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Protocol for Direct Costing of Health Sector Interventions for Economic Modelling (Including Event Pathways)

Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme (BODE^3)

Technical Report: Number 12

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We would greatly appreciate any feedback and comments from readers (please email Rachel Foster as per the above email address).

Competing Interests

The authors have no competing interests.

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Glossary

ALOS	Average length of hospital stay Used in calculating casemix funding[1]
AR-DRG	Australian-refined diagnosis-related group (see also DRG) Used in calculating casemix funding[1]
Average cost	The cost per unit of output produced
Average cost-effectiveness	The ratio of difference in costs for an intervention compared to base-case (eg, partial null), to the difference in utility or health consequences (eg, QALYs, HALYs gained) between intervention and base-case. This differs from **incremental cost-effectiveness** in that costs and outcomes are not compared to an alternative intervention.
CC	Comorbidities or complications Used in relation to **AR-DRG**
Coelig	Eligibility for additional copayments Used in calculating casemix funding when the DRG is eligible for the specified copayment[1]
Cost offsets	These are *future* health system costs incurred or averted by an intervention that prevents, or reduces severity of, disease in the future or prolongs life – these costs would not have been incurred/averted without the intervention under consideration Cost offsets are the sum of all future disease and population health system costs (see **Costs: health system**) that are altered due to the epidemiological impacts of the interventions (e.g. reducing future disease incidence, curing people who live longer). These costs may be either positive (additional costs incurred) or negative (cost savings due to costs averted), but for simplicity the term cost offsets is used for both scenarios.
Costs: health system	For BODE^3 analyses, health system costs are the costs *other* than the direct intervention costs that 'routinely' occur for people with given disease or wellness states. Equivalent to S1 and S3 costs using Drummond's framework.[2] The disease health system costs include all health system costs for

	someone with a given disease, which includes both the costs related to the disease of interest and the unrelated health system costs of 'average' comorbidities for someone of the same sex and age. Linked health administrative datasets held by the Ministry of Health (i.e. 'HealthTracker') will generally be the primary source of health system costs.
Costs: intervention (direct)	The costs incurred directly by the intervention under assessment; for instance, those related to implementing and monitoring the intervention, and in some cases also the set-up costs. That is, the (opportunity) cost of resources consumed in the provision of the intervention (c.f. **Cost offsets**) Where the comparator is a partial null or current standard of care, these costs will be incremental to the comparator. For example, the intervention costs of patient navigators is not just that of patient navigators, but the difference in costs for patient navigators compared to whatever pre-existing coordination services were in place in the current standard of care comparator. Where two interventions are directly compared, the cost of each intervention is calculated. In some cases, the direct cost of each intervention (e.g. different chemotherapy regimens) will be only those costs that are additional to a partial null or standard care costs that are the same regardless of the intervention applied and thus do not need to be costed (e.g. care of cancer patients that is not affected by the choice of chemotherapy). The incremental cost difference between the two interventions informs the incremental cost-effectiveness ratio.
Diagnosis-related group (DRG)	DRG codes categorise patient groups with similar clinical conditions and similar hospital resource use. Used in calculating casemix funding[1]
Fixed costs	Costs that are not affected by the quantity of output in the short run (e.g. buildings, equipment)
Health-Adjusted Life-Years (HALYs)	The remaining expected life expectancy, weighted for quality of life or health status. Quality adjusted life years (QALYs) are one form of HALYs. The HALYs used in BODE^3 are the same in principle as a QALY, except: disability weights (DWs) rather than utilities are used to adjust for quality of life; the maximum HALYs that can be awarded for any given sex by age group is not 1.0, but rather 1 minus the

	population morbidity (or pYLD) [Refer to the full BODE^3 Study Protocol[3] for explanation of pYLDs]. DALYs are also a form of HALY, but are usually reserved for cross-sectional or prevalent quantification of a population's burden of disease; economic decision modelling requires prospective modelling of HALYs, streamed into the future. Thus, to avoid confusion with DALYs as measured in a burden of disease study, we use the term 'HALYs gained' rather than 'DALYs averted'. DALYs also tend to measure years of life lost (YLLs) against an external or model life table, not the population's own life table or life expectancy as for HALYs in economic decision modelling.
Hb	High inlier boundary (in days)[1] Used in calculating casemix funding; Hb is the boundary between length of hospital stay that is within inlier bounds (and thus is funded with the standard **md_in** amount), and length of hospital stay that is deemed a high outlier (and thus funded with the **Ho_pd** rate). Hb is normally set at about 3 times the average length of stay (**ALOS)**
Ho_pd	High outlier multiday *per diem* weight[1] • Used in calculating casemix funding for high outliers for all days of hospital stay in excess of the high inlier boundary (**Hb**)
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification
Incremental costs	The difference in costs for an intervention compared to its comparator
Incremental cost-effectiveness ratio (ICER)	The incremental price of obtaining an additional unit of health effect from a health intervention. For cost-utility analysis, the ICER is calculated as the ratio of: • the difference in costs for an intervention compared to its comparator, and • the difference in effectiveness or "utility" (e.g., QALY, **HALY**) between the intervention compared to its comparator For BODE^3 analyses, where the net cost is the sum of intervention cost plus cost offsets, the ICER is calculated as: $$\frac{\text{Net cost}_{intervention} - \text{Net cost}_{comparator}}{\text{HALYs}_{intervention} - \text{HALYs}_{comparator}}$$

Lb	Low inlier boundary (in days) [1] Used in calculating casemix funding; Lb is the boundary between length of hospital stay that is within inlier bounds (and thus is funded with the standard **md_in** amount), and length of hospital stay that is deemed a low outlier (and thus funded with the **Lo_pd** rate). Lb is normally set at about one-third the ALOS
Lo_pd	Low outlier multiday *per diem* weight[1] Used in calculating casemix funding for low outliers with a hospital stay below the low inlier boundary (**Lb**) and of at least 2 days' duration
Macro-costing	Macro-costing uses cost estimates for units of input and output that are large relative to the intervention being analysed. For example, macro-costing uses cost estimates for hospital stays or doctor visits rather than for the procedures and professional time expended during these events[4]
Marginal cost	The additional cost associated with producing one extra unit of output (e.g. one additional patient treated)
Micro-costing	The direct enumeration and costing of every input consumed in the treatment of a particular patient[4]
md_in	Inlier multiday weight[1] Used in calculating casemix funding for inliers with a hospital stay of at least 2 days Cost weight is per event not *per diem*
Mvelig	Eligibility for the mechanical ventilation severity copayment[1] Used in calculating casemix funding when the DRG is eligible for this copayment
Net cost	[Costs: intervention] + [Cost offsets] The final net cost, including both intervention and health system costs. The latter may be either costs incurred or costs averted (cost savings). This should not be confused with incremental cost, where the net cost of one intervention is compared with the net cost of another intervention.
Od	One day weight[1] Used in calculating casemix funding for hospital stay of one day where admission and discharge are not on the same day

Partial Null	To achieve a 'partial null', the costs and health consequences of current interventions that affect the domain of interest are stripped out of the base-case model, but not the costs and consequences of all other health system interventions (in contrast to a true "null"). Unrelated interventions continue to exist but are assumed to have no impact on incremental costs and health effects of the intervention(s) under study.[5] The partial null is appropriate as a comparator when undertaking economic decision modelling about interventions that are currently in place, or are responsible for some of the projected future 'business as usual' scenario.
Sd	Sameday weight[1] Used in calculating casemix funding for same day in-hospital events (admission and discharge on the same day)
Top-down costing	A method of costing where a cost aggregate (e.g. Vote:Health) is broken down by main expenditure categories or for a specific condition
Variable costs	Costs that vary with the scale of output (e.g. personnel)
Weighted Inlier Equivalent Separation (WIES)	A method to adjust DRG cost weights according to categories of length of hospital stay when calculating casemix funding[1]

This is a dynamic document. It is not possible, or desirable, to describe all possible costs that may be included in BODE^3 modelling. As costing is carried out for each intervention modelled within BODE^3, any additional sources or methods used will be added to this Protocol.

1 Introduction

The objective of this Costing Protocol is to provide guidance for determining the direct costs of interventions for cost-effectiveness analyses for the Burden of Disease Epidemiology, Equity and Cost-Effectiveness (BODE^3) Programme.

The intended audience is those undertaking modelling for the BODE^{3}programme; however, others undertaking cost-effectiveness analyses may also find this guide useful to identify the sources available to determine health care costs for New Zealand. If this guidance is used by others outside the BODE^3 programme, please note that information given is specific to the perspective and principles of the BODE^3 programme as outlined in section 2, and may need to be adjusted for different perspectives.

1.1 Background to BODE^3

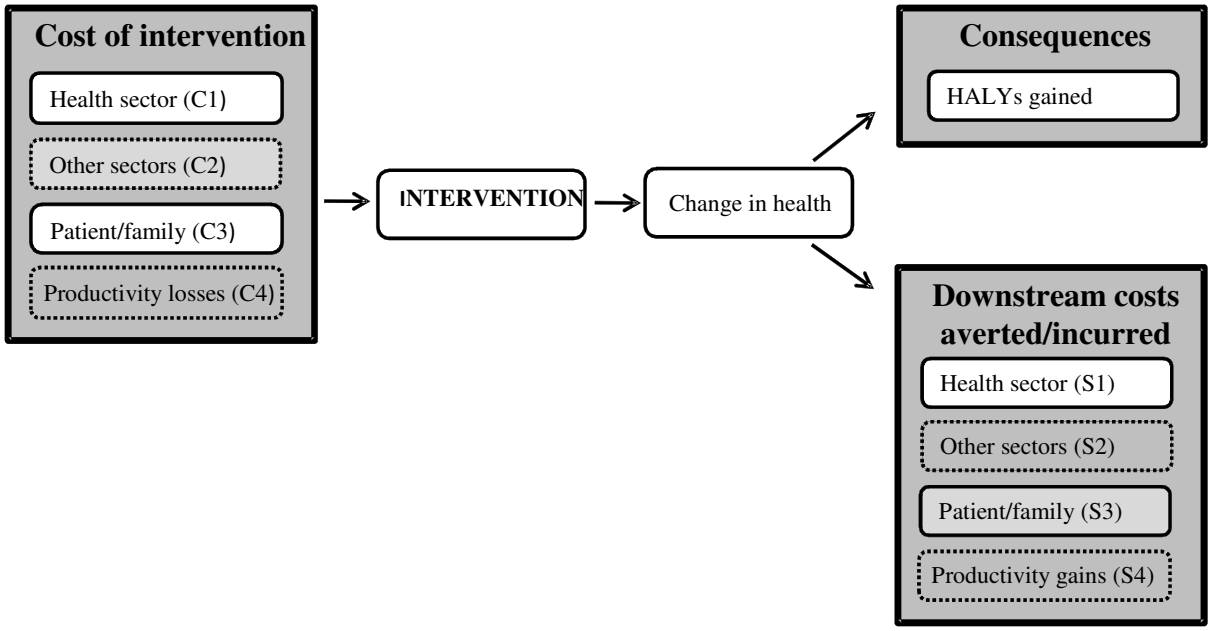
The aim of the BODE^3 programme is to estimate the impact (total & equity-related) and cost-effectiveness of cancer control and preventive interventions using Markov macrosimulation or microsimulation models (e.g. discrete event simulation), multistate life-tables, and/or other suitable models.

The disease impact, measured in Health-Adjusted Life Years (HALYs) gained, is estimated by the way that the intervention of interest changes epidemiological parameters (e.g., incidence of disease and sequelae, disease stage at presentation, mortality and survival rates) when propagated through the BODE^3 models. The morbidity component of the HALY is captured through application of disability weights within the model (refer to the Glossary on page VI for further information on the type of HALY used in BODE^3 modelling). To determine cost-effectiveness, costs include both the direct costs of the intervention and the downstream healthcare system costs that are incurred or averted (referred to as "cost offsets" herein) as a result of the individual receiving the intervention.

The costing is conceptualised by an adaption of the Drummond framework,[2] as demonstrated in Figure 1. BODE^3 will focus primarily on C1 and C3 intervention costs, and S1 and S3 downstream costs averted and incurred, but there may be specific circumstances in which some C2 costs will also be included (see section 2.1.1). Direct costs of the intervention will often be conducted external to the economic decision model, but will at times be generated internally. The opposite applies to cost offsets. Cost offsets are generated as an outcome of the model by capturing the difference in downstream healthcare costs between the general population and the patient population with the disease of interest until death or age 110 years. For instance, if a person lives longer because of an intervention, they will generate both related and unrelated healthcare costs during that additional time lived, but may require less resource-intensive care than if they had not received the intervention. All such costs incurred or averted are included in the cost offsets. The total net cost associated with the intervention includes both the direct costs of the intervention and the cost offsets.

Figure 1: Components of economic decision modelling in BODE^3

Adapted from Figure 2.1 of Drummond et al (2005).[2] Components shaded in white boxes are routinely in scope in BODE^3, and in half-tone boxes are included either as practicable or as scenarios analyses. HALY = health-adjusted life-year.



1.2 Scope of the Costing Protocol

This Costing Protocol relates only to the direct intervention cost component in BODE^3 cost-effectiveness analyses. Cost offsets will be calculated from linked Ministry of Health databases (e.g. Health Tracker) using top-down costing methods as described in the full BODE^3 Study Protocol.[3]

The intent of this protocol is not to identify every possible individual cost and its value, as these will vary widely between interventions, but rather to outline the domains of possible costs and provide some guidance to gathering cost data. That is, identifying: (i) what cost data need to be collected, and; (ii) how and where these cost data can be collected.

This protocol applies primarily to average costs for the "average patient" as suitable for macrosimulation. However, there may be instances in which we will need to take a microsimulation approach, and costing will need to be extended to include the experience of individual patients that may experience the extremes in terms of complications and costs. This may be captured through either higher resource use (i.e. the same unit costs for the cost components of an event but the occurrence of a greater number of events) or greater costs associated with individual events (i.e. higher unit costs for the cost components within an event).

2 Principles of Costing within BODE^3

Costing of interventions in BODE^3 involves 3 basic steps:

- Identifying what costs are to be included
- Measuring the resources consumed (or saved) with and without the intervention
- Valuing these resources

2.1 Identifying what costs are to be included

Which costs should be considered in a cost-effectiveness analysis is determined by the perspective of the analysis and the choice of comparator. BODE^3 adopts a base-case model that is primarily from the health system perspective for determining costs of interventions, including health sector (C1) and patient/family (C3) costs as per Figure 1. A broad interpretation of the types of costs that would be considered under this approach is shown in Table 1.

