RISK RANKING:
DALY ESTIMATES FOR SELECTED FOODBORNE DISEASES IN NEW ZEALAND USING REVISED DUTCH DISABILITY WEIGHTS

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SUMMARY

This report contributes to a project with the following goal:

- The development of a single metric of risk ranking that can be applied to both chemical and microbiological hazards, and is applicable to the varied risk ranking needs of the NZFSA.

From 2002 – 2005 the risk ranking project conducted by ESR for the NZFSA developed a process, and used expert opinion to produce severity and attribution estimates for a number of food/(microbiological) hazard combinations.

A previous report from this project in the 2006-2007 financial year (FW06109) discussed the available metric options, and chose the disability adjusted life year (DALY) as the most appropriate single metric. A further report in 2006-2007 (FW0724) estimated the burden of illness in DALYs as both the total and foodborne proportions for the following illnesses, as agreed with the NZFSA:

- Campylobacteriosis
- Salmonellosis
- Listeriosis (invasive, perinatal and non-perinatal)
- Infection with STEC
- Yersiniosis
- Infection with Norovirus

The approach used in developing DALY estimates for New Zealand was strongly guided by estimates prepared for the Netherlands in 2006 (Kemmeren *et al.*, 2006). Further details were found in specific Dutch estimates for *Campylobacter* (Havelaar *et al.*, 2000) and shiga-toxin producing *Escherichia coli* (STEC) (Havelaar *et al.*, 2004). A key element in developing these estimates was the use of Dutch disability weights for loss of quality of life due to illness.

Since preparation of those New Zealand estimates, further Dutch work examining disability weights has become available (Haagsma *et al.*, 2008a). These new disability weights include consideration of the duration of illness so that it does not need to be part of the calculation. The participant surveys used to develop the disability weights also included a relevance criterion, where minimal disease might be excluded from the burden estimate.

This current report provides revised estimates for New Zealand using the new research from the Netherlands.

While the revised disability weights resulted in some changes in the magnitude of DALY estimates, they had little impact on the relative ranking of the diseases considered.

1 INTRODUCTION

This report contributes to a project to rank the risks associated with pathogens in food, with the following goal:

- The development of a single metric of risk ranking that can be applied to both chemical and microbiological hazards, and is applicable to the varied risk ranking needs of the NZFSA.

During 2006-2007 estimates for the burden of foodborne disease in New Zealand were derived. Methodology used drew heavily on previous work carried out in the Netherlands (Havelaar *et al.*, 2000; Havelaar *et al.*, 2004; Kemmeren *et al.*, 2006). These studies used disability-adjusted life years as the metric for estimation of the burden of foodborne disease.

1.1 Disability-Adjusted Life Years (DALYs)

Disability adjusted life years (DALYs) were originally developed by the World Health Organization for the Global Burden of Disease Study (Murray and Lopez, 1997). The fundamental calculation for DALYs is:

$$\text{DALY} = \text{YLL} + \text{YLD}$$

YLL is the number of years of life lost due to mortality and YLD is the number of years lived with a disability, weighted with a factor between 0 and 1 for the severity of the disability (d).

YLL is calculated by accumulation over all health outcomes (l), the product of the number of fatal cases (n) due to the health outcomes (l) multiplied by the expected individual life span (e) at the age of death.

$$YLL = \sum_{l} n_l \times e_l$$

YLD is calculated by accumulation over all health outcomes (l), the product of the number of cases (n), the duration of the illness (t) and the disability weight (w) of a specific disease. It should be noted that the calculation for YLL above implicitly includes a disability weight factor. The disability weight factors are in the range zero to one, with the disability weight for death being equal to one.

$$YLD = \sum_{l} n_l \times t_l \times w_l$$

Information on the incidence of illness and death is derived from clinical, epidemiological and surveillance studies, whereas information on disability weights is typically derived from elicitation of special panels, preferably from the general population.

1.2 Disability Weights

The disability weight is a measure of the valuation placed on a particular health state and is an indicator of the perceived severity of that health state by the group used to derive the disability weight.

