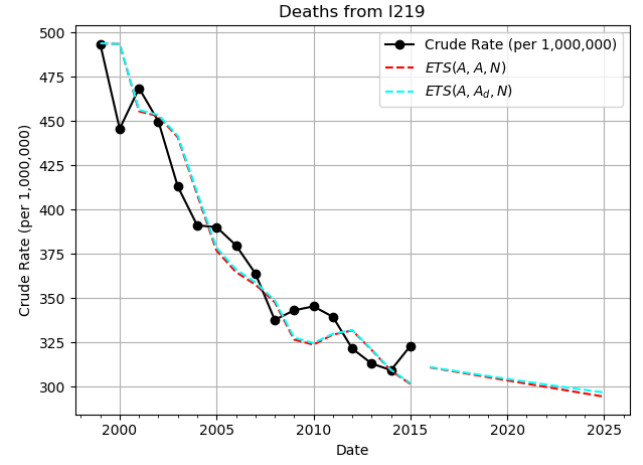


Figure 34: Third priority action from the Minimally grouped (11,316) causes of death for the World: *Acute myocardial infarction, unspecified (I21.9)*

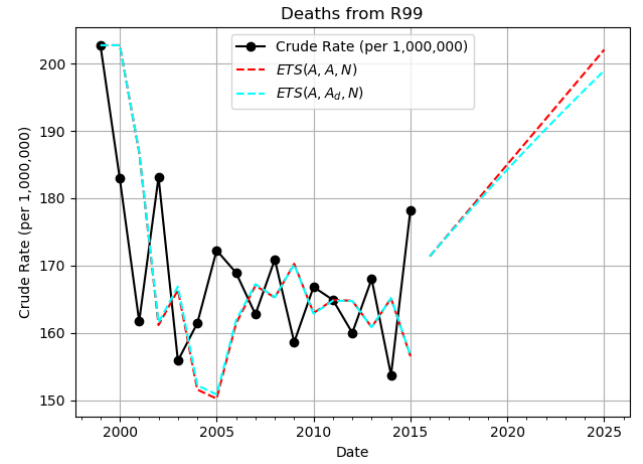


Figure 35: Fourth priority action from the Minimally grouped (11,316) causes of death for the World: *Other ill-defined and unspecified causes of mortality (R99)*

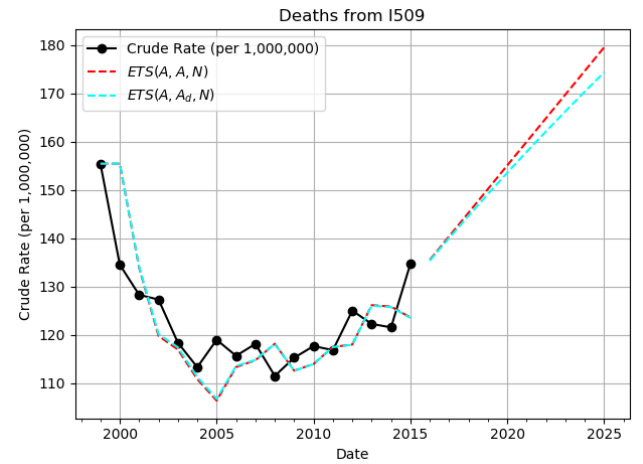


Figure 36: Fifth priority action from the Minimally grouped (11,316) causes of death for the World: *Heart failure, unspecified (I50.9)*

<sup>xxxiii</sup> See Appendix command 7.

<sup>xxxiv</sup> Without  $S_3$  because comprehensive granular age data doesn't exist.

<sup>xxxv</sup> Without  $S_4$  due to the sheer number of causes.

**3.2.8. ICD-10 Chapters for the World with only top-level groupings.** Top 5 MVBV results for the ICD-10 Chapters for the World with only top-level groupings (U.N. WHO, 2019)<sup>xxxvi</sup> in Table 14 and Figures 37-41:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	...circulatory system (I00-I99)	0.321104
2	Neoplasms (C00-D48)	0.194456
3	...respiratory system (J00-J99)	0.092581
4	...nervous system (G00-G99)	0.043816
5	External causes ... (V01-Y98)	0.032951

Table 14:  $Z(t_F)$  table for the ICD-10 Chapters for the World with only top-level groupings