Table 1: BODE^3 base-case approach to costing perspectives[3]

Component	Further details and comments
Intervention costs	
C1. Health sector	
Government costs to Ministry of Health, DHBs, ACC.	Including disability support and Government-funded proportion of primary care, in/outpatient care, community care etc. Can also include cost of public health programmes (mass media campaigns etc).
Voluntary and NGO costs (e.g. Cancer Society, Heart Foundation)	For example, costs of running a health education or supportive care programme (possibly subcontracted from government). E.g., the Quitline service is provided by a government-funded NGO.
Accommodation costs	Funded by the Ministry of Health under the National Travel Assistance Scheme when a patient requires accommodation in order to complete a treatment or other intervention (e.g. out-of-town patients undergoing chemotherapy).
C3. Patient/family	
Patient/family	Patient copayments and out-of-pocket costs for visits to health professionals, pharmaceuticals and other miscellaneous expenses will be included where substantial and/or practicable.
Direct travel costs	Includes vehicle running costs or transport fares, but not travel time

Exclusions from base-case model	
Patient/family time to participate in interventions and travel	Difficult to assess, for example differentiating time for exercise as a leisure activity from exercise as a health-promoting activity
Over-the-counter (OTC) medications	Included only if a key component of the intervention (e.g. the promotion of OTC purchase of aspirin to reduce cardiovascular or cancer risk)
Alternative health providers	Excluded on the basis that the use of alternative health providers is unlikely to be affected by the presence or not of the intervention being modelled
Minor costs	Minor costs that cannot be easily attained will be excluded if it is considered very unlikely that these costs will contribute significantly to the total cost, and their omission will not substantially bias the results (i.e., not of importance at the margin)
Cost-offsets	
S1. Health sector	Principally Vote:Health (i.e., NZ Government) costs as captured by Ministry of Health databases such as HealthTracker Many of the (likely) smaller S1 costs will be excluded for pragmatic reasons.
S3. Patient/family	Including only the costs that are captured by the Ministry of Health databases, such as average copayments for primary care. However, for pragmatic reasons, many of other potential S3 costs will be excluded.
ACC = Accident Compensation Corporation; DHB = district health board; NGO = nongovernment organisation.	

All set up and ongoing running costs (over and above current practice, unless comparing to the partial null) of the intervention will be included in direct costing, *from the point in time of a decision being made to implement the intervention by Government.* This means that:

- Research and development by universities and private industry are not included (although they may already be factored in the purchase price of, say, a drug)
- Initial training of staff to administer the new intervention is included, and ongoing training of staff is included if it is not absorbed back into 'routine' continuing professional development and staff training. (There is some inescapable arbitrariness here, and thus clear documentation will be required.)

- Additional equipment or other resources needed to implement the intervention will be included.
- The costs of developing and enforcing regulations (say) will be included if the activity post-dates a Government decision in principle to implement a legislative or regulatory change.

Capital costs are included.

A cost may be excluded on protocol grounds (not relevant to the perspective) or practicality grounds (not easily attained) when it is considered very unlikely that it will contribute significantly to the total cost, and its omission will not substantially bias the results (i.e., it is not of importance at the margin). For each intervention studied, identified costs that have been excluded will be specified and justified. The same criteria will be applied to both the intervention and its comparator(s) to avoid bias.

Costs associated with non-adherence will be included. The non-adherence rate is important to the incremental cost-effectiveness ratio because the participants who don't adhere to the intervention would be expected to incur some costs but receive little or no health benefit. Information needs to be sought on the likely subsequent health care costs of non-adherers. In the absence of such information, it will be assumed that the non-adherers incur part of the intervention costs, receive no benefit and have the same subsequent health care costs as those currently not receiving the evidence-based intervention.

Costs for treatment in the private sector will be included. The way in which direct intervention costs for private treatment are incorporated will vary depending on the relevance to the intervention. Where the intervention is performed predominantly in the public sector and a patient would have incurred costs to the public sector if they had not chosen to have private treatment, the public health sector cost will be used. The public health sector cost better represents the true cost of treatment as it does not include the additional profit and likely higher capital and staff costs of private treatment. Furthermore, it is likely that differences in costs between public and private treatment for the same type of event will not be substantially different in real terms across a population because private hospitals tend to treat less complex and thus less resource-intensive cases but apply higher costs per unit of resource, whereas public hospitals will often treat the more complex and higher resource-intensive cases but with lower costs per unit of resource.

2.1.1 Costs outside the base-case scenario

Beyond the base-case scenario shown in the table above, there may be cases in which it is appropriate to assess variations about this scenario. The perspective may be broadened in specific cases where excluding other costs would substantially misrepresent the value of the intervention. The most likely alternative scenario will additionally include "other non-healthcare sector" (C2) costs in analysing preventive interventions. If included, C2 costs will be limited to those for the government, government agencies and NGO costs.

Government costs of a health-related law will be included. From our perspective, the machinery of government becomes part of the health sector when it is focused on passing a health-related law. There may be costs associated with repealing laws and regulations, but this is too complex to consider.

In some cases other government agencies will be considered as working for the health sector on an episodic basis; e.g., when police do road safety work, such as compulsory breath testing for alcohol, which involves personnel time and equipment costs.

The revenue gained from a tax intervention (e.g., higher taxes on alcohol, tobacco or unhealthy food) will not be included in the costs because it is a transfer payment. This is even so for "dedicated" taxes that are specifically returned to the health sector. This is because it is assumed that the overall funding of the health sector will be adjusted down to balance any new dedicated taxes. Similarly, income support payments/benefits are transfer payments and are not included.

Costs imposed on industry from new laws and regulations are generally considered to be outside of scope; e.g., the cost to the tobacco industry of putting warnings on cigarette packs. Drawing the line at including private industry costs is largely a pragmatic exclusion. However, it is debateable. For example, the food industry being forced to change labelling in response to a regulatory change may result in a cost passed on to the consumer. But on the other hand, such costs are minor as packaging is often frequently updated.

The costs pertaining to the enforcement of laws incurred by Government agencies, or funded by Government agencies, will be considered on an intervention by intervention basis. Of note is that sometimes enforcement can be a trivial cost when the social norms have shifted markedly; e.g., the minimal number of prosecutions for breaches of the law on smoking in pubs and restaurants.[6] Some types of enforcement can even be potentially revenue generating (e.g., fines from use of speed cameras). For completely new laws, we will consider the option of the enforcement costs being "fully recoverable" from the fines imposed for breaches of the laws.

Productivity costs will not be included as a rule, but if there is a compelling case for their inclusion in specific analyses they may be included in sensitivity analysis. Similarly, unpaid caregiver costs for time spent caring for the patient are considered out of scope. The primary reason for excluding productivity costs of either the patient or their caregiver is that they are outside of the study costing perspective. However, there are also several problems with including productivity costs. One is that there is disagreement among experts about whether there is an element of 'double-counting' in constructing such estimates (if, for instance, income effects are taken into account in 'health-related quality-of-life' measurements). Also, there is uncertainty about the best way of valuing any 'lost contribution'. If a person is unable to work or prematurely dies due to illness, the actual production loss for society from sickness is likely to be much smaller than the estimated value of potential production lost. If a person is sick, the work may be covered by others or made up by the individual on his/her return to work. If the worker needs to be replaced, a previously unemployed person may fill the vacancy.[2,7] In our view, this strengthens our default position of not including productivity costs.

Other non-economic costs, such as those associated with pain and suffering (so called 'intangible costs') are to some extent captured in the HALY and will not be separately included.

2.1.2 Comparators for costing

The approach to selecting the most relevant comparator(s) may differ between interventions for BODE^3, and will depend at least in part on the anticipated audience. The choice of comparator will affect what costs need to be included. One approach is for 'current practice' to be the comparator,

where any effect of an intervention is assumed to be over and above the cumulative effect of current interventions. This is appropriate to determine the *incremental* cost-effectiveness ratio for interventions that occur in addition to the current array of interventions. However, if current practice is inefficient, this approach can make a new intervention appear unduly favourably cost-effective. An alternative approach, therefore, is to use a 'do nothing' or 'partial null' comparator in which the baseline is stripped back to a scenario in which there are no interventions affecting the domain of interest in place. The 'partial null' approach allows a full evaluation of both current practice and alternative practices by comparing the *average* cost-effectiveness ratios of all options. Additional details can be found in the full BODE^3 Study Protocol.[3]

BODE^3 will use a 'current practice' comparator unless a 'partial null' comparator is justified. Regardless of whether the comparator is 'current practice' or some 'partial null', each intervention must be costed relative to that comparator.

2.2 Measuring the resources consumed (or saved)

Resources should, where possible, be measured in natural physical healthcare units, for instance the number of general practitioner visits or the number of endoscopies performed. Sometimes it is necessary to use data for 'bulk-service' contracts (e.g. laboratory tests), in which case it will be necessary to estimate an "average" number of units covered by the contract. This approach was used successfully in the Ministry of Health (MoH) Price of Cancer[8] report (see section 6.2). For inpatient events funded by the casemix framework (see section 0), the resource unit will be the "package" of services provided under the event code.

Approaches may vary by intervention, but construction of an event pathway is likely to be helpful. The event pathway captures who does what to whom, where and how often (see section 5).

2.3 Valuing the resources consumed (or saved)

BODE^3 aims to measure costs in "opportunity cost" terms; that is, measuring the cost as the value of benefit that is foregone because the resource is not available to be used in its best alternative use. Pragmatically, the opportunity cost will be estimated from the market costs of the resources consumed, as a substitute for full and proper measurement of opportunity costs.[2] Therefore, if 'purchase costs' are more readily available but deviate from the 'market value' (e.g., because of subsidies on GP consultations or pharmaceuticals) the cost should be adjusted to equate more closely to the 'market value' (e.g., by adding the subsidy amount to the 'purchase cost').

BODE^3 will usually treat intervention costs (e.g. C1 and C3) and cost offsets (e.g. S1 and S3 downstream costs incurred or averted) separately, although the distinction does at times become blurred. Intervention costs will primarily be estimated by standard activity costing methods using event pathways and patient flowcharts, but other macro- and micro-costing methods will be used as required. For instance, macro-costing is appropriate for discrete events such as doctors' visits and hospital stays.

Cost offsets will primarily be estimated by a top-down approach, as described in the full BODE^3 Study Protocol.[3] Cost offsets for different socio-demographic strata, disease states and time (e.g. time from diagnosis) will be attached to states within the economic decision model. As an

intervention alters the flow through different health states (e.g. healthy, stable disease, progressive disease), the flow-on costs to the health sector are captured; for example, changes in costs due to prolonged survival or reduction in occurrence of sequelae. Sometimes direct costs of interventions will be modelled this way too, where they can be tied pro-rata to a person at a particular stage of the epidemiological model. But more usually the direct costing will be external to the model.

Average costs will be used for stand-alone, mutually exclusive programmes. Marginal costs will be used as appropriate for scaling up or down of interventions (when there is no substantive change in fixed costs), and for interventions that occur in series. The marginal cost excludes any 'fixed cost' component in the market price of a good or service.[2,4] However, this principle should not be applied too inflexibly. For instance, drug prices often include a substantial R&D component. The 'marginal cost' principle implies that this component should be excluded. In practice it sometimes makes better sense to include this fixed cost as a cost that in any case is recaptured in the market price and still has to be met from health sector budgets.

Ideally, costing of the intervention will be disaggregated by sex, age, ethnicity, and deprivation and disease state. However, this may either be too challenging to implement (e.g., inadequate data) or conceptually erroneous (e.g., where an intervention is developed for the whole population and cannot be divided unequally across individuals).

2.3.1 Year of costing

For BODE^3 modelling, prices will be expressed in 2011 dollars. However, the intervention will be modelled as part of the *current* New Zealand health system structure, i.e. the organisation of health services will reflect current practice. For instance, if a drug has been recently listed on the Pharmaceutical Schedule, but was not listed in 2011, then this drug should be priced as listed on the Schedule with prices deflated back to 2011. Where subsidies on doctors' visit and prescription fees, for example, have changed since 2011, current subsidy levels will be applied. The best quality and most recent sources of cost data should be used, and costs then adjusted to 2011 real cost values, specifically **1 July 2011** (or the 2011/2012 financial year) when possible. Note that future analyses may have different years of costing reflecting the most recent year for which price and cost indices, and other required data (e.g. disease incidence), are available.

Currently New Zealand lacks adequate indices of healthcare costs that include employee remuneration. The default is to use the Consumer Price Index (CPI) to convert data time series to 'real' dollars of a given year (e.g. as done in Health Expenditure Trends in New Zealand[9]). Historically, the health inflator has increased at a greater rate than the CPI in New Zealand. However, with recent strategies to improve health sector productivity, it is not clear whether this trend will continue into the future; our proposed method, therefore, is to just use the all groups CPI (ie, health sector and non-health sector) The CPI 'Health sub-group' index is not useful because it excludes the government subsidy components and has other disadvantages. A properly constructed healthcare cost index will be used for future modelling if it becomes available.

The standard CPI is currently adjusted to a base of 1000 for the June quarter 2006, which gives a CPI of 1157 for Q2 2011. To allow more direct adjustment to 2011 values for BODE^3, we have recalculated the CPI for a base of 1000 in 2011 (Table 2). This was achieved by applying the 2006:2011 CPI ratio (e.g. 1000/1157 for Q2) to each CPI value.

Using the BODE^3 index, it is then possible to adjust to 'real' dollar values for 2011. The index for the year 2011 is divided by the index for the year of interest. For instance, to adjust a 2008 cost to 2011 Q2 values, the CPI adjustment value would be 1000/917 = 1.09. This is then applied to the cost, e.g. an item costing $500 in 2008 would be adjusted to 500*1.09 = $545.25 in 2011 values.

Table 2: New Zealand Consumer Price Index (all groups) by quarter

	Standard (base Q2 2006 = 1000)				**BODE^3 (base 2011 = 1000)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2000	843	849	860	870	736	734	740	751
2001	869	876	881	886	758	757	758	765
2002	891	900	904	910	777	778	778	786
2003	913	913	918	924	797	789	790	798
2004	928	935	941	949	810	808	810	820
2005	953	962	973	979	832	831	837	845
2006	985	1000	1007	1005	860	864	867	868
2007	1010	1020	1025	1037	881	882	882	896
2008	1044	1061	1077	1072	911	917	927	926
2009	1075	1081	1095	1093	938	934	942	944
2010	1097	1099	1111	1137	957	950	956	982
2011	1146	1157	1162	1158	1000	1000	1000	1000
Source: Statistics New Zealand. Consumers Price Index: December 2011 quarter – tables http://www.stats.govt.nz/browse_for_stats/economic_indicators/CPI_inflation/ConsumersPriceIndex_HOTPDec11qtr.aspx More specific data can be obtained from the InfoShare table builder (Economic Indicators: CPI)								

Caution will be required in combining or comparing costs from different time periods where there have been substantial changes in costs between time periods beyond those simply due to inflation or deflation; for instance, a major change in drug price when a generic becomes available, or if the agreed contract price is in dollars of the year of initial agreement and is not permitted to be adjusted for subsequent inflation (e.g. PHARMAC may bind drug companies into 2- or 5-year fixed-price contracts). Additional adjustments may need to be made.