In the absence of health state specific disability weights, disability weights used in the Dutch studies of the burden of foodborne illness were often derived from those for diseases that were considered by the researchers to be approximately equivalent. However, work has recently been completed in the Netherlands to derive disability weights specifically for diseases or health states associated with foodborne diseases (Haagsma *et al.*, 2008a).

1.3 Current Study

The work reported here looks to incorporate the new disability weights, derived in the Netherlands, into the existing New Zealand model for the burden of foodborne illness (Cressey and Lake, 2007) to determine the impact on absolute and relative estimates of disease burden.

2 DISABILITY WEIGHTS FOR DALY ESTIMATION

There are no New Zealand specific severity/disability weightings available for foodborne disease outcomes. The Ministry of Health estimate of the burden of disease and injury in New Zealand (Tobias, 2001) used disability weights principally from the Netherlands and Australia. For this reason disability weights used to determine the burden of foodborne disease for New Zealand have been 'borrowed', with the Netherlands being the most comprehensive source for these weights (Kemmeren *et al.*, 2006). The following sections will outline methodological approaches for determining disability weights, summarise the Dutch disability weights used in the original New Zealand burden of foodborne illness study (Cressey and Lake, 2007), and introduce the revised Dutch disability weights (Haagsma *et al.*, 2008a).

2.1 Derivation of Disability Weights

Disability weights are determined by eliciting health state valuations from a cohort of expert or lay individuals using one or more valuation techniques. Information on the health states are presented to participants in a standardised format. This format will include information on the symptoms of the illness, but may or may not consider its (variable) duration.

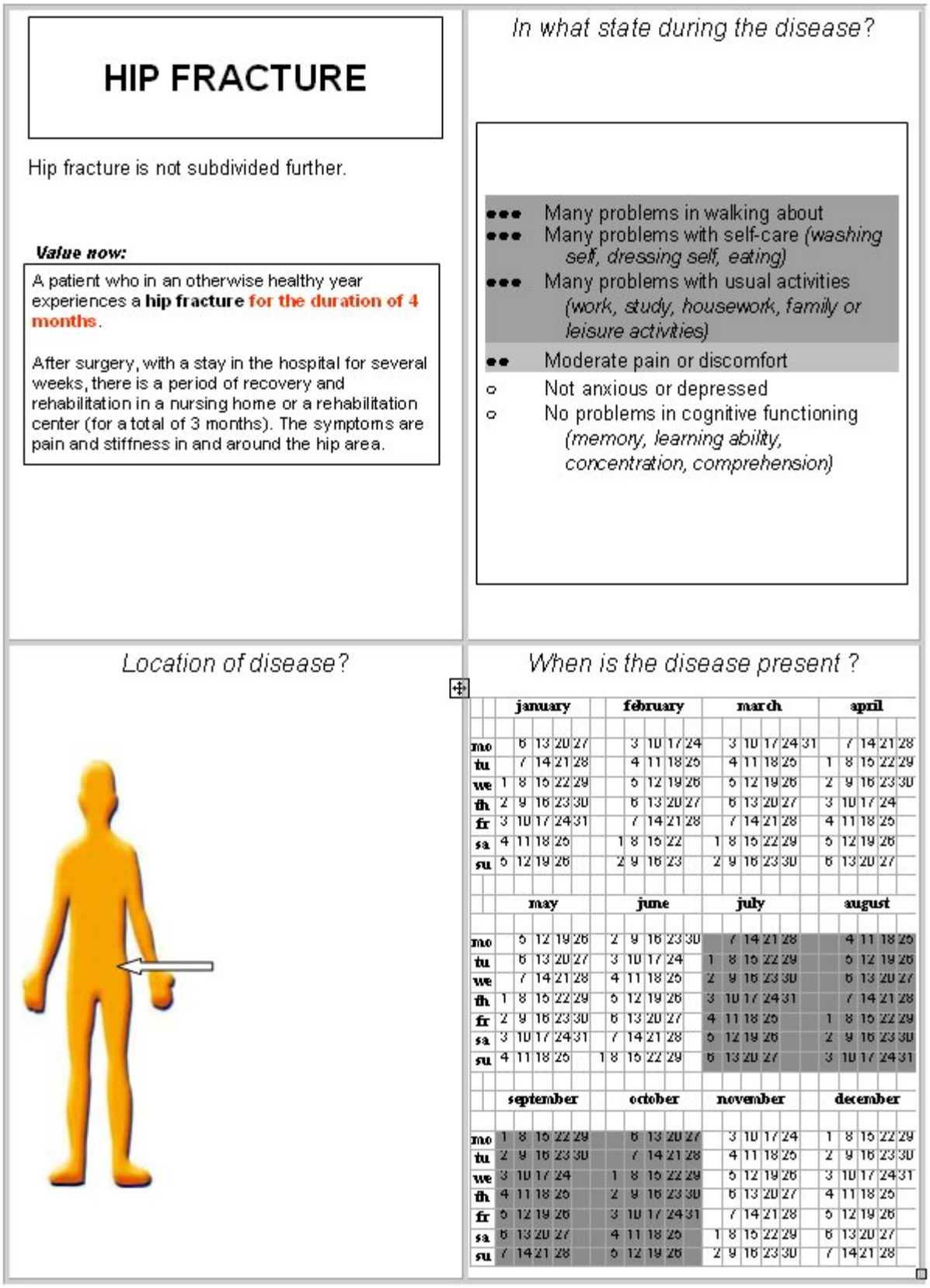
An alternative is to explicitly present the typical duration of illness as part of the development of disability weight. This may be presented along with symptoms description in the form of A4 vignettes, such as that shown in Figure 1. The symptoms are described in both words and "dots" to indicate severity. The location of the disease symptoms are presented in a gender neutral figure.