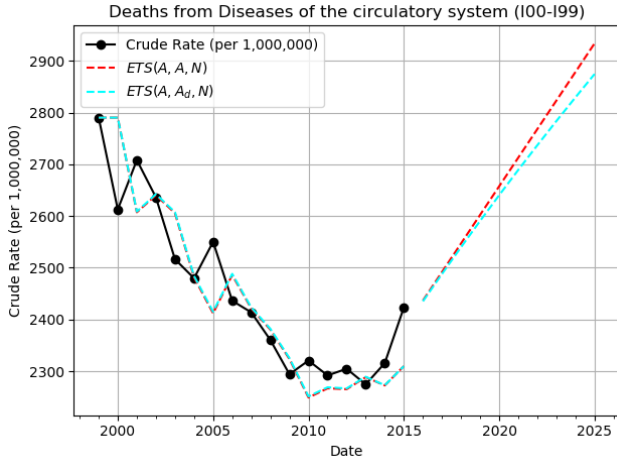


Figure 37: First priority action from the ICD-10 Chapters for the World with only top-level groupings: *Diseases of the circulatory system (I00-I99)*

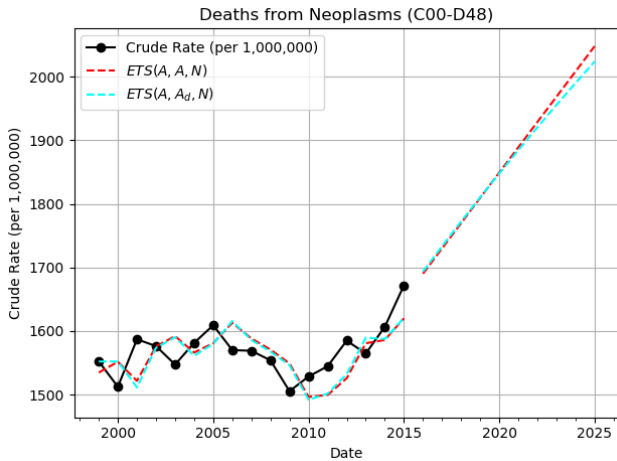


Figure 38: Second priority action from the ICD-10 Chapters for the World with only top-level groupings: *Neoplasms (C00-D48)*

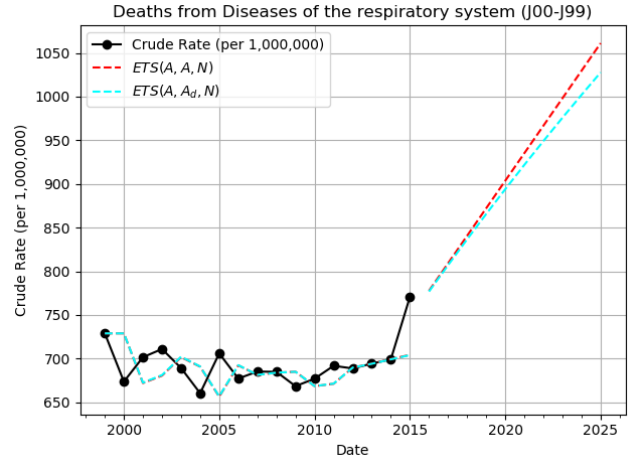


Figure 39: Third priority action from the ICD-10 Chapters for the World with only top-level groupings: *Diseases of the respiratory system (J00-J99)*

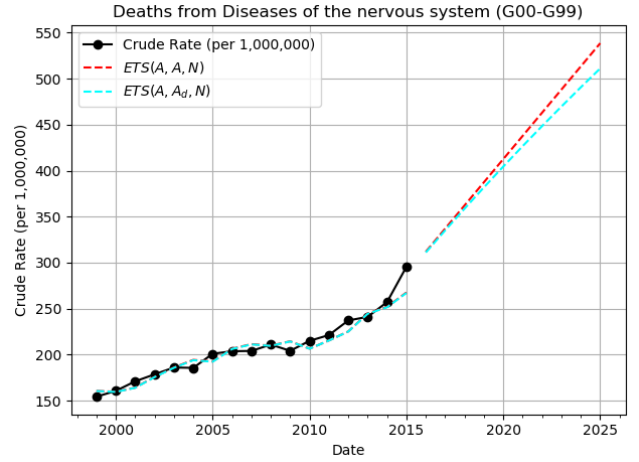


Figure 40: Fourth priority action from the ICD-10 Chapters for the World with only top-level groupings: *Diseases of the nervous system (G00-G99)*