2.3.2 Discount rate

As explained in the full BODE^3 Study Protocol,[3] the default discount rate will be 3% per annum and will be applied to both costs and benefits. Use of this 3% figure will optimise comparisons with existing international work and allows direct comparison with the Australian ACE-Prevention Programme,[10] from which the BODE^3 NZACE-Prevention project is derived. Analyses may include

other discount rates in sensitivity analyses (i.e., definitely 0%, but also at times 3.5%, 5% and/or 7%); PHARMAC and NICE apply a discount rate of 3.5% p.a.

Note that discounting is applied to the costs after adjustment to real values (e.g. after inflation to 2011 values).[3]

(Note: if a *budget impact analysis* is carried out, neither discounting or inflation should be applied.[11] This allows decision-makers to easily study the effect of changes to these rates.)

2.3.3 Annuitisation

Annuitisation will be applied in BODE^3 only when, and if, required. The standard annuitisation formula is [2]:

$$\mathrm{E} = \frac{\mathrm{K}}{(1-(1+r)^{-n})\,/\,r}$$

Equation 1

The equivalent annual cost (E) = capital (K) divided by the annuity factor: $(1-(1+\mathrm{r})^{-n})/r$, where:

E = equivalent annual cost

K = capital (purchase price, initial outlay)

r = interest rate (equivalent to the discount rate)

n = number of years over which capital depreciates (expected working lifetime)

If the item retains some resale value, the equation is modified as follows:

$$\mathrm{E} = \frac{\mathrm{K} - (\mathrm{S}/((1+\mathrm{r})^{n}))}{\mathrm{A}(n,r)}$$

Where:

S = resale value

n = useful life of the equipment

r = interest rate (equivalent to the discount rate)

A*(n,r)* = annuity factor (*n* years at interest rate *r*) = $(1-(1+\mathrm{r})^{-n})/r$

The alternative to annuitisation is to fully cost the capital in the year of purchase. The expected lifetime of the capital item determines when a replacement will need to be purchased. The capital cost is discounted if the purchase occurs in the future. This method may be preferred from an intuitive point of view because it can be more clearly seen when funds have been required for capital.

2.3.4 Overheads

In the context of BODE^3, overheads are those indirect costs that are necessary for running an organisation or programme but have no identifiable products that are consumed by patients/participants.[12]

As a general principle, incremental changes in overhead costs resulting from the intervention will be included in BODE^3 modelling.

The Treasury states that overhead costs should be included in cost-benefit analysis where there is an incremental change in overhead costs resulting from the initiative that causes a significant increase in overheads relative to current organisational funding, but not when there is no significant increase.[13] For instance, an increase of 2 staff from a base of 100 staff is unlikely to result in an incremental change in overheads whereas an increase of 50 staff probably would. Thus, the appropriateness of inclusion of overheads in BODE^3 may vary between interventions.

Our default position is to add overheads equivalent to 50% of the average salary, regardless of incremental change in the type of staff or service. This is an estimate only and may be updated as further information becomes available (e.g. estimations by PHARMAC[7]). For aggregate unit costs, it must be determined whether or not overheads are already factored into the cost; note that inpatient case-mix funding and outpatient purchase units already include overheads. A 50% overhead should be added to salaries calculated separately from aggregate unit costs.

These overheads include on-costs (e.g. superannuation and/or Kiwisaver, ACC etc) and other overheads such as utilities, facilities, maintenance and cleaning, insurance, general equipment (e.g. desk space, computer access, phone, fax etc), support services (e.g. nonpatient administration, IT systems, management , finance and human resources services) etc.[12] However, where an intervention requires investment in specific equipment (e.g. new scanning machines), this will be costed separately as capital (with depreciation as appropriate).

2.3.5 Deadweight costs

Deadweight costs ("excess burden") arise as a net cost to society when an intervention (e.g. a tax, subsidy or other regulatory change) causes a move away from the economy's competitive equilibrium. Deadweight costs will not be included in the BODE^3 base-case models. Our stance is in line with Treasury, who state that whether or not deadweight losses are included in cost-benefit analysis should be decided on a case-by case basis.[13] Deadweight costs are likely to be important where taxes increase substantially to fund a new intervention, but have less (or no) impact where an intervention is funded within the same government budget (e.g. a new programme replaces an existing programme). The base-case modelling for BODE^3 assumes the latter.

Of note, deadweight costs are notoriously difficult to estimate with any accuracy. Rates reported internationally are generally in the range of 15-50%, but can be more than the actual tax revenue in some cases.[14-18] The New Zealand Treasury recommends a default rate of 20%.[13]

Deadweight losses may be optionally considered as a supplementary point for NZACE-Prevention analyses of tobacco or alcohol taxes when calculating the net additional revenue to the government of the tax change.

2.3.6 Administrative costs of taxes

New Zealand has a relatively simple tax system such that marginal changes in administration costs around changes in taxation will be small, and can be ignored in most cases. Data from the UK and Canada report administrative costs of 0.5 to 1% of tax revenue.[19,20] Administration costs will be included only where they are likely to be significant, e.g. the introduction of a major new tax such as taxing saturated fat content of foods.

As noted above, revenue from tax will not be included in costs because it is a transfer payment.

GST must be excluded from all costs because it is a transfer payment.

3 Overview of Funding in New Zealand

As noted in section 2.1, the intervention costs included in BODE^3 include both public and private sector funding. Government costs include those borne by the MoH, DHBs and ACC. Voluntary and non-government organisations (NGO) costs are also included.

Understanding how health funding is structured and the relative contribution of each funding source provides a context for how important each sector is in determining the total cost for BODE^3 models. The latest detailed data available are for the 2009/2010 year.[9] Approximately 80% of total expenditure on health in New Zealand is funded publicly, and the remainder funded privately (see Table 3).

Although almost 1.4 million New Zealanders have health insurance, only 5% of total health expenditure was paid by health insurers in 2009/2010.[9] Given this small proportion, in cases where only public funding data are available, we may be able to simply scale in the additional 5% to account for health insurance claims. Other sources of private funding (e.g. patient out-of-pocket payments [OOPs] or copayments) will also be included.

Table 3: Distribution of funding between public and private sectors in New Zealand 2009/2010[9]

	% of Total Funding	% of Public Funding	% of Private Funding
Public funding			
MoH	72.5	87.1	
ACC	8.4	10.1	
Other[a]	2.3	2.8	
Total	**83.2**	**100**	
Private funding			
Household OOP	10.5		62.5
Health insurers	4.9		29.2
Not-for-profit organisations[b]	1.4		8.3
Total	**16.8**		**100**

a Central government agencies, regional and local authorities

b Organisations such as The Cancer Society, National Heart Foundation, Plunket etc.

ACC = Accident Compensation Corporation; OOP = out-of-pocket payments; MoH = Ministry of Health

3.1 Ministry of Health Funding

Funding through the MoH accounted for 87% of public expenditure (72.5% of total health expenditure) in 2009/2010.[9] The remainder was funded by ACC (about 10% of public funding) and central government agencies and regional and local authorities (2.3%).

Overall, about 80% of Ministry spending is in the form of bulk funding that is devolved to DHBs for purchasing at a local level, while the remainder is directly funded by the Ministry. This split (shown in Table 4) will need to be considered if using DHB funding to estimate a cost, and appropriate scaling should be used if necessary. This will be more important for some domains of costs than for others. Inpatient or outpatient services for curative or rehabilitative purposes are around 90% or more funded through the DHB. However, only 45 to 60% of long-term nursing care in the patient's home or in the community is funded by the DHB, and public health initiatives are more commonly funded directly by the Ministry.

Table 4: Allocation of Ministry of Health spending 2007/2008[9]

Domain	Percentage of total MoH expenditure			Proportion DHB funded (vs direct funded)
	Total funding	Direct MoH funding	DHB devolved funding	
Inpatient				
Inpatient curative/rehabilitative	31.1	2.6	28.5	91.7
Inpatient long-term nursing	8.9	0.9	8.0	89.9
Day care				
Day care curative/rehabilitative	1.0	0	1.0	100.0
Day care long-term nursing	0.8	0.3	0.5	61.2
Outpatient				
Outpatient curative/rehabilitative	23.5	2.4	21.1	89.8
Home care				
Home care curative/rehabilitative	2.4	0.0	2.4	99.7
Home care long-term nursing	8.7	4.9	3.9	44.4
Other				
Medical goods dispensed to outpatients	9.6	0.2	9.4	97.9
Ancillary services	4.3	1.3	3.0	69.1
Total expenditure on personal health care	90.2	12.6	77.6	86.0

Prevention/public health	6.5	4.5	2.0	30.6
Health admin and health insurance	3.4	2.5	0.9	25.4
Total expenditure on health care	100	19.6	80.4	80.4

4 Domains of Costs

The intent of this protocol is to identify what types of costs need to be considered when costing an intervention, and to identify sources for calculating these costs. Costs can be considered within domains to ensure that all relevant costs are included and, just as importantly, that no costs are double-counted.

As discussed in section 2.1, the comparator within the model will determine the extent to which the options need to be costed. The costs included will also be affected by whether average or marginal costs are more appropriate. Average costs will be used for stand-alone, mutually exclusive programmes. The marginal cost excludes any 'fixed cost' component, and is appropriate for scaling up or down of interventions.

4.1 Intervention Domains

Each intervention can be considered in terms of an overarching domain within which it is situated, as shown in

Table 5. Note that some interventions may incorporate more than one domain; for instance, an intervention regarding aspirin for prevention of cancer may include a marketing campaign. In this case, costs for *each* domain need to be included, with careful attention to avoid double-counting.

Table 5: Domains for interventions

Domain	Key characteristics	Key costs	Specific examples
Treatment	Applies to a defined group with specified diagnosis Curative, rehabilitative or palliative treatment	Acquisition and administration costs of the treatment Health professional services (Hospital costs)	- Pharmaceuticals - Palliative radiotherapy
Prophylactic treatment	Applies to an at-risk or general population Preventive treatment	Mechanisms to identify/contact suitable recipients Acquisition and administration costs of the treatment Follow-up	- Polypill - Aspirin for cancer prevention
Diagnostics	Applies to a defined group with a suspected diagnosis	Cost of diagnostic test Follow-up	- Changes in diagnostic protocols with introduction of new treatments
Screening programmes	Applies to an at-risk or general population	Set-up of programme and registry	- CT screening for lung cancer

		Cost of screening test Subsequent referrals Follow-up (Capital investment)	- Colorectal cancer screening
Delivery of Services	Reorganisation of structural processes	Service delivery personnel Administration costs (Capital investment)	- Care co-ordinators - Survivorship care - Palliative community care - ABC targets for smoking cessation - Specialised surgery units
Health promotion programmes	Provision of services within a single (multicomponent) programme	Programme development Service delivery personnel	- Community heart health programmes - Diet and physical activity programmes
Regulatory[a]	Creation of a new law, or alteration of an existing law	Parliamentary time and personnel Policy advice	- Unhealthy food tax - Mandatory salt reduction in processed foods - Alcohol and tobacco taxes - Restrictions on advertising - Restrictions on outlets/supply channels -Product labelling and/or packaging
Enforcement[a]	Strategies to increase compliance with existing laws/regulations	Personnel or equipment for monitoring	- Reducing underage tobacco sales
Marketing and education campaigns[a]	Mass media or targeted	Development of materials Media costs	- Salt reduction/substitution - Pedometer use - Quitline - Tobacco/alcohol - Health promotion (exercise, diet)
a These domains may extend to include C2 (other sector) costs if appropriate (see section 2.1.1).			

4.2 Costs within domains

Within each intervention domain, costs should be categorised into subdomains. Some tabulated examples are shown in Appendix 1: Cost Domains and Sources for Costs. These tables will be added to as experience is gained with costing different kinds of interventions as the BODE^3 project

progresses. The specific costs included will differ between interventions, and each intervention will not necessarily include all of the listed costs. However, the subdomain categories of potential costs can be used as a checklist to ensure that all costs are included, and none are double-counted.

Costs will need to be obtained from various sources (see Section 6). It is essential to understand what components are included in each cost. In particular, which costs already include overheads. For instance, the total cost for visiting a GP (government funding and patient copayment) calculated in section 6.4 covers all costs for the GP practice (e.g. personnel (receptionists, nurses, doctors), overheads, profit etc) so these latter components should not also be calculated separately. Casemix funding for inpatient events already includes overheads (see section 0). In contrast, a cost calculated on salary alone will need overheads added. A cost for a pharmaceutical is not the acquisition cost alone, but must also include pharmacy fees and mark-ups, administration costs etc.

For all costs, the total costs should be calculated, i.e. both the government-funded and privately paid portions (e.g. OOPs or copayments).

Subdomain cost categories for treatment- and diagnostic-based interventions

- Key intervention components
    - Diagnostic and investigational procedures
    - Acquisition and administration cost of pharmaceutical treatment, medical device, surgery, procedure or test
        - Primary treatment/intervention
        - Monitoring of effectiveness/toxicity
        - Follow-up
        - Treatment of adverse events if applicable
    - Aids and appliances
    - Health professional services
        - GP visits
        - Inpatient/outpatient/day patient attendance
        - Rehabilitation
        - Palliative care
        - Specialist appointments (if not incorporated above)
        - Nursing time (if not incorporated above)
        - Emergency services
        - Ambulance services
        - Allied health providers
        - Ancillary services
    - Patient support and care
        - Home care
        - Home help
        - Long-term care in nursing homes
- Personnel costs (administrative and support, where not incorporated elsewhere)
- Overheads, including utilities and facilities (where not incorporated elsewhere)
- Intervention-specific equipment (where not captured in overheads)
- Out-of-pocket payments for patients (e.g. GP fees, pharmaceutical copayments, other self-funded walking aids etc)

- Patient travel and accommodation.

Additional costs may be applicable to preventive treatment to ensure adequate uptake and follow-up:

- Set-up and training costs if applicable
- Marketing and media costs
- Identification and participation of target population.

Subdomain cost categories for programme-based interventions (including screening and health promotion programmes)

- Development and implementation of programme/materials.
- Programme/registry running costs (e.g. administration and support staff)
- Recruitment and training of providers
- Marketing and media costs
- Identification and enrolment of eligible participants
- Key intervention components
    - Advice, consultations, care/services, products etc
    - Screening kits and sample testing (if applicable)
    - Communication of results/progress
- Referral (and possible treatment) of identified cases of disease
- Ongoing monitoring of programme performance
- Overheads, including utilities and facilities
- Marketing and media costs
- Patient travel.