For the disability weights discussed in this document two valuation techniques were used (Haagsma *et al.*, 2008a; Krabbe *et al.*, 1997):

Visual Analogue Scale (VAS). Participants score the health state on a vertical scale or "thermometer" with a scale from 0 to 100. The anchors are labeled 'best imaginable health state' (100 = perfect health) and 'worst imaginable health state' (0 = death). On this scale more severe disease states will be assigned lower scores.

Time Trade Off (TTO). Participants are asked how many days of one year in full health they would be willing to trade off (exchange) in order to be restored from the designated health state. In this approach more severe disease states will attract a higher TTO. For example, an individual may be prepared to trade most of a year of full health to avoid a year spent in quadriplegia. Conversely, participants are unlikely to trade large amounts of time to avoid a short period of acute gastrointestinal illness (AGI).

Figure 1: Vignette for hip fracture



Kindly provided by Juanita Haagsma, RIVM, the Netherlands

2.2 Original Dutch Disability Weights for Foodborne Diseases

Health states for which disability weights are derived usually include a definition of their duration e.g. mild gastroenteritis for 3 days. Thus, health states are not 'timeless' and what is valued is the combination of health state and duration (Essink-Bot and Bonsel, 2002). Kemmeren *et al.* (2006) and earlier studies into the burden of foodborne disease in the Netherlands separated duration and disability weight into separate components in the DALY calculation. While this has few implications for diseases with an extended or chronic time course, for health states with short time courses disability weight estimates will be much more sensitive to differences in duration e.g. gastroenteritis for 1 or 2 days is a 100% difference.

A list of disability weights used in the Netherlands for all of the outcomes relevant to this New Zealand foodborne illness study is provided in the CARMA report on priority setting of foodborne illnesses (Kemmeren *et al.*, 2006). Values used have been reproduced from Kemmeren *et al*. (2006) unless otherwise indicated (Table 1).

These disability weights were derived primarily in terms of symptoms, not duration. They can be recalculated as 'approximate annual profile disability weights' by multiplying them by disease duration, expressed in years. For comparison purposes, mean duration of diseases from Kemmeren *et al.* (2006) and resulting annual profile disability weights are also included in Table 1. For diseases with a time course of one year or more, disability weights were calculated for one year.