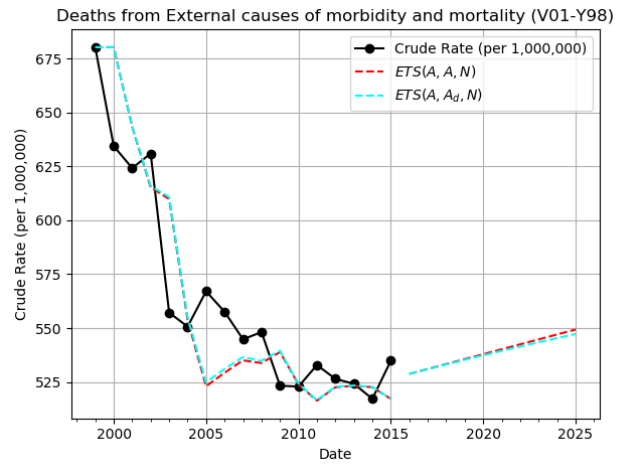


Figure 41: Fifth priority action from the ICD-10 Chapters for the World with only top-level groupings: *External causes of morbidity and mortality (V01-Y98)*

<sup>xxxvi</sup>See footnote <sup>xxxiv</sup>.

**3.2.9. ICD-10 Sub-Chapters for the World.** Top 5 MVBP results for the ICD-10 Sub-Chapters for the World (U.N. WHO, 2019)<sup>xxxvii</sup> in Table 15 and Figures 42-46:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Malignant neoplasms (C00-C97)	0.216971
2	Ischaemic heart diseases (I20-I25)	0.076670
3	Other forms of heart disease (I30-I52)	0.038095
4	Influenza and pneumonia (J09-J18)	0.032015
5	...respiratory diseases (J40-J47)	0.031105

Table 15:  $Z(t_F)$  table for the ICD-10 Sub-Chapters for the World

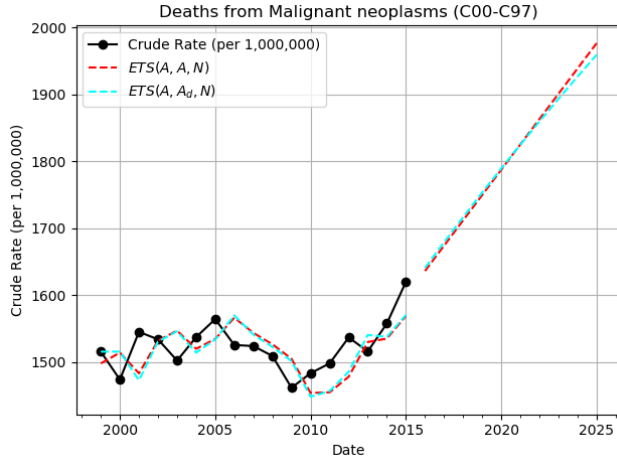


Figure 42: First priority action from the ICD-10 Sub-Chapters for the World: *Malignant neoplasms (C00-C97)*

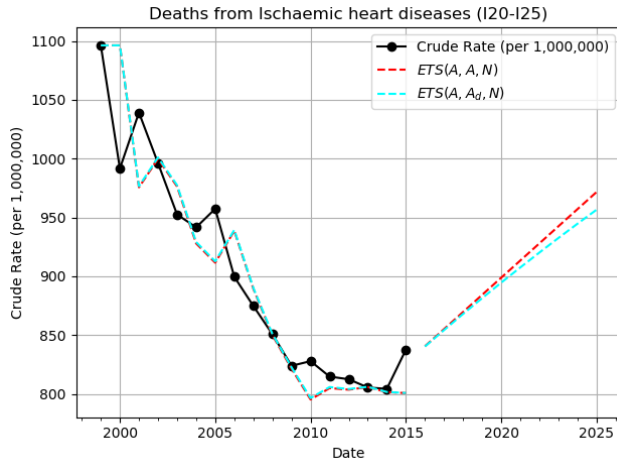


Figure 43: Second priority action from the ICD-10 Sub-Chapters for the World: *Ischaemic heart diseases (I20-I25)*