Subdomain cost categories for regulatory-based interventions

- Cost of passing a statute or regulation
- Marketing and media costs
- Enforcement costs
- Evaluation or monitoring of outcomes.

Note that enforcement costs are idiosyncratic; e.g. imposed fines may cover costs of monitoring compliance (see section 2.3 for further discussion of such costs).

For some interventions, additional monitoring may be required e.g., measuring population sodium excretion levels more regularly following an intervention to increase use of salt substitutes. This cost could be determined by taking a proportion of the costs from the latest NZ Adult Nutrition Survey.[21]

For regulatory or programme-based interventions that can be expected to make a change to consumption at a population level, consideration will be given to costs which best reflect production at relatively high levels in order to obtain economies of scale from production. For example, salt substitutes on the NZ market are currently a relatively expensive niche product, while the costs of such products in China are very similar to normal salt.

For modelling complex packages of interventions we will consider extrapolating from cost estimates from countries where the intervention has been successfully used. For example, a salt reduction programme in Finland involved: working with industry, regulations around salt labelling on food products, and a mass media campaign.[22]

5 Event pathways for activity costing

One approach for the direct costing of interventions in BODE^3 is to calculate the costs by applying standard activity costing methods based on event pathways and patient flowcharts, as was done by ACE-Prevention (Australia).[23]

Creating an event pathway for an intervention involves identifying all activities that vary (in nature, intensity, duration etc) between the intervention and comparator. We then define the probability of each event occurring for an "average patient", and how many times each event occurs. Through this process, the resources consumed are identified, and quantity consumed can then be multiplied by the relevant unit cost. The unit of resource may be either a specific item/service or a macro-costing item such a doctor's visit or hospital admission, depending on which is more practical and appropriate to measure

To avoid bias, event pathways (and applied costings) must be constructed in a consistent way for both the intervention and the comparator. As noted previously, for a partial null comparison the scope of events to cost increases. For comparison to "current practice", only those events (and associated costs) that differ between the intervention and the current practice comparator need to be defined. Of note, direct costing of interventions for BODE^3 starts from the "*the point in time of a decision being made to implement the intervention by Governmen*t".[3] Thus, event pathways must also start from this point.

Important aspects of intervention characteristics to be identified "for the average participant" can be conceptualised as "who does what, to whom, when, where, and how often?":[23]

1. *who* (the type of personnel delivering the service or treatment);
2. *does what* (specific technologies used);
3. *to whom* (the target population for receiving the intervention);
4. *when* (the timing of the intervention; whether the service is bundled or piggy-backed with other services);
5. *where* (the site of delivery), and;
6. *how often* (the frequency, intensity and/or duration of the intervention).

A 'patient flowchart' that describes how we get from the target population to those who actually participate in the activities is useful to determine "whom".

The methods for costing each activity will depend on the sources for costs that are available. In some cases, use of outpatient purchase unit costs (see section 6.4) or inpatient case-mix funding (section 0) may be appropriate. These aggregate unit costs include all activities related to the outpatient or inpatient event, such as "hotel" costs for hospitalisation and related capital costs, administration, nursing and physician time, tests and pharmaceuticals (noting that costs of cancer pharmaceuticals are not included). When these aggregate cost units are used, costs for the individual components do not need to be included in the event pathway for costing.

The event pathway should correlate to the domains of costs as outlined in section 4.

An example of an event pathway for the administration of a new anticancer drug is outlined in Appendix 2: Examples of event pathways.

6 Datasets for unit costs and cost aggregates

This section provides guidance to calculating specific costs. The section is arranged by the costing sources available and describes how costs can be derived from them. The tables in Appendix 1: Cost Domains and Sources for Costs list these costs according to the type of cost, and are cross-referenced to the relevant parts of this section.

Uncertainty around costs is covered in section 7. In most circumstances, uncertainty around the amount of resource use rather than the unit cost itself will be incorporated (unless there is good reason to think that the unit cost is unreliable).

6.1 Existing BODE^3 protocols

Separate detailed documents have been written for the following:

- Cost of making a new law
  - Wilson N, Nghiem N, Foster R, Cobiac L, Blakely T. *Estimating the cost of new public health legislation.* Bulletin World Health Organ [e-Publication 8 May 2012].[24]
    - http://www.otago.ac.nz/wellington/otago034147.pdf
  - Includes methods to calculate the average cost of a new act or regulation, and the associated 95% confidence intervals for uncertainty analysis
  - Includes some discussion of enforcement issues.

- Costing of pharmaceuticals
  - *Costing Of Pharmaceuticals In New Zealand For Health Economic Studies: Backgrounder And Protocol For Costing*[25]
    - http://www.otago.ac.nz/wellington/otago025160.pdf
  - Includes background to funding of pharmaceuticals in New Zealand and the role of PHARMAC
  - Includes methods to calculate the acquisition cost of individual pharmaceuticals, with and without patient copayments.
  - See also section 6.7.

6.2 Ministry of Health Cancer Care Price Estimates

In 2011, the Ministry of Health undertook a costing project on cancer using Health Tracker (see section 6.10.1).[8] The report – "The Price of Cancer: The public price of registered cancer in New Zealand" – has a range of unit costs that are potentially of use for BODE^3 modelling. The perspective is that of the Ministry of Health, and thus only those costs paid by the Ministry are included. As much as possible, only costs wholly attributable to cancer are included. The costing year for the MoH report is 2008/2009, so any costs used for BODE^3 will have to be inflated to 2011 values.

Unit costs from this project (after adjustment to 2011 values) can be used directly as cost inputs for BODE^3. The report also presents average costs per patient by cancer site for some items such as lab tests, patient travel, hospice costs etc. Costs are separated for the year before cancer registration and the 5 years afterwards. These average costs can be used directly in BODE^3 modelling if the item is not a key driver of costs; more precision may be required if the item is a key cost driver.

Relevant costs included are:

- Outpatient
    - DHB contracted price purchase units
    - The report provides costs for >30 different cancer-related outpatient services for oncology, haematology, radiotherapy or chemotherapy (excluding cost of the actual chemotherapy drug)
    - Outpatient costs are based on the mean of high and low DHB prices, or the national price
        - National Purchase Unit prices are also discussed further in section 6.4.
    - Also provides average outpatient costs per patient by cancer site
- Community laboratory tests
    - The report provides costs for >150 laboratory tests
    - Costs given are the actual price of the claim, or contracted price divided by the contracted volume for bulk contracted tests
    - Also provides average lab costs per patient by cancer site
    - Other sources for lab costs are given in section 6.8.3.
- Patient travel
    - National Travel Assistance (NTA) Scheme claims, costed as the claim value paid
    - The report provides average NTA costs per patient by cancer site.
    - Unclear whether the costs are for NTA travel only, or also NTA accommodation claims (Note that MoH datasets for NTA claims include both travel and accommodation).
    - Important note: the NTA data in the report include GST – remove GST before using the data.
- Primary care consultations
    - Capitation payment divided by number of consults
    - Cost included health promotion and services to improve access
    - The report estimates an average public price of $31.15 per visit ($34 in 2011 values)
        - This is similar to the BODE^3 calculation of $36.68 (section 6.6.1)
    - Also provides average primary consultation costs per patient by cancer site.

- Hospice costs
    - Costs are based on the operating budget for New Zealand hospices, assuming 90% of people cared for in hospices have cancer.
    - The report provides the mean hospice funding per person with cancer by site for the MoH funded portion, which is 70% of the total cost
        - This can be translated into a cost for BODE^3 by adjusting back up to 100%, and inflating to 2011 values
        - e.g. MoH estimate for hospice care for a patient with colorectal cancer is $2469
            - the total cost is 1/0.7 * 2469 = $3527 in 2008/2009 values
            - total cost $3845 in 2011 values for input into BODE^3.
    - See also section 0 regarding estimations by PHARMAC.[7]
- Private hospital discharge data
    - The report costs private hospitals at public hospital rates (casemix funding; see section 0)
    - The report includes the percentage of cancer care that involves inpatient care in a private hospital, and the estimated cost per patient by cancer site.
    - This can be used for BODE^3 modelling to determine whether private hospital care is a significant factor in costs for a specific cancer, and whether private care requires costing separately from public care.
    - The MoH estimated that private hospital discharge costs are about 5% of the average cost per patient with cancer in the year before and the 5 years after diagnosis;[8] however, this may be an underestimate because it was based on NMDS data and not all private treatment is recorded in the NMDS database.

Further details of the study, including cost sources, are included in Appendix 3: Ministry of Health Price of Cancer Report.

6.3 Inpatient Activity: Casemix Funding

Use of casemix (WIES) funding methods to calculate inpatient costs provides an *aggregate cost unit*. That is, the casemix cost includes all activities associated with the inpatient event, including nursing and physician time, tests and procedures, "hotel" costs (e.g. laundry, cleaning etc), overheads and capital. Costs of pharmaceuticals other than cancer treatments are included.

Casemix funding is based on an agreed price being paid for inpatient activity according to the type of patient and their expected resource use, as categorised by DRG code. Cost weights are calculated by the Ministry of Health for each DRG code, and a Purchase Unit Price is set each year. By applying the cost weight to the Purchase Unit Price, an average cost for the inpatient event can be calculated.

This will be of use in BODE^3 for modelling the *total* inpatient cost of an event that is defined by a DRG code (e.g. NZDRG60: G61B Gastrointestinal haemorrhage without catastrophic or severe complications/comorbidities). However, these costs are not further broken down from the DRG level so it is not possible to cost a specific procedure.

In contrast to the casemix funding model used in Victoria (Australia), New Zealand casemix funding aims to fully cover the inpatient component of an episode of care, other than specific exclusions as outlined in the Casemix Framework.[1] Thus, all costs to the hospital around that inpatient event are included, e.g. capital, overheads, staffing, diagnostics, laboratory tests etc (personal communication, Ministry of Health, 2 May 2012). Inpatient pharmaceutical costs are included *except for PCT oncology-related agents.* Health Workforce New Zealand funding for training is also funded separately, and would need to be costed as a separate item if part of a modelled intervention.

Casemix funding is applied only to admitted inpatient events, including certain same-day admissions, but not to emergency department or short-stay events where the patient is not admitted.

Importantly for BODE^3 modelling, nonsurgical oncology events are often funded through non-casemix Purchase Units.

- Pharmaceuticals funded as part of the Pharmaceutical Cancer Treatments (PCTs) basket are funded through a separate budget line and are not included in the casemix funding (personal communication, Ministry of Health, 2 May 2012). The removal of PCTs from hospital purchase lines occurred on 1 July 2008, and there was no transitional period or double-counting. Costs for PCTs are included in the Pharms database (see section 6.10)
- Same-day/outpatient events for chemotherapy for cancer and radiotherapy are excluded from Casemix Purchasing. However, *inpatient* chemotherapy (excluding the PCT cost) and radiotherapy are funded within the casemix system.
- Certain other procedures, such as some same day colonoscopies, gastroscopies and colposcopies, are also excluded (please refer to the Casemix Framework[1]).

Where casemix funding will not be appropriate for BODE^3 costing of cancer events (e.g. PCT costs, outpatient chemotherapy and radiotherapy, colonoscopies etc) other sources include the following:

- Acquisition costs of PCTs can be obtained from the Pharmaceutical Schedule and adjusted for pharmacy fees etc as described in the BODE^3 "Costing Of Pharmaceuticals in New Zealand for Health Economic Studies" protocol[25] (see also section 6.7).
- The cost of many cancer-related outpatient events can be derived from the Ministry of Health report on the Price of Cancer[8] (see section 6.2) and/or national prices for outpatient purchase unit (see section 6.4).
- Other sources include the MoH National Non-Admitted Patient Collection (NNPAC) database and/or Health Tracker (see section 6.10).

6.3.1 Casemix Funding Background

Overall funding for DHBs is set by the Population-Based Funding Formula. From its budget, the DHB pre-purchases a range of inpatient services from its provider arms (e.g. a public hospital).[1] Most, but not all, inpatient activity is funded using agreed prices determined from casemix methods that calculate the *average* cost of treating that type of patient.[26] The resultant costs account for both fixed costs (e.g. overheads and minimum staffing levels etc) and marginal costs (e.g. the additional cost for each additional patient).

6.3.2 Casemix Funding Methodology

For casemix funding, DRG codes are used to classify patients with similar clinical conditions and similar levels of resource use. A cost weight is attached to each eligible DRG. New Zealand uses Australian refined DRGs (AR-DRGs) derived from the International Statistical Classification of Diseases and Related health Problems, 10th Revision, Australian Modification (ICD-10-AM). As of the 2011/2012 year, AR-DRG6.0 and ICD-10-AM 6th edition codes are used.[1]

The casemix model is further refined to include different cost weights for different length of hospital stay, using Inlier Equivalent Separations:[26]

- Extended hospital stay (high outlier cost weight)
- Average length of hospital stay (ALOS; inlier cost weight)
- Short hospital stay (low outlier cost weight)
- Same day and overnight stay (same day/overnight cost weights).

Funding in this way is called Weighted Inlier Equivalent Separation (WIES). Low and high inlier boundaries (Lb/Hb) of length of stay are set for each DRG. To be funded at the "standard" inlier multiday weight amount (md_in), the length of stay must fall between these boundaries. Note that funding based on the inlier multiday weight is *per event*, not per day of hospital stay. Patients whose length of hospital stay falls outside these boundaries are funded at a different *per diem* rate for those days that fall outside the inlier boundaries (Lo_pd for low outliers and Ho_pd for high outliers). For most DRGs, the boundaries are set to cover a range of length of stay from approximately one-third up to three times the ALOS for the procedure.[1]

Different cost weights are applied for same day in-hospital (Sd) events where admission and discharge occur on the same day, and for one-day hospital events (Od) where the length of stay is one day but admission and discharge occur on different days.

Cost weights are adjusted by copayment for mechanical ventilation within eligible DRGs (mvelig). Note that high outlier payments are made only for length of stay that exceeds the sum of the high inlier boundary plus adjusted mechanical ventilation copayment days (see section 4.4.2 of the MoH Casemix Framework[1]). Additional copayments are made for special types of care: abdominal aortic aneurysm (AAA); atrial septal defect (ASD) stenting; scoliosis implants (Scol), and; electrophysiological studies (EPS).[1]

To calculate the cost, the cost weight is applied to the Purchase Unit Price as set each year by the National Pricing Programme. The standard Purchase Unit Price for the 2011/2012 year is $4567.49 excluding GST.[1] The Unit Price is updated each year. Cost weights are updated approximately every 2 years to reflect changes in costs, clinical practice, technology, policy etc. Information on actual costs submitted by DHBs to the National Pricing Programme helps inform future casemix cost weights and Unit Prices, although there is a timelag of 2-3 years.