Table 1: Disability weight for disease states relevant to potentially foodborne infectious intestinal disease

Illness	Disability weight#	Mean Duration (Years)	Annual Profile Disability Weight
Death	1.00		
Gastroenteritis (do not visit a GP and recover)	0.067	0.0095-0.015	0.0006-0.001
Gastroenteritis (visit a GP and recover)	0.393	0.016-0.058	0.006-0.023
Gastroenteritis (hospitalised and recover)	0.393	0.02-0.079	0.008-0.031
GBS (mild)*	0.10 (F1) – 0.30 (F2)	1	0.10 (F1) – 0.30 (F2)
GBS (severe)*	0.44 (F3) – 0.80 (F4) – 0.94 (F5)	1	0.44 (F3) – 0.80 (F4) – 0.94 (F5)
ReA (not visiting a GP)	0.127	0.608	0.077
ReA (visiting GP)	0.21	0.608	0.128
ReA (hospitalised)	0.37	0.608	0.225
IBD	0.26	1	0.26

Illness	Disability weight#	Mean Duration (Years)	Annual Profile Disability Weight
STEC: Gastroenteritis with non-bloody diarrhoea**	0.067	0.009	0.0006
STEC: Gastroenteritis with bloody diarrhoea**	0.393	0.016	0.006
HUS**	0.90	0.058	0.052
Listeriosis: gastroenteritis	0.01	0.02	0.0002
Listeriosis: Sepsis	0.93	0.02	0.019
Listeriosis: Meningitis	0.32	0.5	0.16
Listeriosis: Pneumonia	0.04	0.02	0.0008
Listeriosis: Long term sequelae	0.25	1	0.25

GBS: Guillain Barré Syndrome, ReA: reactive arthritis, IBD: inflammatory bowel disease, STEC: shiga-toxin producing E. coli, HUS: haemolytic uraemic syndrome, GP: general practitioner

Kemmeren *et al*. (2006)

* The states F1-F5 refer to the functional severity of the illness. Actual values used were further refined using time course of the illness. Recovery from the illness was modeled by defining a time period and modeling the decrease in the disability weight over that time period.

** (Havelaar *et al.*, 2004)

2.3 New Dutch Disability Weights

The revised Dutch disability weights followed a more classical approach, using annual profiles and defined duration (Essink-Bot and Bonsel, 2002; Haagsma *et al.*, 2008a). This will be more fully explained below.

The recent determination of novel disability weights for the Netherlands used VAS and TTO to elicit health state valuations from a cohort of 115 lay people (Haagsma *et al.*, 2008a). VAS values were converted to TTO equivalents using the logarithmic transformation of Krabbe *et al.* (1997). For some mild conditions participants were not prepared to trade off any time at full health to avoid the condition. This information was used to define a 'relevance criterion' – if greater than 50% of participants were not prepared to trade any time, then the health state was assigned a zero disability weight (Haagsma *et al.*, 2008a; Haagsma *et al.*, 2008b). Mean VAS and TTO values, TTO equivalents calculated from VAS and relevance criteria for foodborne disease health states are summarized in Table 2.

Table 2: Health state valuation data (Haagsma *et al.*, 2008a)

State	VAS mean	TTO transformed*	TTO median	TTO mean	Relevance Criterion (%TTO=0)
Gastroenteritis, mild, 1 day	0.036	0.0004	0	0.002	88
Gastroenteritis, mild, 5 days	0.102	0.004	0	0.01	60
Gastroenteritis, moderate, 10 days	0.13	0.008	0.005	0.015	26
Gastroenteritis, severe, 7 days	0.231	0.031	0.008	0.025	25
Gastroenteritis, severe, 14 days	0.295	0.055	0.011	0.041	17
Gastroenteritis, chronic, 6 months	0.368	0.093	0.058	0.099	8
GBS, F1, whole year	0.185	0.018	0.008	0.044	40
GBS, F2, whole year	0.42	0.127	0.077	0.137	7
GBS, F3, whole year	0.545	0.236	0.153	0.215	2
GBS, F4, whole year	0.7	0.428	0.252	0.367	2
GBS, F5, whole year	0.722	0.460	0.403	0.46	0
ReA, mild, 1 week	0.107	0.005	0	0.004	68
ReA, mild, 6 weeks	0.197	0.021	0.011	0.023	25
ReA, moderate, 6 months	0.447	0.147	0.058	0.115	8
ReA, severe, 6 months	0.503	0.195	0.153	0.186	4
HUS, moderate, 1 month	0.279	0.048	0.022	0.056	13
HUS, severe, 1 month	0.481	0.175	0.038	0.11	0
Renal failure, whole year	0.628	0.330	0.252	0.328	0
Crohn's disease, 6 months	0.347	0.080	0.067	0.105	4
Ulcerative colitis, 6 months	0.492	0.185	0.115	0.154	7