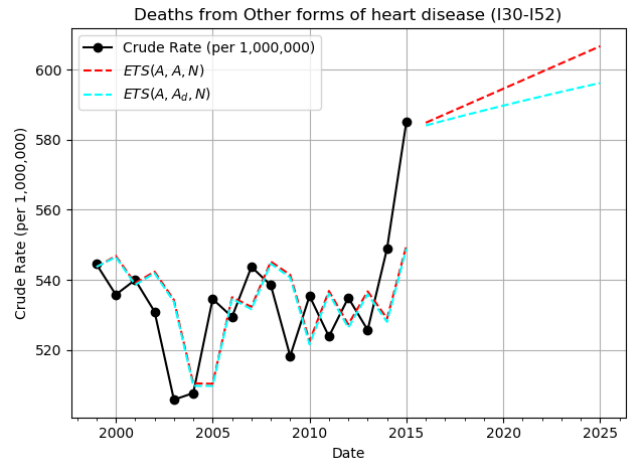


Figure 44: Third priority action from the ICD-10 Sub-Chapters for the World: *Other forms of heart disease (I30-I52)*

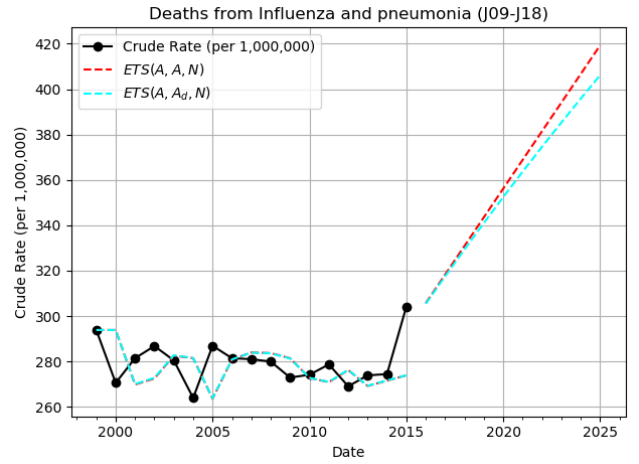


Figure 45: Fourth priority action from the ICD-10 Sub-Chapters for the World: *Influenza and pneumonia (J09-J18)*

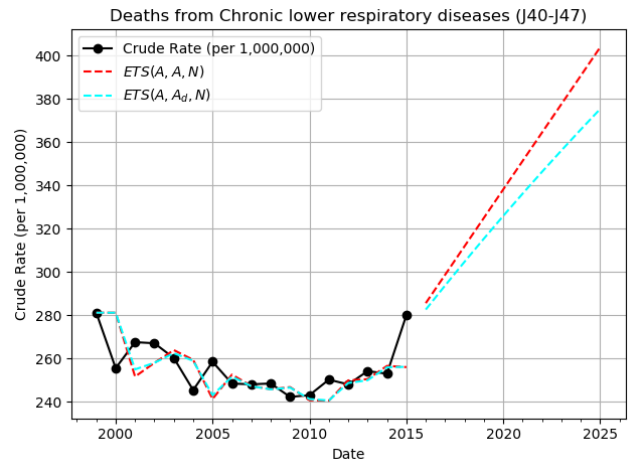


Figure 46: Fifth priority action from the ICD-10 Sub-Chapters for the World: *Chronic lower respiratory diseases (J40-J47)*

<sup>xxxvii</sup>See footnote <sup>xxxiv</sup>.



**3.2.10. Sub-selection.** Further sub-selection may be done by filtering by ICD codes (U.N. WHO, 2016a)<sup>xxxviii</sup>. For example, the top 5 MVBP results for the minimally grouped causes of death for the United States for heart diseases (codes I00-I99) in Table 16 and Figures 47-51:

$k$	Action (Eliminate: ...)	$Z(t_F)$
1	Atherosclerotic heart disease (I25.1)	0.037527
2	Atherosclerotic cardiovascular. . . (I25.0)	0.022493
3	Cerebral infarction, unspecified (I63.9)	0.022395
4	Congestive heart failure (I50.0)	0.015612
5	Hypertensive heart disease . . . (I11.9)	0.012890

Table 16:  $Z(t_F)$  table for the minimally grouped causes of death for the United States for heart diseases (codes I00-I99)