6.3.3 Calculation of costs for WIES-funded events (WIESNZ11)

The steps in the final calculation of costs for WIES-funded events is briefly outlined below. The steps provided in the Casemix Framework[1] should be followed. The 2011/12 Cost Weight Schedule (WIESNZ11) is available in Excel from the following website: http://www.health.govt.nz/nz-health-statistics/data-references/weighted-inlier-equivalent-separations/wiesnz11-cost-weights. SAS code is also available.

WIES calculation:

- Identify the appropriate NZDRG, and match to the associated cost weights and other variables in the Cost Weight Schedule
    - http://www.health.govt.nz/nz-health-statistics/data-references/weighted-inlier-equivalent-separations/wiesnz11-cost-weights
    - A copy of the 2011 rates is stored in G:\Data\Direct costs of interventions\Cost resources\Casemix Wiesnz11-final20052011.xls
- Adjust for mechanical ventilation copayment days
    - Refer to section 4.4.2 of the MoH Casemix Framework[1]
    - For most DRGs, mechanical ventilation must be supplied continuously for ≥6h to be eligible for a copayment (indicated by category D for mvelig).
- Adjust for length of stay
    - Refer to section 4.4 of the MoH Casemix Framework[1]
    - Determine if multiday, same-day or one-day rates apply
    - Determine if the length of stay is within the inlier, low outlier or high outlier category
        - Note inlier funding (md_in) is per event, while outlier funding (lo_pd and ho_pd) are *per diem* rates
- Apply cost weights to the Purchase Unit Price
    - $4567.49 for the 2011/2012 year[1]
- Add any other copayments (AAA, ASD, Scol or EPS)
    - Refer to sections 4.4.3 and 4.4.4 of the MoH Casemix Framework[1]
    - Note that these copayments are unlikely to be of relevance to BODE^3.

Abbreviations used are defined in the Glossary of this protocol on page II.

Where an admission is coded by more than one DRG code, the cost per admission should be weighted by the number of discharges associated with each DRG code.

A worked example of how costs would be calculated for BODE^3 modelling is shown in the Box below, using example data from the Cost Weight Schedule (Table 6). For macrosimulation modelling, the "average cost" based on the ALOS and inlier multiday weight (md_in) will usually be sufficient (with adjustment for mechanical ventilation and other copayments if appropriate). High or low outlier costs may need to be calculated for microsimulation modelling to capture costs of extreme cases.

Further help can be obtained from the Ministry of Health at data-enquiries@moh.govt.nz.

Worked example for BODE^3 modelling purposes

Costing for a bladder cancer procedure for modelling, simplified for the "average" scenario with mechanical ventilation less than 6 hours (no mechanical ventilation copayment).

Information in the WIESNZ11 cost weight schedule is replicated in Table 6 for this example, which is based on NZDRG60 code LO3C: *Kidney, Ureter and Major Bladder Procedures for Neoplasm without catastrophic or severe complications*.[1]

For this DRG code, ALOS is 4.64 days, with a low inlier boundary (lb) of 1 day and a high inlier boundary (hb) of 14 days. The inlier multiday weight (md_in) is 2.9924.

If length of stay is anywhere between the low and high inlier boundaries (between 1 and 14 days for this event), the cost will simply be the inlier multiday weight applied to the Purchase Unit Price, plus any copayments

- 2.9924 x $4567.49
- Total = $13,667 plus any mechanical ventilation or other copayments

If length of stay is one day in any scenario, the cost is simply the same day or one day weight (as appropriate) applied to the Purchase Unit Price (plus any copayments).

For high outliers where the length of stay is greater than the sum of the high inlier boundary *plus* adjusted mechanical ventilation copayment days (>14 days in this case), the cost is calculated as follows for an example length of stay of 20 days:

- the inlier portion of stay (up to day 14) is funded as above at $13,667 *plus*
- the *per diem* high outlier rate (ho_pd = 0.2829) is multiplied by the number of high outlier days (length of stay in excess of the high inlier boundary *plus* adjusted mechanical copayment days) applied to the Purchase Unit Price
    - = $4567.49 x (0.2829 x 6 days) = $7753
- Total = $21,420 plus any mechanical ventilation or other copayments

For low outliers where the length of stay is less than the low inlier boundary, the cost is calculated as:

- The one day weight (od) applied to the Purchase Unit Price *plus*
- the *per diem* low outlier rate (lo_pd) multiplied by the number of days from day 2, and applied to the Purchase Unit Price plus any mechanical ventilation or other copayments

Table 6: Examples from the WIESNZ11 Cost Weight Schedule for 2011/2012[a]

All abbreviations are defined in the Glossary on page II

NZDRG60	NZDRG60_description	lb	hb	alos	mvelig	Coelig	day_flag	sd	od	lo_pd	md_in	ho_pd
L03A	Kidney, Ureter and Major Bladder Procedures for Neoplasm W Catastrophic CC	4	37	12.00	D		X	2.2104	2.7158	0.8003	5.9169	0.2490
L03B	Kidney, Ureter and Major Bladder Procedures for Neoplasm W Severe CC	2	24	8.52	D		X	1.8797	2.5236	0.6491	3.8218	0.2134
L03C	Kidney, Ureter and Major Bladder Procedures for Neoplasm W/O Cat or Sev CC	1	14	4.64	D		X	2.0557	2.9924	0.0391	2.9924	0.2829

a The full schedule at http://www.health.govt.nz/nz-health-statistics/data-references/weighted-inlier-equivalent-separations/wiesnz11-cost-weights should be referred to.

CC = complications or comorbidities

6.4 Public versus Private Funding of Hospital Events

The BODE^3 perspective explicitly includes private as well as public funding of health care.

Data on the funding of hospital discharges is available from the National Minimum Dataset (NMDS), which includes data on both inpatients and day patients.[27] However, the private facility data are incomplete because it is not mandatory for private hospitals to report data. Furthermore, some ACC-funded events that are contracted to private facilities are not reported. Nevertheless, it is useful to consider the split between public and private funding from the data available.

In the 2009/2010 financial year, funding of all hospital discharges (inpatient and day patient) was split as follows:[27]

- Public facility, publicly funded 87.8%
- Public facility, privately funded 0.03%
- Private facility, publicly funded 5.8%
- Private facility, privately funded 6.1%

Day case hospital treatment is more commonly funded privately: 4.5% of inpatient events and 9.6% of day case events are funded privately. Around 10% of hospital procedures are funded privately.[27]

There are two possible approaches to incorporating privately paid health care. From an opportunity cost perspective, one can simply assume that the per-patient public cost (e.g. the DHB cost) is a reasonable approximation of the true cost of the event and this cost should be applied to all patients regardless of whether or not an individual patient would seek private care. This would then exclude the additional costs of private care that are not directly related to the event (e.g. profit, higher capital and equipment costs, and better quality non-health services such as food and personal care). This approach will be appropriate for many BODE^3 models where an average per-patient cost is sufficient.

The second approach is to cost private and public events separately. This may be needed where an intervention may cause a significant increase in demand in private hospital care; for instance, privately performed colonoscopies following a positive test from colorectal screening.

When one does not have reliable data on costs for people known to receive all/most of their treatment in public, it may be necessary to inflate the observed public costs to be what it would have been if there was not (unobserved) private expenditures. The relative important of private hospital care varies by diagnosis, as shown in Table 7. Private hospital care is unlikely to have an important impact for calculating costs for cardiovascular disease, respiratory diseases or diabetes. For instance, only 3-4%

of coronary angioplasties and bypass surgery are performed privately.[27] However, for some cancers private care makes up a significant proportion of the costs, especially breast cancer and prostate cancer. Thus, consideration should be given to weighting up public costs for these latter cancers. For instance, 28.5% of prostatectomies are performed privately,[27]suggesting a weight of 1/(1-0.285) – although care will have to be taken to allow for the modest amount of private expenditure already captured in HealthTracker.

Table 7. Hospital discharge rates for selected diagnoses 2009/10 (inpatient and day stays; age-standardised rates per 100,000 people)[27]

Diagnosis	Public	Private	Proportion private (%)
Cancer			
Total	830.2	39.4	4.5
Stomach	13.7	0.2	1.4
Colorectal	66.1	2.1	3.1
Lung	47	0.7	1.5
Melanoma	23.6	0.9	3.7
Breast	49.4	7.1	12.6
Cervical	7.5	0.1	1.3
Prostate	30.6	18.1	37.2
Cardiovascular			
Hypertensive diseases	19.9	0.5	2.5
Ischaemic heart disease	383.9	9.5	2.4
Other heart diseases	395.8	6.7	1.7
Cerebrovascular diseases	136.2	2.8	2.0
Other			
Diabetes mellitus	215.0	3.2	1.5
COPD	187.3	1.1	0.6
Chronic lower respiratory tract	457.6	2.2	0.5
Pneumonia and influenza	324.3	3.2	1.0

6.5 Purchase Units for Outpatient Activity

Use of Outpatient Purchase Unit methods to calculate outpatient costs provides an *aggregate cost unit*. That is, the Purchase Unit cost includes the activities associated with the outpatient event, e.g. nurse and physician time, administration, overheads and capital. The description for the Purchase Unit provides details about what procedures are included in the cost. Costs for cancer pharmaceuticals must be calculated separately.

The National Pricing programme (a joint programme between DHBs New Zealand and the MoH) has set national prices for Purchase Unit prices for outpatient activity. The national prices reflect the interdistrict flow price, i.e. the price charged when a DHB provides a service for a patient from another DHB.

Outpatient activity is categorised by Purchase Unit Code, which is described in the Outpatient Purchase Unit Data Dictionary (refer to version 16.1, 1 July 2011, available from: http://www.nsfl.health.govt.nz/apps/nsfl.nsf/pagesmh/462 and also stored G:\Data\Direct costs of interventions\Cost resources). The data dictionary contains important information on what is included and excluded within the code.

The code can then be matched to the national price in the file on the G drive (G:\Data\Direct costs of interventions\ Cost resources \Outpatient Purchase Unit Final National Prices.xls). Costs exclude GST and include overheads. Note that national prices are not available for all codes. Where not available, the average of low and high DHB prices has been calculated for a number of oncology-related outpatient services in the MoH Price of Cancer report (see section 6.2).

Some examples of Outpatient Purchase Unit prices are shown in Table 8.

Table 8: Examples of Outpatient Purchase Units

Code	Activity	Description	Measure	Cost 2011/12	Database
M25005	Gastroenterology - Colonoscopy	Colonoscopy performed as an outpatient or elective day case.	Cost per procedure	$921.30	NNPAC
MS02007	Colonoscopy - Any health specialty	Colonoscopy performed as an outpatient or elective day case regardless of the Health Specialty providing the service, and not provided under any other purchase unit.	Cost per attendance	$978.09	NMDS and NNPAC
S00004	General Surgery - Colonoscopy	Colonoscopy performed as an outpatient or elective day case.	Cost per procedure	$921.30	NNPAC
MS02009	IV Chemotherapy - cancer - Any	An attendance where the purpose is to receive IV chemotherapy treatment for	Cost per attendance	$493.83	NMDS and NNPAC

	health specialty	cancer as defined by the Pharmaceutical Cancer Treatment (PCT) schedule. The specialist may or may not be in attendance. Includes all pharmaceuticals administered during the attendance net of PCT drug cost recovery from Sector Services. Includes day case treatment excluded from CWDs as per definition of WIESNZ. Excludes treatment not for cancer. Note special PU codes for Haematology and Paediatric Services			
M50002	Oncology - 1st attendance	First attendance to oncologist or medical officer at registrar level or above or nurse practitioner for specialist assessment.	Cost per attendance	$617.46	NNPAC
M50003	Oncology - Subsequent attendance	Follow-up attendances to oncologist or medical officer at registrar level or above or nurse practitioner. Excludes chemotherapy and radiotherapy.	Cost per attendance	$420.11	NNPAC
M50005	Oncology - Radiotherapy	An attendance where the purpose of the attendance is to plan for or to receive prescribed radiotherapy treatment. The specialist may or may not be in attendance. Includes all planning and simulation, radioactive isotope implants or treatments, and radiation.	Cost per attendance	$351.07	NMDS and NNPAC
S00006	General Surgery (excl vascular surgery) - 1st attendance	First attendance to general surgeon or medical officer at registrar level or above or nurse practitioner for specialist assessment.	Cost per attendance	$400.95	NNPAC
S00007	General Surgery (excl vascular surgery) - Subsequent attendance	Follow-up attendances to general surgeon or medical officer at registrar level or above or nurse practitioner.	Cost per attendance	$351.67	NNPAC

6.6 Primary Care Costs

General practitioner (GP) visits are likely to be a component of some interventions in BODE^3 modelling. Primary care services in New Zealand are funded by a combination of public funding from capitation-based payments and privately-funded patient copayments (fees). BODE^3 modelling needs to consider total costs (i.e. both government and patient costs). Although capitation funding is not paid on a per-visit basis, this section provides a method to estimate the *average* capitation funding and patient fee per visit by age for enrolled patients.

Note that the total cost is the cost of interest. However, because government costs and patient costs for GP visits are estimated by different methods, the sections below first outlines each component separately, and then combined to estimate the total cost.

Note that the following calculations apply to enrolled patients; costs for casual or after hours visits to GPs other than where the patient is enrolled is discussed in section 6.6.5.

6.6.1 Capitation funding

Under the capitation based payment system, Primary Health Organisations (PHOs) and their associated general practices are paid according to the number of people *enrolled*, not the number of visits made by patients. Age, sex, ethnicity, and deprivation level of the enrolled patients are considered in calculating capitation levels. In general, people need more care when they are very young and as they get older. Also women in their child-bearing years tend to need services more frequently than men.