VAS = Visual Analogue Scale, TTO = Time Trade Off – see section 2.1 for an explanation of these health state valuation methods

GBS: Guillain Barré Syndrome, ReA: reactive arthritis, HUS: haemolytic uraemic syndrome

* Calculated from VAS using the logarithmic transformation method of Krabbe *et al*. (1997)

While there is evidence that the ranking of the severity of different health states is reasonably consistent across different countries, elicitation panels and study methods (Essink-Bot *et al.*, 2002; Ustun *et al.*, 1999), the application of a relevance criterion is novel and it is not currently known whether the societal norms expressed are 'transportable' from the Netherlands to New Zealand.

As participants were asked to "trade off" a portion of one year of full health, for illness with a duration of less than one year, duration is not further considered in the DALY calculation. However, for illnesses lasting more than one year (e.g. end stage renal disease), the duration (based on life expectancy for life-long illnesses) is included in the calculation, in terms of the number of periods of one year.

Three conditions did not meet the relevance criterion; mild gastroenteritis for 1 or 5 days and mild reactive arthritis for one week. Therefore, in the calculation of DALYs these conditions would have a disability weight of zero.

2.4 Mapping Disability Weights

In order to recalculate DALYs for foodborne diseases in New Zealand using the novel Dutch disability weights it is necessary to match or map the health state descriptors used in the study of Haagsma *et al*. (2008a) to those previously used in New Zealand (Cressey and Lake, 2007).

2.4.1 Gastroenteritis

In the previous DALY study conducted for New Zealand, gastroenteritis cases without recourse to a GP visit (community cases) were assigned durations in the range 3.4-5.6 days, depending on the causative organism (Cressey and Lake, 2007). It has been confirmed that community cases of gastroenteritis have been equated to mild gastroenteritis (1 or 5 day) in the novel Dutch study (J. Haagsma, RIVM, personal communication). As neither of these health states met the relevance criterion a zero disability weight will be used in the DALY recalculation.

Gastroenteritis cases attending a GP were assigned durations in the range 5.7-10.6 days, depending on the causative organism and appear best matched to moderate gastroenteritis of 10 days duration. It has been confirmed that this was the approach adopted by RIVM (J. Haagsma, RIVM, personal communication).

Hospitalised gastroenteritis cases were assigned durations in the range 7-16 days in the initial model for estimation of DALYs for foodborne disease in New Zealand. In the Dutch study the vignettes for severe gastroenteritis explained that the patient was admitted to hospital and severe gastroenteritis of 14 days duration was used by RIVM as the basis for disability weights for hospitalized cases (J. Haagsma, RIVM, personal communication).

2.4.2 Guillain-Barré syndrome (GBS)

The severity of GBS can be expressed in terms of an F-score, with scores ranging from 0 = Healthy to 6 = Dead (Havelaar *et al.*, 2000). For GBS, an F score <3 (able to walk without assistance) is considered to be mild, while an F-score of 3 (able to walk with assistance) or greater is considered to be severe (Havelaar *et al.*, 2000). The ratio between old and new disability weights for GBS was used to adjust mean disability weights for mild and severe cases to reflect the new disability weights.

2.4.3 Reactive arthritis (ReA)

Reactive arthritis cases were treated in a similar manner to gastroenteritis cases, with mild, moderate and severe being equated to no-GP, GP and hospitalised cases. Cressey and Lake (2007) adopted the approach for duration of ReA of Mangen *et al.* (2004) of assigning all ReA cases duration randomly selected from an exponential function with mean of 0.608 years, irrespective of severity. Haagsma *et al*. (2008a) elicited disability weights for mild ReA of duration one and six weeks of 0.004 and 0.023. In recalculating DALYs for foodborne diseases the Dutch group reasoned that a duration of 6 weeks was more likely for mild ReA and that cases with ReA persisting for more than 6 weeks were likely to consult a GP. They used the annual profile disability weight of 0.023 for mild ReA cases (J. Haagsma, RIVM, personal communication) and this approach has been adopted for the current study.