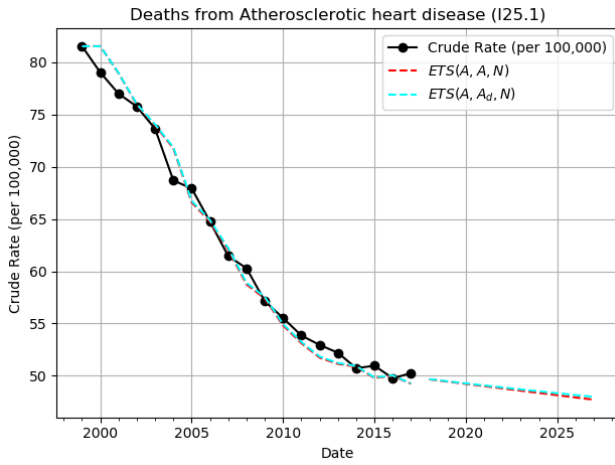


Figure 47: First priority action from the ICD-10 Sub-Chapters for the World: *Atherosclerotic heart disease (I25.1)*

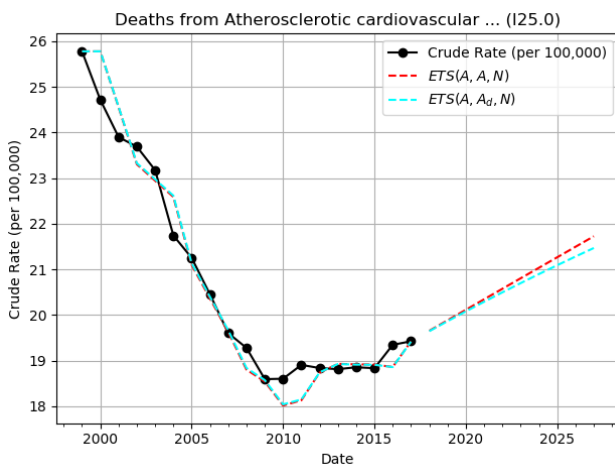


Figure 48: Second priority action from the ICD-10 Sub-Chapters for the World: *Atherosclerotic cardiovascular disease, so described (I25.0)*

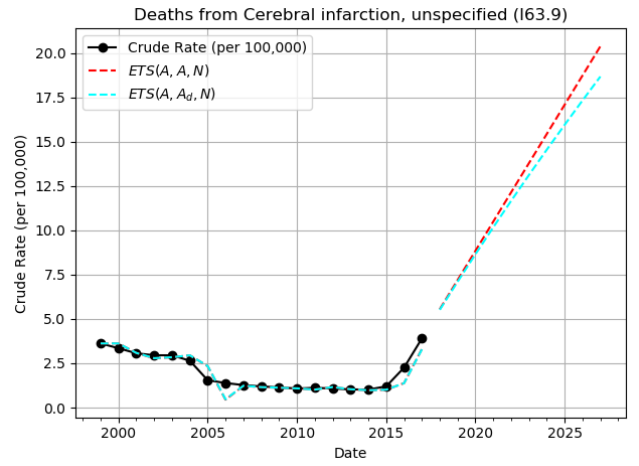


Figure 49: Third priority action from the ICD-10 Sub-Chapters for the World: *Cerebral infarction, unspecified (I63.9)*

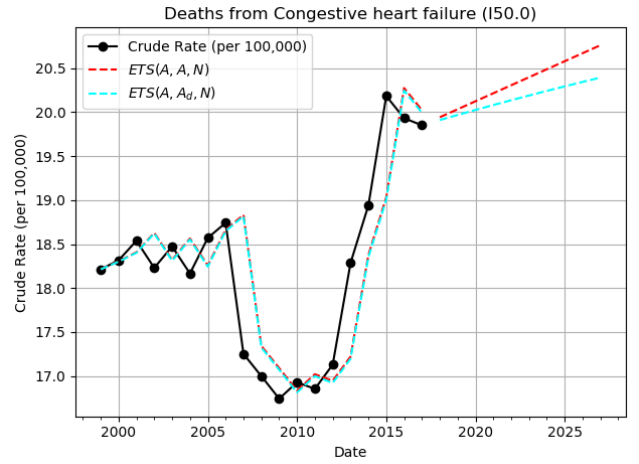


Figure 50: Fourth priority action from the ICD-10 Sub-Chapters for the World: *Congestive heart failure (I50.0)*