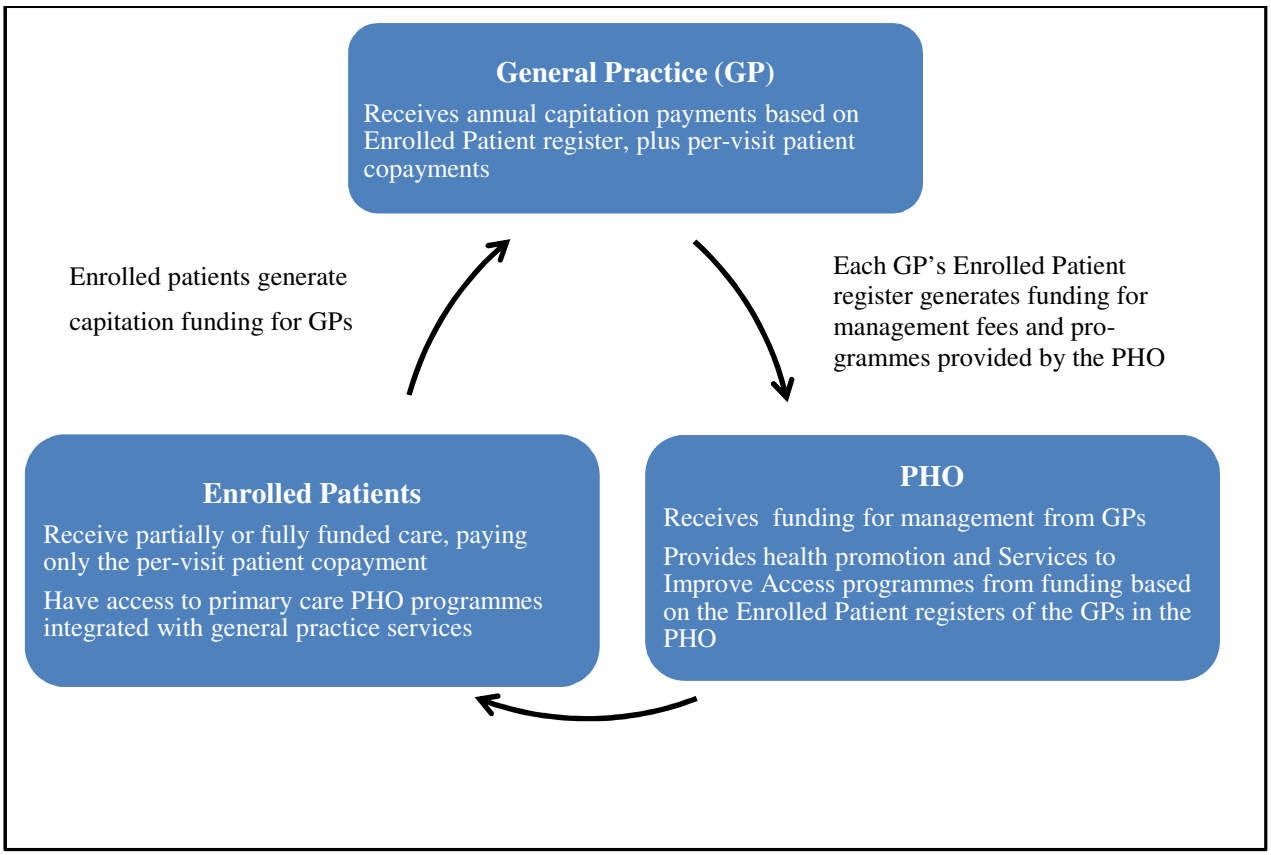
Capitation rates are revised each year and published on the Ministry of health website.[28]

- http://www.health.govt.nz/our-work/primary-health-care/primary-health-care-services-and-projects/capitation-rates
- Use 1 July 2011 rates
- A copy of the 2011 rates is stored on G:\Data\Direct costs of interventions\Cost resources\Ministry of Health Capitation Rates 2011.docx

A general overview of capitation funding is shown in Figure 2.

Figure 2: Overview of capitation funding

Modified from: The ProCare Blueprint (ProCare Health Limited)
http://www.procare.co.nz/PublicSite/media/Documents/ProCare-Blueprint-SHORT-VERSION-as-at-18-March.pdf



6.6.2 Approximation of average capitation subsidies

A template is available from District Health Boards New Zealand (DHBNZ) that has both the average actual capitation payment for 2010/2011 and the average utilisation rate by age band.[29] This provides an approximation of the average capitation subsidy per visit by age band (see Table 9).

- http://www.dhbnz.org.nz/Site/Current-Issues/Annual-Fees-Statement-2011-12.aspx (Open the 2011/2012 DHBNZ copayment adjustment template - Option A 2011l12 link).
  A copy is also stored on G:\Data\Direct costs of interventions\ Cost resources \DHBNZ capitation co-payment adjustment template 2011.xls

The capitation rate cited by DHBNZ closely approximates the 1 July 2011 capitation rates from the Ministry of Health for those without a High-Use Health Card, averaged across males and females, and with no additional access payments, i.e. they represent the average for a general population of males and females who are not high needs and don't have a High-Use Health Card.

As well as the general capitation rate, additional payments based on the Enrolled Patient register are made to cover PHO management fees and health promotion services.[28]

The estimations of total government cost per visit in Table 9 will be adequate for macrosimulation modelling of average costs in BODE[3] where GP visits are not a key cost driver and an average New Zealand population is being considered. Where more precise estimates are needed or the study population has a high proportion of Māori or Pacific individuals or those in high deprivation areas, additional information should be obtained from the Ministry of Health capitation rates schedule (see section 6.6.3 below). The capitation rates differ between adult males and females (e.g. rates are 1.5- to 2-times higher for females than males between ages 15 and 44 years), so the more detailed MoH rates should be used for male- or female-predominant populations. The rates are 1.5- to 5-times higher for those who have a High-Use Health Card. Costs for children aged under 6 years are also best calculated more specifically, as outlined in the following section.

Table 9: Average annual capitation rates for enrolled patients (2011, excluding GST)

Age group	Average no. visits per enrolled patient[a]	Annual government capitation per enrolled patient[a]*	Annual Funding to PHO per enrolled patient[b,c]	Annual total government cost per enrolled patient	Government capitation subsidy per visit[a]	Average total govt cost per visit
Under 6 years	8.47	$335.21	$9.50	$344.71	$39.58	$40.70
6 to 17 years	2.74	$95.78	$9.50	$105.28	$34.96	$38.42
18 to 24 years	2.42	$85.31	$9.50	$94.81	$35.25	$39.18
25 to 44 years	2.44	$80.58	$9.50	$90.08	$33.02	$36.92
45 to 64 years	3.55	$116.26	$9.50	$125.76	$32.75	$35.43
65 years +	6.89	$217.59	$9.50	$227.09	$31.58	$32.96
Average[d]					$33.86	$36.81

a Data from DHBNZ (http://www.dhbnz.org.nz/Site/Current-Issues/Annual-Fees-Statement-2011-12.aspx)

b Data from MoH (http://www.health.govt.nz/our-work/primary-health-care/primary-health-care-services-and-projects/capitation-rates)

c Includes health promotion payment of average $2.50 per year per enrolled patient, and annual management fees of average $7 per enrolled patient.

d Weighted by the proportion of the population in each age group.

* Government capitation rate is the 2010/11 average actual payment for each age band.

6.6.3 Detailed calculation of capitation rates

Capitation rates differ by age, by sex, and for those with and without a High-Use Health Card (HUHC).[28]

- Where a more precise estimate is needed for modelling, it may be appropriate to weight the different capitation rates by the proportion of each category of patient within the study population.
- This will require knowledge of the proportions of males and females by age in the population
- Capitation rates are 1.5- to 5-times higher for those with a HUHC, but only about 1.5-2% of the population have a HUHC.[30]
    - Unless an intervention is targeted to a population that has a high likelihood of HUHC use, it will not be necessary to adjust for the small proportion of HUHC users in the general population when modelling for BODE^3.
- Refer to http://www.health.govt.nz/our-work/primary-health-care/primary-health-care-services-and-projects/capitation-rates
- Use 1 July 2011 rates
- A copy of the 2011 rates is stored on G:\Data\Direct costs of interventions\Cost resources\Ministry of Health Capitation Rates 2011.docx

Calculations will be different for those aged under 6 years. All practices that provide free standard consultations to children aged under 6 years are entitled to additional capitation payments of about $70-$75 per year for their enrolled patients in that age band.[28] In 2011, 85% of GP practices provided free services to the under 6s.[31] Thus, this should be factored in when calculating costs for under 6s.

Additional access payments are paid to improve access and reduce inequalities for high needs populations, defined as Māori, Pacific people and those in NZDep deciles 9-10.[28] These payments are given in addition to the standard capitation payments. Further detail is given below. The specific rates are available from the MoH webpage on capitation rates

- http://www.health.govt.nz/our-work/primary-health-care/primary-health-care-services-and-projects/capitation-rates

Additional capitation is paid to practices that agree to keep their patient copayments very low and within the defined thresholds (Very Low Access payments).[28]

- Maximum fees: 0-5y = free; 6-17y = $11.50; Adults 18+ = $17.
- These are primarily practices that have at least 50% high needs population
- This would likely be included for BODE^3 modelling only if it was an intervention limited to practices with a high proportion of high needs patients.
- Lower patient fees would also be modelled (see section 6.6.4.1).
- If absolute precision was required, it would be possible to calculate from the GP fees spreadsheet (in G:\Data\Direct costs of interventions\Cost resources\ GP_Fees_2011) how many practices have sufficiently low patient fees to qualify for this payment.

- http://www.health.govt.nz/our-work/primary-health-care/primary-health-care-services-and-projects/very-low-cost-access-payments

Services to Improve Access (SIA) payments are paid where approved new services or strategies to improve access and reduce inequalities for high needs people are implemented, e.g. Marae-, church- or community-based health programmes in high need areas, outreach services, etc.

- This additional payment is only likely to need to be included in BODE^3 modelling if the intervention under study is likely to qualify for SIA payment.
- http://www.health.govt.nz/our-work/primary-health-care/primary-health-care-services-and-projects/services-improve-access

The SIA payments would only be relevant to BODE^3 modelling if investigating how a service is funded, rather than for calculating the cost of a GP visit.

Care Plus payments of $244 are made for every patient enrolled in the scheme.[28] It is unlikely that Care Plus payments will be relevant to BODE^3 modelling, unless an intervention is targeted to a population that has a high likelihood of Care Plus use. Five percent of the New Zealand population are eligible for Care Plus, but uptake to 2006 (two years after its introduction) was only about 1.5 to 2% of the population.[30] Care Plus patients are often charged lower copayments (see section 6.6.4.1).

There are also specific payments for administering vaccines and rural incentives.

6.6.4 Patient copayments

The default assumption from DHBs is that capitation contributes 50% of income, [29] while patient fees cover the remainder, but this can vary between individual practices which can set their own patient fees within acceptable limits.

Patient copayments (fees) for 1064 New Zealand medical practices have been compiled by the MoH for 2011 (copy in G:\Data\Direct costs of interventions\Cost resources\ GP_Fees_2011). The summary data are shown in Table 10. Note that these are the *standard* patient copayments charged for enrolled patients and do not include circumstances where a less than standard fee is charged, e.g. for beneficiaries or those with community services cards, or for accident-related consultations partially funded by ACC.

There is a lot of variation between individual practices, and between some DHBs. For instance, in the MoH data, average fees in the Counties Manukau DHB area (encompassing South Auckland, where much of the population has lower socioeconomic status) are around 30% lower than the average, while fees in the Capital and Coast DHB area (Wellington region) are around 15% higher than average.

If the GP fee paid by the patient is not a key driver of costs for an intervention in BODE^3, use of the average cost across New Zealand (shown in Table 10) will be adequate. If GP fees are a key driver, it may be appropriate to calculate costs more accurately, for instance by DHB or PHO, and taking into consideration the exceptions outlined below (section 6.6.4.1).

- Note that the MoH data of general practice fees includes GST – the GST component must be removed for modelling for BODE^3.
- The excel sheet of the data is available at G:\Data\Direct costs of interventions\Cost resources\ GP_Fees_2011
- Data are presented for each medical practice and can be filtered by DHB, PHO, practice name, highest cost, lowest cost etc.

Table 10: Average general practitioner copayments (fees) for enrolled patients by age for New Zealand in 2011[a]

Patient age group	Including GST		Excluding GST			
	Mean	Median	Mean	Median	Max	Min
Under 6 years	$2.16	0	$1.88	0	$36.52	0
6 to 17 years	$22.24	$24.00	$19.34	$20.87	$50.00	0
18 to 24 years	$29.16	$32.00	$25.36	$27.83	$50.00	0
25 to 44 years	$30.51	$33.00	$26.53	$28.70	$56.52	0
45 to 64 years	$30.53	$33.00	$26.55	$28.70	$56.52	0
65 years +	$29.27	$32.00	$25.45	$27.83	$50.00	0
Average[b]	$26.48		$23.03			

a Based on Ministry of Health data for 1064 GP practices

b Weighted by the proportion of the population in each age group

6.6.4.1 Exceptions

There are specific cases where patient copayments are lower than average, and this is compensated for by higher capitation rates (see section 6.6.3):

- 85% of general practices offer zero fees for children aged under 6 years.
- Practices that qualify for Very Low Cost Access Payments must not charge fees of more than:[28]
    - 0-5y = free
    - 6-17y = $11.50
    - Adults 18+ = $17.
- For those enrolled in Care Plus, the mean patient copayment is $6.61 (median $0, range $0 to $42).[30]

6.6.5 Total primary care costs

The total primary care cost is the government funded portion (Table 9) plus the patient copayment (Table 10). This is the cost that will be input into BODE^3 modelling.

The average total cost per GP visit for enrolled patients is summarised by age in Table 11. This estimate is appropriate for macrosimulation modelling where GP costs are not the main cost driver. For more exact estimates refer to sections 6.6.1 and 6.6.4. This cost includes all operating costs for the general practice, e.g. payment of salaries for all personnel (receptionists, nurses, doctors etc), overheads including utilities and facilities etc, and profit.

Table 11: Average total cost per GP visit for enrolled patients by age (excluding GST) [28,29]

Patient age group	Proportion of the population	Mean patient copayment	Government capitation subsidy per visit	Average total government cost per visit[a]	Total average cost per visit	
					Excluding PHO fees and health promotion	Including PHO fees and health promotion
Under 6 years	8.4%	$1.88	$39.58	$40.70	$41.46	$42.58
6 to 17 years	16.2%	$19.34	$34.96	$38.42	$54.30	$57.76
18 to 24 years	10.3%	$25.36	$35.25	$39.18	$60.61	$64.54
25 to 44 years	26.6%	$26.53	$33.02	$36.92	$59.55	$63.45
45 to 64 years	25.2%	$26.55	$32.75	$35.43	$59.30	$61.98
65 years +	13.3%	$25.45	$31.58	$32.96	$57.03	$58.41
Average all patients*		$23.03	$33.86	$36.81	$56.89	$59.84
Average all adults (18+)*		$26.19	$32.98	$36.03	$59.17	$62.22

a Includes PHO management fees and health promotion payment

* Weighted by the proportion of the population in each age group

For direct costs of an intervention BODE^3 makes the assumption that the individual participating in the intervention will attend the GP practice in which they are enrolled. If for any reason this is not expected to be the case (e.g. after hours or casual visits), there is no government subsidy for those aged over 6 years and without a Community Services Card or High-Use Health Card (CSC/HUHC). Thus, the fee charged for a casual or after hours visit can be considered to represent the full cost. Casual/After Hours care for those under 6 years of age or adults with a CSC/HUHC is partly funded by the General Medical Subsidy (GMS): see: http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/general-medical-subsidy-collection.