In the previous DALY studies, both GP and hospitalized cases of ReA were also considered to have durations of disease with means of 0.608 years (7.3 months) (Cressey and Lake, 2007; Mangen *et al.*, 2004). Haagsma *et al.* (2008a) elicited valuations for moderate and severe ReA of six months duration. These were used for GP and hospitalized ReA cases without further adjustment (J. Haagsma, RIVM, personal communication) and this approach has been adopted for the current study.

2.4.4 Inflammatory bowel disease (IBD)

Cressey and Lake (2007) adopted the approach of Mangen *et al*. (2004) in assuming that IBD, once developed, would persist lifelong. Haagsma *et al.* (2008a) elicited disability weights for Crohn's disease (CD) of six months duration and ulcerative colitis (UC) of six months duration. A New Zealand study found the incidence of CD (16.5/100,000) to be more than twice the incidence of UC (7.6/100,000) (Gearry *et al.*, 2006). These figures were used to derive a weighted disability weight for incident IBD in New Zealand.

Both CD and UC symptoms tend to subside and flare up over time and the vignette used for the Dutch disability weight study described a year course with six months of active IBD symptoms spread throughout the year. On this basis, the disability weights derived by Haagsma *et al.* (2008a) were used directly for recalculation of DALYs (J. Haagsma, RIVM, personal communication) and this approach has been adopted for the current study.

2.4.5 Haemolytic uraemic syndrome (HUS)

Haagsma *et al*. (2008a) elicited valuations for moderate and severe HUS of duration one month. Early Dutch and New Zealand models used a uniform duration distribution from 14 to 28 days, with a mean of 21 days (Cressey and Lake, 2007; Havelaar *et al.*, 2004). However, no severity grading of HUS was included in the earlier work. For the current exercise, it was assumed that severe HUS cases would be those who subsequently developed End Stage Renal Disease (ESRD). The disability weights of Haagsma *et al*. (2008a) were applied without further modification.

2.4.6 End stage renal disease (ESRD)

Haagsma *et al*. (2008a) elicited a valuation for one year of renal failure (0.328). Earlier models distinguished three states; dialysis, transplantation and functioning graft (Cressey and Lake, 2007; Havelaar *et al.*, 2004). For the current study it will be assumed that a case can be considered to be in renal failure from the point of developing ESRD until death. It was also assumed that each year of this time would be equally valued.

2.4.7 Summary

Table 3 provides a direct comparison between health state descriptors and annual profile disability weights from the previous New Zealand burden of foodborne illness study (Cressey and Lake, 2007) with mapped equivalents from the study of Haagsma *et al.* (2008a).

Table 3: Comparison of old and new disability weights

Old descriptor	Old Disability Weights	New descriptor	New Disability Weights (mean)
Gastroenteritis (do not visit a GP and recover)	0.0006-0.001	Gastroenteritis, mild, 1 day or 5 days	0.00*
Gastroenteritis (visit a GP and recover)	0.006-0.023	Gastroenteritis, moderate, 10 days	0.015
Gastroenteritis (hospitalised and recover)	0.008-0.031	Gastroenteritis, severe, 14 days	0.041
GBS (mild, 1 year)#	0.10 (F1) – 0.30 (F2)	GBS (mild, 1 year)	0.044 (F1) – 0.137 (F2)
GBS (severe, 1 year)#	0.44 (F3) – 0.80 (F4) – 0.94 (F5)	GBS (severe, year)	0.215 (F3) – 0.367 (F4) – 0.46 (F5)
ReA (not visiting a GP, 7.3 months)	0.077	ReA, mild, 6 weeks	0.023
ReA (visiting GP, 7.3 months)	0.128	ReA, moderate, 6 months	0.115
ReA (hospitalised, 7.3 months)	0.225	ReA, severe, 6 months	0.186
IBD, 1 year	0.26	Weighted mean of Crohn's disease and ulcerative colitis, 6 months	0.120
HUS (21 days)	0.052	HUS, moderate, 1 month	0.056
ESRD -dialysis, 1 year -transplantation, 1 year - functioning graft, 1 year	 0.18 0.18 0.12	Renal failure, 1 year	0.328

GBS: Guillain Barré Syndrome, ReA: reactive arthritis, IBD: inflammatory bowel disease, HUS: haemolytic uraemic syndrome, ESRD: End Stage Renal Disease, GP: general practitioner

* While the mean disability weights determined for mild gastroenteritis of one or days were 0.002 and 0.010 respectively, application of the relevance criterion effectively reduces these weights to zero.