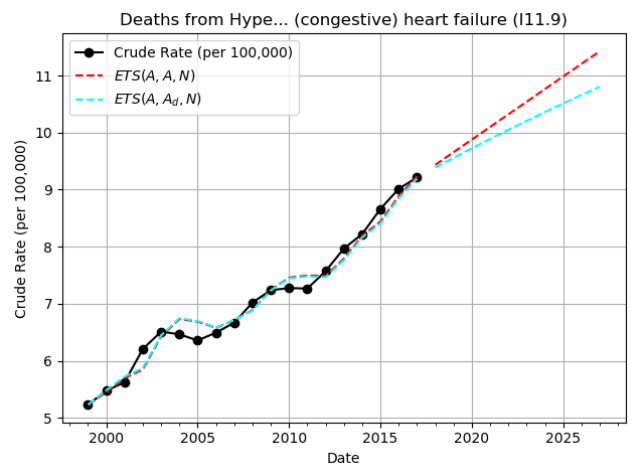


Figure 51: Fifth priority action from the ICD-10 Sub-Chapters for the World: *Hypertensive heart disease without (congestive) heart failure (I11.9)*

<sup>xxxviii</sup>See Appendix command 8.

## 4. Discussion

This article proposes a method called value based prioritization which uses value theory to establish a goal and the set of known actions to accomplish said goal. Each action is relatively ranked based on some quantitative measurement(s) as called for by the same value theory. This ranking is transformed by a set of functions which scale up and down each action's relative score based on other relevant measurements and subjective opinions. The resulting list provides a prioritized relative ranking of actions that should be pursued in a particular order. Given that it may take significant time to ramp up and execute actions, modeled value based prioritization forecasts estimated relative rankings into the future to try to anticipate relative rankings by the time ramping up is complete. In essence, value based prioritization is a method to triage the proper actions to take given limited time and resources.

This method is applied to the example of choosing meaningful work using an example value system based on the goal to reduce human suffering. The method is sensitive to the choice of values and there are many ways to measure and scale the resulting relative rankings. Even with pretty clear measurements such as death, which is a binary and straightforward metric, there are endless questions about data quality ("Garbage In, Garbage Out"), how to define the underlying cause of death, which data sets to use ("e.g. would world death rates significantly change if political conditions changed?"), etc. Groupings of deaths introduce another dimension to evaluation: it's not clear how to relatively evaluate different groupings of deaths. Finally, there is a significant risk of missing actions that don't neatly categorize into measurable quantities. In short, there is no obvious way around certain philosophical questions, definitions, and evaluations.

Despite these shortcomings, alternative approaches are less quantitative, less explicit, and thus more difficult to evaluate and improve; and, more difficult to continuously evaluate progress on without such clear metrics. Further research and experience may help accumulate a database of value-metric mappings and scale functions that may be combined by people in different ways to help them prioritize actions such as finding meaningful work. ■

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## 5. Appendix

Notes on Section 3:

1. To generate the longterm comparable leading causes of death for the United States:

- (a) Generate data from 1959 for all long-term, comparable, leading causes of death<sup>xxxix</sup>:

```
python3 -m vbp.run prepare_data
UCODUnitedStates
```

- (b) Rows 1900:1957 and the sheet “Comparability Ratios” in comparable\_ucod\_estimates.xlsx were manually input from [https://www.cdc.gov/nchs/data/dvs/lead1900\\_98.pdf](https://www.cdc.gov/nchs/data/dvs/lead1900_98.pdf).

- (c) Open comparable\_data\_since\_1959.xlsx and copy rows 1959:Present.

- (d) Open comparable\_ucod\_estimates.xlsx and paste on top starting at 1959.

- (e) Process comparable\_ucod\_estimates.xlsx with its “Comparability Ratios” sheet to generate comparable\_ucod\_estimates\_ratios\_applied.xlsx:

```
python3 -m vbp.run
prepare_data UCODUnitedStates
--comparable-ratios
```

2. Age adjustment<sup>xi</sup> is not performed on crude rates because the goal of the example is to predict future *relative* total death rates which already implicitly takes into account population age changes over time.
3. The WHO Mortality Database population and death statistics are quite incomplete, reporting only about  $\frac{1}{3}$  of the world population and about  $\frac{1}{3}$  of world deaths:

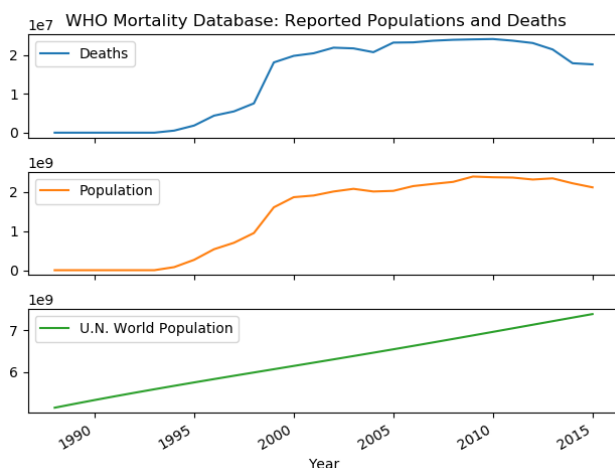


Figure 52: WHO Mortality Database: Reported Population and Deaths

4. “There is a substantial literature on the projection or forecasting of all-cause mortality rates and mortality rates for specific diseases. The methods used fall into two broad groups. First are those methods based on time-series analysis of historical trends in mortality rates. These ‘aggregate models,’ whether

for all-cause mortality or for specific causes, use the previous trend of the variable of interest as the basis for predicting its future value. By their data requirements, such methods are generally limited to high-income countries with good death registration data [...]. Second are the ‘structural models,’ which are based on relationships between mortality and a set of independent variables, and are necessarily projections of those independent variables. To the extent that the structural model identifies the important components — and the relationships among them — of the ‘system’ that determines the variable of interest, they offer the potential for more robust predictions. When the underlying system is complex and sensitive to one or more of its components, a shift in some of the system variables can introduce large changes in the outcome that may be missed by extrapolation (such as the discovery of antibiotics and infectious disease trends or the change in tuberculosis mortality after the HIV epidemic). Aggregate models, in contrast, require considerably less knowledge of the system components and the relationships among them. These models can therefore provide more reliable estimates when such information is not available, especially when the system is not very sensitive to its inputs in time intervals that are in the order of the prediction time.” (Mathers and Loncar, 2006)

5. “Substantial research remains to develop robust and unbiased methods for measuring trends in case fatality rates, survival times, and disability due to specific causes, let alone collecting such data across all regions of the world. Despite these uncertainties, projections provide a useful perspective on population health trends and health policies, provided that they are interpreted with a degree of caution. Projections enable us to appreciate better the implications for health and health policy of currently observed trends, and the likely impact of fairly certain future trends, such as the ageing of the population, and the continuation of the epidemiological transition in developing countries.” (Mathers and Loncar, 2006)
6. “The process of coding underlying causes of death involves some extent of misattribution or miscoding even in countries where causes are assigned by medically qualified staff [due to] incorrect or systematic biases in diagnosis, incorrect or incomplete death certificates, misinterpretation of ICD rules for selection of the underlying cause, and variations in the use of coding categories for unknown and ill-defined causes.”<sup>xli</sup>

<sup>xxxix</sup> [https://www.cdc.gov/nchs/data/dvs/lead1900\\_98.pdf](https://www.cdc.gov/nchs/data/dvs/lead1900_98.pdf)

<sup>xi</sup> <https://seer.cancer.gov/seerstat/tutorials/aarates/definition.html>

<sup>xli</sup> <https://apps.who.int/healthinfo/statistics/mortality/whodpms/help/desc.htm>

## 5.1. Python Commands

1. `python3 -m vbp.run list UCODUnitedStates`
2. `python3 -m vbp.run manual_scale_functions -a -t excel -o  
manual_scale_functions.xlsx -n "Scale Values" -p "Eliminate: "  
UCODUnitedStates S4`
3. `python3 -m vbp.run action_data UCODUnitedStates Cancer`
4. `python3 -m vbp.run predict UCODUnitedStates --ets-no-multiplicative-models  
--do-not-obfuscate -p 10 Cancer`
5. `python3 -m vbp.run modeled_value_based_prioritization UCODUnitedStates  
--ets-no-multiplicative-models -k 5 -p 10 --manual-scales  
manual_scale_functions.xlsx --average-ages S2 --average-age-range 5`
6. `python3 -m vbp.run modeled_value_based_prioritization -a UCODUnitedStates ...`
7. `python3 -m vbp.run modeled_value_based_prioritization UCODWorld  
--ets-no-multiplicative-models -k 5 -p 10 --manual-scales  
manual_scale_functions.xlsx`
8. `python3 -m vbp.run modeled_value_based_prioritization UCODUnitedStates  
--filter "I00.0-I99.9" --do-not-obfuscate --data-type US_ICD10_MINIMALLY_GROUPED  
--ets-no-multiplicative-models -k 5 -p 10 --manual-scales  
manual_scale_functions.xlsx --average-ages S2 --average-age-range 5`