6.7 Costing of Pharmaceuticals

A useful starting point for costing pharmaceuticals is to obtain the full New Zealand Prescribing Information from Medsafe (http://www.medsafe.govt.nz/profs/datasheet/dsform.asp), which will provide much of the dosage and administration information needed.

The total cost of the pharmaceutical includes:

- the acquisition cost of the medication (including dispensing, pharmacy mark-ups, wastage etc), *plus*
- the costs around administering the medication, e.g. nursing and physician time, monitoring equipment, overheads, hospital "bed costs" if applicable.

6.7.1 Acquisition cost

To calculate the acquisition cost of pharmaceuticals for BODE^3 modelling refer to "Costing Of Pharmaceuticals In New Zealand For Health Economic Studies: Backgrounder And Protocol For Costing"[25]

- http://www.otago.ac.nz/wellington/otago025160.pdf

The primary source of drug cost data is the New Zealand Pharmaceutical Schedule, produced by PHARMAC, which includes cost information on all pharmaceuticals that are subsidised by the government:

- Wholesale price excluding GST
- Level of subsidy
- Prescribing restrictions

The schedule does not include any information on non-subsidised pharmaceuticals; the acquisition cost for nonsubsidised pharmaceuticals can be obtained from MIMS.[32]

The New Zealand Pharmaceutical Schedule is accessed from the PHARMAC website:

- http://www.pharmac.govt.nz/patients/Schedule

Section H that lists (some) pharmaceuticals purchased by DHBs for use in their hospitals, including "Hospital Pharmaceuticals" for which national prices have been negotiated by PHARMAC, is contained in a separate document:

- http://www.pharmac.govt.nz/SectionH

Calculating the total acquisition cost of a pharmaceutical involves inputting the following as per the "Costing of Pharmaceuticals" protocol:[25]

- government subsidy and/or the manufacturer's price
    - with adjustments for rebates if possible
- pharmacy margin on the subsidy and/or pharmacy mark-up on non-subsidised portion
- pharmacy services fee (dispensing fee)
- patient copayment.

6.7.1.1 Dosage calculations

For high costs drugs, the dosage will greatly affect the acquisition cost. The dosage of a cancer drug often needs to be calculated by bodyweight or by body surface area (BSA; m^2).

For cost-effectiveness analysis comparing pharmaceutical agents, PHARMAC recommends that the dose modelled should be that used in key clinical trials; if this dose does not reflect current clinical practice, the latter dose can be used only if there is evidence of efficacy at the proposed dose.[7] PHARMAC recommends that sensitivity analyses should be run for different doses.[7] These recommendations should be applied for $BODE^3$ analyses where pharmaceutical agents are a key component of the intervention. However, where a pharmaceutical agent is included only on the costing side of the equation (e.g. a drug for treating an adverse effect of the modelled intervention, where only the additional cost and not the efficacy is modelled), then it may be more appropriate to base costing on the average dose in clinical practice (possibly from Health Tracker; see section 6.10). Sensitivity analyses for dose will only be needed for $BODE^3$ modelling if the dose is a key driver of the costs and/or the effectiveness.

For $BODE^3$ it is important that any clinical trials used have a patient population similar to that being modelled. Clinical trials will capture where doses have had to be reduced or delayed due to toxicity. These trials may provide information on the mean or median duration of treatment, or the median time to disease progression. This may be more accurate than the scheduled number of doses or scheduled duration of treatment.

If clinical trial information is not available, the following estimates can be used for body weight- or BSA-based dosing:

- The mean bodyweight in New Zealand is 78kg (85kg for men and 72kg for women) for the general adult population (note that this differs by ethnicity and age).[33]
- Australian data suggest that the average weight for adult cancer patients is approximately 72kg (67kg for women and 76kg for men).[34]
- The mean BSA for adult patients with cancer can be estimated to be $1.8m^2$ ($1.7\ m^2$ for females, and $1.9m^2$ for males) on the basis of UK and Australian data.[34,35]

For drugs administered parenterally with single-use vials, wastage according to the vial sizes available must be allowed for, i.e. doses must be rounded up to the nearest vial size. Similarly, any pharmaceutical that comes in a single dispensing unit (e.g. a tube of ointment, inhaler etc) must be costed for the whole unit regardless of how much of that unit is used.

6.7.2 Costs of administration

For most oral drugs (unless administration is supervised), the cost of the drug will simply be the acquisition cost (including dispensing fees, mark-ups etc) and any cost involved in prescribing (e.g. a GP visit to receive the prescription).

For inpatient events, costs of pharmaceuticals are included within the WIES casemix funding except for oncology-related agents (PCTs). Thus, costs for PCTs must be calculated separately and added to the inpatient event WIES cost (see section 0).

The cost of an outpatient IV infusion of chemotherapy can be calculated based on outpatient purchase units, as described in section 6.4. This cost includes nursing time, physician time, the bed cost, overheads etc, and costs for all other pharmaceuticals except for the PCT chemotherapy itself, which must be calculated separately.

Where an outpatient purchase unit price is not available, a "bed cost" for an outpatient infusion has been estimated by PHARMAC,[36] but this estimate does not include the nursing and/or physician time that must be costed (including any preparation or post-treatment monitoring time). Pharmacist time is normally captured by the pharmacy services fee, but should be costed separately if there is likely to be a significant impact on pharmacist time.

Premedication costs and costs for treatment of significant adverse effects (e.g. ≥ grade III events) should be included (note that premedication costs are already captured in the outpatient purchase unit price and WIES casemix funding for inpatient events).

Materials used in the administration of the drug need to be identified and costed *if they are a significant contributor to the cost*. Note that often these costs will not be significant, or will have been captured in either outpatient purchase unit costs or WIES casemix funding if delivered in the inpatient setting. Examples include:

- Infusion material costs
    - Infusion sets, saline or other diluent, filter, swabs etc
    - Some cancer drugs may require special materials because of interaction with the PVC/DEHP of standard infusion sets, and specific diluents rather than saline
- Injection devices (e.g. for insulin) etc.

Lab tests prior to or after treatment should be included if not already included in outpatient purchase unit prices or inpatient WIES casemix funding. For targeted drugs, the costs involved in determining who is eligible for treatment will need to be included, e.g. testing for presence of HER2 receptors before initiation of trastuzumab (Herceptin®) therapy. These costs will apply to all patients who are potentially eligible, not just those who are treated.

6.7.3 Adjustment for change to generic formulation

Where the cost of a pharmaceutical is a key cost drive in a BODE^3 analysis, the change in costs that will occur when the pharmaceutical comes off patent may be included in sensitivity analysis.

PHARMAC recommends that where the patent expiry is expected within 10 years, the analysis should include time to and price reduction of a generic substitute. If patent expiry is >10 years, they recommend use of a conservative proxy (e.g. 25 years until expiry and a 70% price reduction).[7]

6.7.4 Adjustment for inflation

PHARMAC recommends that the price of pharmaceuticals should be deflated by 2% per annum in sensitivity analysis (but not in the base-case analysis).[7] This adjustment acts as a proxy for inflation of prices of other goods because pharmaceutical prices tend to either decrease or remain fixed over time in New Zealand, whereas all other costs tend to increase.

Whether this is appropriate for BODE^3 modelling will be decided on a case-by-case basis.

6.8 Other Specific Cost Sources

6.8.1 Health professionals salaries

DHBs have Multi-Employer Collective Agreements (MECAs) that specify annual salaries for nurses and doctors and can be used to calculate health professionals' salaries as a separate cost in BODE^3 modelling. These costs should be used only where salary costs are not already included in the cost of the item (e.g., casemix funding and outpatient purchase units include all salary costs (section 0 and section 6.4), as do unit costs from the MoH Price of Cancer report (section 6.2)).

The salaries quoted in the MECA are full-time base salaries according to an "ordinary" number of hours work per week. They do not include overtime, call-backs, additional benefits etc. Unless the level of seniority is known, select a median salary scale (see Table 12). The hours and days worked per year must take into account the following:

- Nurses
    - Ordinary work hours 80 per fortnight
    - Annual leave 4 weeks (20 working days)
    - Public holidays 11 days
    - Sick leave maximum 10 days (assume average 5 days)
- House surgeons/registrar
    - Salary scales differ by number of ordinary hours worked; assume average 52.5 hours/week.
    - Annual leave 6 weeks (30 working days)
    - Public holidays 11 days
    - Sick leave maximum 7.5-9 days (assume average 5 days)
- Specialists/senior doctors
    - Ordinary work hours 40 per week
    - Annual leave 6 weeks (30 working days)
    - Public holidays 11 days
    - Sick leave maximum 10 days (assume average 5 days)

The opportunity cost approach should be considered if costing salaries by the hour, and thus the salary should be applied to only productive or clinical activity hours. The number of productive/clinical hours is assumed to 62.5% of each working day, i.e. 5 hours of an 8 hour work day, and excluding annual leave, public holidays and sick leave (see Table 12).

Overheads of 50% must be added to salaries if not already included (see section 2.3.4).

Table 12: Salaries for a range of health professionals for 2011

Position	Grade/step	Annual salary	Salary per hour of productive/clinical time	
			Excl overheads	Including overheads
House surgeon/officer[37]	Category D, year 2	$74,557.00	$52.84	$79.26
Registrar[37]	Category D, year 5	$95,631.00	$67.78	$101.67
Consultant[38]	Grade 10	$173,349.00	$161.25	$241.88
Registered nurse[39]	Step 5	$61,362.00	$54.54	$81.82
Clinical nurse specialist[39]	Grade 4, Step 2	$79,347.00	$70.53	$105.80
Ward Clerk		$40,000.00	$35.56	$53.33

The MECAs are normally updated every 1-2 years. The MECAs for 2011 for nurses, house surgeons, registrars and specialists for 2011 are available from G:\Data\Direct costs of interventions\Cost resources. A spreadsheet to calculate productive/clinical hours is also provided.

6.8.2 Residential Care Costs for the Aged

Total daily costs for residential care have been calculated in the Aged Residential Care Service Review 2010.[40]. The report is presented for 2010 values.

Data were collected by surveying New Zealand rest homes. Additionally a model was developed of an efficient, fully modernised facility. Average bed occupancy was 91% for rest home, 93% for hospital and 96% for dementia beds; the model assumed 93% occupancy as the average.

Costs are shown in Table 13. The operating costs include: patient care, catering, cleaning, laundry, property and maintenance and administration. Total costs include operating costs and capital charges (including depreciation and return on investment). Capital charges were calculated for a land price of $200, $350 or $500 per m^2; the costs in the table are shown for $350 per m^2, with the range representing $200-$500 per m^2. It was not stated whether these costs are inclusive or exclusive of GST, but given the methodology costs are assumed to include GST.

Note that the total costs are slightly higher than those estimated by PHARMAC (section 0), but unless residential care is an important cost driver in a $BODE^3$ intervention, the difference is not likely to be important.

Table 13: Daily residential care costs for the aged (2010, including GST)[40]
Costs are per resident per day; the costs in the table are shown for land price of $350 per m^2, with the range representing $200-$500 per m^2

	Rest home care	Hospital care within residential home	Dementia care
Operating costs			
Average in survey	$81.90	$134.77	$108.21
Model of efficient care	$78.70	$126.60	$104.25
Total costs			
Model of efficient care (2010, incl GAT)	$155.31 ($148.33–$162.30)	$203.21 ($196.23–$210.20)	$180.86 ($173.88–$187.85)
Model of efficient care (adjusted to 2011 values and exclusive of GST)	**$142.16** ($135.77–$148.56)	**$186.00** ($179.62-$192.40)	**$165.55** ($159.16-$171.95)

6.8.3 Laboratory Test Costs

There are several sources for laboratory test prices:

- The MoH Price of Cancer Report
  - see section 6.2
- DHB prices from Waikato DHB
  - http://www.waikatodhb.govt.nz/lab/
- DHB prices from Auckland DHB (LabPLUS)
  - http://testguide.adhb.govt.nz/EGuide/?elv=1&name=LabPLUS%20Price%20List&pn=5057&mn=1478&sd=3&ts=12da0febddb
- Commercial price from Labtests
  - http://www.labtests.co.nz/index.php?option=com_wrapper&view=wrapper&Itemid=219
  - These are the prices *charged* if the patient is not eligible for Auckland DHB funding, and appear to be inflated to cover overheads, profits etc. For instance, the Waikato DHB price for a complete blood count is $9.24 (excl GST), while the Labtests cost is $22 (incl GST). In most cases, the DHB or MoH cost will more appropriate for $BODE^3$.
- Canterbury Health Laboratories
  - http://www.labnet.health.nz/testmanager/

6.8.4 Ambulance Charges

St John and the Wellington Free Ambulance operate as charities. Government funding, through ACC and DHBs, covers about 80% of ambulance operating costs (http://www.wfa.org.nz/youcanhelp.htm and http://www.stjohn.org.nz/products/ambulance.aspx). The remainder is primarily obtained from sponsorship, fundraising, donations and, in the case of St John, part charges.

BODE^3 aims to capture the market cost of use of an ambulance service, which would include government funding, part charges and other funding. The closest approximation of this is non-funded private hire charges for St John ambulances, which are described as the "full charges". These charges for 2011 were $145 for a trip less than 35km; beyond that, trips are per km, e.g. a 100km would cost $410 (refer to 2011 St John price schedule in G:\Data\Direct costs of interventions\Cost resources).[41] A minimum of $615 is charged to non-eligible visitors. Note that these charges will include GST, which must be removed for BODE^3 modelling.

The government cost can be approximated as 80% of these charges. If we wish to capture patient OOP alone, part charges for St John in 2011 were $46-$74 (including GST) depending on location.[41].

It is unlikely that ambulance costs will be a key cost driver in BODE^3 analyses, so the above approximations should be adequate in most circumstances.

6.8.5 Cost of Travel

The private cost to individuals of travel associated with an intervention is included in BODE^3 (note: the time cost of travel is not included). We incorporate only the marginal cost of this travel, i.e. the additional cost for the extra intervention-related travel. As such, fixed costs (e.g. depreciation, licensing, insurance) are excluded.

For BODE^3 costing purposes, the Ministry of Health mileage reimbursement rate for private vehicles under the National Travel Assistance (NTA) Scheme can be used as an approximation of the cost for private travel. This rate was 28c per kilometre for 2011.[42] This rate can be considered to cover the "running costs" for private vehicle usage. It corresponds closely to the New Zealand Automobile Association (NZAA) estimation of running costs, which includes petrol, oil, tyres and repairs/maintenance costs, but not fixed costs. Other forms of transport (buses, trains, taxis, ferries, planes etc) are reimbursed under NTA at the actual cost (note that this includes GST, which must be removed for BODE^3 modelling).