Mild GBS is classed as those cases in functional score groups F1 or F2, severe GBS refers to cases in functional score groups F3-F5. Values given here are the disability weights corresponding to one year at the stated functional level.

The direct comparisons of disability weights suggest that YLDs due to GBS, ReA, IBD and HUS will decrease. The impact of the new disability weights on YLDs due to gastroenteritis is harder to predict and will depend on relative proportions of cases in the three categories (No GP, GP, hospitalized).

3 RESULTS AND DISCUSSION

A comparison of DALY estimates using the two sets of disability weights outlined in Table 3 is summarised in Table 4. Listeriosis was not included in the Dutch novel disability weights study and no listeriosis estimates are included in Table 4. As the current exercise does not have implications for the variability or uncertainty of DALY estimates, only mean values are listed here.

Table 4: Comparison of DALY estimates using two different sets of disability weights (Haagsma *et al.*, 2008a; Kemmeren *et al.*, 2006)

Disease State	YLL	YLD		DALYs		Foodborne DALYs	
		Old	New	Old	New	Old	New
Campylobacteriosis and sequelae							
GE	30	508	672	538	702		
GBS	18	156*	70	174	88		
ReA		290	145	290	145		
IBD		535	247	535	247		
Total	**48**	**1489**	**1134**	**1537**	**1182**	**863**	**663**
Norovirus infection							
GE	6	530	690	536	696		
Total	**6**	**530**	**690**	**536**	**696**	**210**	**272**
Salmonellosis and sequelae							
GE	46	66	73	112	119		
ReA		27	11	27	11		
IBD		47	22	47	22		
Total	**46**	**141**	**106**	**187**	**152**	**111**	**90**
STEC infection and sequelae							
GE	33	1.0	2.1	34	35		
HUS	26	0.5	0.5	27	27		
ESRD	14	13*	20	27	34		
Total	**73**	**14.5**	**22.6**	**88**	**96**	**34**	**37**
Yersiniosis and sequelae							
GE	29	57	21	86	50		
ReA		7	4	7	4		
Total	**29**	**64**	**25**	**93**	**54**	**52**	**30**

YLL: Years of Life Lost, YLD: Years of Life Lived with Disability, DALY: Disability Adjusted Life Years

GE: gastroenteritis, GBS: Guillain Barré Syndrome, ReA: reactive arthritis, IBD: inflammatory bowel disease, HUS: haemolytic uraemic syndrome, ESRD: End Stage Renal Disease, STEC: shiga-toxin producing E. coli, GP: general practitioner

* Figures vary slightly from the original report (Cressey and Lake, 2007), due to minor corrections.

Revision of disability weights applicable to potentially foodborne diseases has resulted in some changes in foodborne DALY estimates, but only one change in the relative ranking of the diseases, with STEC infection now ranked higher than yersiniosis.

While the revised disability weights do not assign any YLD to mild cases of gastroenteritis, in most cases this is countered by increased disability weights for moderate and severe gastroenteritis cases. In a Dutch recalculation of DALYs, based on the new disability weights, the relative ranking of norovirus infection reduced quite dramatically as they had estimated that only 2% of norovirus cases would attend a GP, whereas for New Zealand the DALY estimate for norovirus infection actually increased with application of the new disability weights, largely due to the fact that an estimated 11% of norovirus cases in New Zealand would attend a GP. For cases attending a GP the revised annual profile disability weight (0.015) was significantly higher than that previously used (0.006 for an annual profile).

There is independent evidence to support the modelled differences in GP attendance rates between New Zealand and the Netherlands. It has been estimated that approximately 22% of people experiencing acute gastrointestinal illness in New Zealand will consult a GP (Lake *et al.*, 2007), while in the Netherlands only 9.4% of acute gastroenteritis cases are estimated to consult a GP (De Wit *et al.*, 2001).

The new disability weights result in a decreased proportion of DALYs being due to sequelae and an increased proportion due to the primary disease, acute gastroenteritis. For example, gastroenteritis now accounts for 59% of the disease burden of campylobacteriosis, compared to 34% under the previous model.

3.1 Impact of Applying a Relevance Criterion

Haagsma *et al*. (2008a) also considered the impact of not applying a relevance criterion. Under this alternative approach, mild cases of gastroenteritis not involving presentation to a GP would have a disability weight of 0.01 (see Table 2, equivalent to mild gastroenteritis for 5 days), rather than a zero disability weight. Applying the same approach to the current New Zealand exercise results in the DALY estimate being dominated by the total number of cases of gastroenteritis. The foodborne DALYs estimate for norovirus infection would increase from 272 to 1670 DALYs, while that for salmonellosis would only increase from 90 to 164 DALYs. The main consequents of such an approach would be the elevation of norovirus infection above campylobacteriosis and yersiniosis above STEC infection.

Foodborne DALYs calculated with and without application of a relevance criterion are compared in Table 5.

3.2 Impact of using Mean Estimates of Disability Weights

The DALY estimates for foodborne diseases presented in the current study are derived through application of the mean disability weight (mean TTO values) determined in a recent Dutch study (Haagsma *et al.*, 2008a). However, median estimates of the disability weight were also determined and the authors of the Dutch study noted that “the benefits of using median TTO values is that the majority rules principle is applied to all health states and not only minimal disease”. In all cases mean TTO values are greater than median values,

indicating that the distributions of responses are right-skewed. There is potential with right-skewed distributions that infrequent high values will leverage the mean value.

DALY estimates were recalculated using median estimates of the disability weight. While the recalculated values were substantially lower than those presented in Table 4, there was no change in the ranking of foodborne diseases. As using median disability weight markedly reduces YLD but not YLL, disease with high mortality rates (e.g. perinatal listeriosis) would be elevated in risk rankings.

It should be noted that using median TTO values automatically results in application of a relevance criterion, as if less than half of respondents are prepared to trade off time to avoid a particular health states then the median TTO will be zero.

Foodborne DALYs calculated using median rather than mean disability weights are compared to other approaches in Table 5.

Table 5: Comparison of foodborne DALY estimates under differing disability weight scenarios

Disease	Mean Foodborne DALYs			
	Old DWs	New DWs		
		Mean DW, RC	Mean DW, no RC	Median DW
Campylobacteriosis and sequelae	863	663	1118	308
Norovirus infection	210	272	1682	92
Salmonellosis and sequelae	111	90	164	54
STEC infection and sequelae	34	37	38	35
Yersiniosis and sequelae	52	30	67	21

DALY = disability-adjusted life year
DW = disability weight, derived from mean Time Trade Off valuations
RC = relevance criterion

The application of disability weights derived from a Dutch panel to the New Zealand population assumes that societal perceptions of disease and healthcare system factors do not influence the derived values, at least in relative terms. For example, there is evidence that gastroenteritis cases are less likely to attend a GP in the Netherlands than New Zealand (De Wit *et al.*, 2001; Lake *et al.*, 2007). The costs of a GP visit appear to be similar in the two countries (Cressey and Lake, 2008; Kemmeren *et al.*, 2006), but there is a lower density of GPs relative to the population in the Netherlands (Norton *et al.*, 2007) than in New Zealand (Atmore, 2004). Whatever the reasons, such health system factors may influence the perceptions of illnesses requiring a GP visit.

The application of the relevance criterion is a novel approach for DALY estimates, which potentially affects the relative risk ranking for New Zealand. It may not be appropriate to apply the relevance criterion in a public health context, where a minor burden for an individual that is trivial for more than half the panel, is nevertheless magnified through large numbers of cases in a national population. In addition, the annualised TTO approach for

short term acute illnesses may not be equivalent to the same approach for longer term illnesses.

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