As a default position, BODE^3 will estimate the average number of kilometres travelled by patients in the group of interest and apply a cost of 28c (24.50c excl GST) per kilometre. This same rate will be applied regardless of the method of travel that might be used in reality as it would not be feasible to determine how each patient would choose to travel. The distance is calculated as the distance travelled by road from the population-weighted centroid point of the patient's Census Area Unit to the nearest appropriate treatment centre within their DHB catchment area. The number of patients in each Census Area Unit is derived from the New Zealand Cancer Registry or other patient registries. This information is then combined to determine an average distance travelled per patient. A travel cost will be applied to all patients, not just those who are eligible for NTA. Knowing the proportion of patients who are eligible for NTA versus those who pay out of their own pocket for travel will be necessary only if we need to separate government-funded travel from patient-funded travel.

The Ministry of Health has calculated the average travel costs (from NTA claims) per patient by cancer site (see section 6.2). Note that these values include GST, which must be removed from the costs for BODE^{3}modelling.

6.8.6 Accommodation

Accommodation costs may be important for BODE^3 modelling when comparing interventions that require different frequencies of hospital attendance (e.g. weekly paclitaxel versus 3-weekly docetaxel).

Accommodation is funded by the Ministry of Health under the National Travel Assistance Scheme for generally only those people who meet the NTA eligibility criteria and live more than 100km one-way from the facility.[42] The reimbursement rate is the actual cost up to a maximum of $100 (including GST) per night for staying in accommodation.

Up to two night's accommodation is funded for each outpatient or day-stay visit for which the patient must arrive the day before, or if they cannot feasibly return home in the same day. Patients requiring long stays near to a hospital are also funded.

For BODE^3 costing , we will include accommodation costs for all patients living more than 100km from the closest treatment centre. To cost this, we will determine the proportion of patients who live in Census Area Units >100km from the treating hospital and apply a cost of $100 ($87 excl GST) per night for this proportion of patients. We will not include accommodation costs for support/carers, in line with the BODE^3 perspective that excludes caregiver costs.[3]

6.9 PHARMAC Unit Costs for non-pharmaceutical costs

This section refers to unit costs for healthcare services that have been estimated by PHARMAC for use in their cost-utility analyses and are cited in the "Prescription for Pharmacoeconomic Analysis: Methods for cost-utility analysis"[7] and the accompanying costing manual.[36] Methods to cost pharmaceuticals are covered in section 6.7.

The PHARMAC perspective is that of the funder, including costs to government (i.e. impact on the health budget) and direct patient healthcare costs. The unit costs from PHARMAC are *proxy costs* estimated for use in their cost-effectiveness analyses, and are expected to be updated over time.[7,36] If not available from other sources, these costs may be used directly in BODE^3 modelling after inflation or deflation to 2011 values. The costs given exclude GST. Unless stated otherwise, costs include overheads.

The types of costs that have been estimated are shown in Table 14, although this may be updated by PHARMAC over time.

Table 14: Types of unit costs estimated by PHARMAC[7,36]

Item	Comments
Hospitals, hospices and residential care	
Rest home per day	National average cost from MoH Includes overheads and patient care (e.g. nursing and physician time)[a,b]
Dementia care per day	
Hospital care for health of older people (within a residential care facility) per day	
Hospice care per day	Average across various hospices for 24-hour stay. Includes overheads and patient care (e.g. nursing and physician time)[a]
Hospital ward per day	Average across various hospitals Includes overheads and patient care (e.g. nursing and physician time)[a]
Bed cost for outpatient infusion per hour	Average across various hospitals. Note that this is the bed cost only: other costs such as nursing, specialist or pharmacist time, pharmaceutical costs etc must be added.
ICU per day	Average across various hospitals Includes overheads and patient care (nursing and physician time)[a]
Emergency roo7m per visit	

Item	Comments
Specialists (includes overheads)	
Private: Initial specialist consult	Based on private specialist charges averaged across specialties (Southern Cross)
Private: subsequent specialist consults	
DHB: specialist hourly rate	DHB collective agreement (MECA) Note: MECA of annual salary for specialists, registrars and house surgeons is available at G:\Data\Direct costs of interventions\Cost resources
Nurses (includes overheads)	
Practice nurse visit per consult	Charges from PHO websites. 10-15 minute visit at doctor's surgery
Home practice nurse visit	Based on two practice nurse visits
Hospital nurse per hour	DHB collective agreement (MECA) Note: MECA of annual salary available at G:\Data\Direct costs of interventions\Cost resources
Community health services nursing	
GPs (includes overheads)	
GP practice visit total cost	From MoH data: includes both government capitation payment and patient copayment Calculated for a normal consult of 10-15 mins – a long consult (e.g. 20-30mins) would be approx. double
GP home visit	Average from various GP practices Includes overheads and travel time for GP
Hospital pharmacist (includes overheads)	
Hospital pharmacist per hour	Auckland DHB collective agreement
a Personal communication PHARMAC, 28 June 2012	

6.10 Ministry of Health and Linked Databases

The Ministry of Health collect a large amount of data that are potentially useful for determining actual costs in New Zealand. The utility of these databases for direct costing in BODE^3 will be established as we seek out specific data. To obtain useful data, the population for whom costs are required must be carefully defined. The list below is not exhaustive: more information can be found at: http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections.

- **National Minimum Dataset (NMDS)**
  - http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/national-minimum-dataset-hospital-events
  - NMDS collects public and private hospital discharge information, including coded clinical data for inpatients and day patients
  - It is not mandatory for private hospitals to report data; some, but not all, private facilities do report.
    - DHB-funded events that are sub-contracted to private facilities are usually reported by the DHB involved
  - Some ACC-funded events that are contracted to private facilities are not reported
  - As of June 2012, only data to 2010 can be considered complete (personal communication, Chris Lewis, Ministry of Health, 9 July 2012).
    - Data tend to be more complete for medical and surgical events.

- **National Non-Admitted Patient Collection (NNPAC)**
  - http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/national-non-admitted-patient-collection
  - NNPAC includes event-based purchase units that relate to medical and surgical outpatient events and emergency department events
  - NNPAC is used for the calculation of Inter District Flows (IDF) which are used for cross-DHB payments when patients are treated outside their own DHB area; IDF prices are set nationally to reflect the average cost of the service across all DHBs (see section 6.4)
  - Implemented in 2006.

- **Pharmaceutical Information Database (Pharms)**
  - http://www.health.govt.nz/publication/pharmaceutical-information-database-data-guide
  - Pharms is a data warehouse that supports the management of pharmaceutical subsidies. It is jointly owned by PHARMAC and the MoH.
  - It contains claim and payment information from pharmacists for subsidised dispensings that have been processed by the Sector Services.
- Primarily it includes pharmaceuticals from section B of the Pharmaceutical Schedule (i.e. Community Pharmaceuticals and PCTs):
    - PCT chemotherapy drugs have been included since 1 July 2008, regardless of whether used in the community or in hospital
    - Most other pharmaceuticals dispensed in hospitals are not included (note that costs for pharmaceuticals used in hospitals other than PCTs are included in

WIES casemix funding for inpatient events and purchase units for outpatient events)

- The Pharmaceutical Collection was started in 1 July 1992; as of Feb 2011, it holds claims for over 477 million scripts.

- **Laboratory Claims Collection (Labs)**
  - http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/laboratory-claims-collection
  - Labs contains claim and payment information for community laboratory tests, and allows the Ministry of Health and DHBs to monitor the primary care test subsidies.
  - It contains information for laboratory tests that have been processed by the Sector Services General Transaction Processing System (GTPS), and from Pegasus and Medlab South IPA providers.
  - The Labs collection was established in 2000 and contains data from July 1997.

6.10.1 Health Tracker

A related recently developed tool is Health Tracker, which allows health care events to be linked through all of the Ministry of Health databases that use (encrypted) NHI numbers. The only costs included are Government costs (i.e. Vote:Health costs), and most are from claiming data where the Ministry of Health pays for the service.

Health Tracker currently includes the following databases:

- National Health Index (NHI)
- National Minimum Dataset (NMDS; hospital events)
- National Non-Admitted Patient Collection (NNPAC; outpatient and emergency department events)
- General Medical Subsidy Collection (GMS)
- Laboratory Claims Collection (Labs)
- Pharmaceutical Collection (Pharms)
- National Travel Assistance Claims
- Mortality Collection
- New Zealand Cancer Registry
- Primary Health Organisation Enrolment Collection
- [Programme for the Integration of Mental Health Data (PRIMHD; replaces Mental Health Information National Collection (MHINC))]
- [National Immunisation Register]
- [SOCRATES (disability needs assessment)]

Relevant Costing data in Health Tracker includes:

- hospital costs paid by the Ministry or DHBs (casemix cost weights)
- outpatient costs (contracted purchase units)
- GP visits (average capitation cost only, using enrolled capitation costs and population-based funding formula according to ethnicity, NZDep, sex and age)
- general medical subsidy for visits to GPs outside of enrolled PHO

- emergency department triage level contracted purchase unit cost for event (costs differ by seriousness of presentation)
- community pharmacy, and more recently hospital pharmacy costs (excluding non-subsidised medications)
- lab tests funded by Vote:Health
- NTA travel and accommodation.

Within Health Tracker, indicators (e.g. indicating a particular health condition or use of a particular health service) are attached to each person identified by an (encrypted) NHI number. Costs for particular groups of people can be identified by using health condition or service use indicators together with cost indicators. Using the encrypted NHI numbers, health care events can be tracked 'cross-sectionally', within a given year or other time-period, or 'longitudinally' linking to NHI numbers for earlier years in which NHI coverage was reasonably complete. Alternatively, for cancers, links can be made to the year in which the patient was diagnosed with cancer and was added to the Cancer Register Tracker tool (or its component databases) are expected to be the main tool for calculating cost offsets, but it will also prove useful for direct costing for $BODE^3$.

6.11 Data directly from PHOs, DHBs and other funded bodies

Many of the cost-effectiveness analyses that have been conducted in New Zealand have used cost data supplied directly by DHBs or hospital finance departments (see section 6.13). This may prove to be a useful avenue for determining specific costs for $BODE^3$, but the information required will be intervention-specific and should be sought as required.

6.12 WHO-Choice Unit and Programme Costs

As part of the World Health Organization CHOosing Interventions that are Cost Effective (WHO-CHOICE) project, country-specific unit and programme costs have been developed.[5,43,44] These estimates are somewhat generic, but may be of use for BODE^3 modelling if other NZ data sources do not seem adequate, and/or to validate our estimates.

6.12.1 Country-specific unit costs

Unit cost values for primary and secondary healthcare services have been estimated for 191 member states:

- http://www.who.int/choice/country/country_specific/en/index.html.

Estimates were updated in 2011 but are still presented only for base years of 2007 and 2008.

New Zealand-specific data (2008 values) are as follows:

- Cost per hospital day: $510-$688
- Outpatient hospital visit: $73-$75
- Health centre visit $52

WHO-Choice describes these as 'average' values of unit costs for the country, based on specific assumptions regarding the organisation of health services and operational capacity. The values represent costs for public facilities operating at 80% capacity level. Outpatient facilities are assumed to be in an urban area. All costs exclude drugs and diagnostics. Inpatient care costs represent only the "hotel" costs (e.g. personnel, capital and food costs).

The weakness of these WHO-Choice estimates is that they are not derived directly from New Zealand costs. An econometric model used data collected across a number of countries to predict unit costs for countries for which data were not available.[44] Of the 1171 observations used, only 4 were from New Zealand.[5] The updated regression model for inpatient costs was adjusted for: GDP per capita; occupancy rate; average length of stay; total number of inpatient admissions, and; type of facility (public or private, and hospital level (i.e. general district hospitals versus major hospitals with specialist capabilities)).[45] The updated regression model for outpatient costs was adjusted for: GDP per capita; total number of outpatient admissions; number of visits per provider per day; urban location, and; type of facility.[45]

Due to the lack of specificity to New Zealand of the WHO-Choice estimates for patient care, estimates available from other local sources (as outlined in the other subsections of section 6), are preferred.

6.12.2 Price of Programme Cost Inputs

The World Health Organization (WHO) has developed a useful method for costing the implementation of health sector programmes (i.e., the "WHO Choice" model http://www.who.into/choice/costs/prog_costs_intro/en/index.html (see also Johns et al 2003[46]). This approach is bottom-up and considers various inputs such as personnel time and resources to generate a new programme at a national or more local level. It has been used, for example, in costing the implementation of mandatory legal interventions for reducing salt in food[47] (including by ACE-

Prevention Australia[48]). Other selected examples of the use of WHO Choice costing data (of potential interest to NZACE-Prevention) include:

- Cost-effectiveness of breast, cervical and colorectal cancer screening in sub-Saharan Africa and South East Asia.[49]
- Prevention, screening and treatment of colorectal cancer: a global and regional generalized cost effectiveness analysis.[50]
- Cost effectiveness of strategies to combat cardiovascular disease, diabetes, and tobacco use in sub-Saharan Africa and South East Asia.[51]
- Intervention strategies to reduce the burden of non-communicable diseases in Mexico: cost effectiveness analysis.[52]
- Cost-effectiveness analysis of interventions to prevent cardiovascular disease in Vietnam.[53]
- Costs, health effects and cost-effectiveness of alcohol and tobacco control strategies in Estonia.[54]

Published literature relating to the "WHO Choice" approach has explored the prices of selected "non-traded" intermediate inputs into health programmes (e.g., printed matter and media advertising, and water and electricity).[55] But this work does not estimate costs for New Zealand or Australia, though it does for two other English-speaking countries (Canada and the United Kingdom).

A WHO Choice systematic review on the scaling up of interventions has also been published.[56] This review found that the costs of scaling up an intervention are specific to both the type of intervention and its particular setting. Nevertheless, general principles were:

1) calculate separate unit costs for urban and rural populations;
2) identify economies and diseconomies of scale, and separate the fixed and variable components of the costs;
3) assess availability and capacity of health human resources; and
4) include administrative costs, which can constitute a significant proportion of scale-up costs in the short run.

None of the studies included in this review were from New Zealand, but there was an Australian and also a Canadian study.

The WHO Choice website has information on prices for "local non-traded goods" as follows:

- Personnel Costs (health workers, administration, finance, lawyers, police, computing/IT, logistics, transport, media, maintenance, buildings etc).
- Media and Information, Education and Communication (IEC) Operating Costs (at national, provincial and regional levels for: TV, radio, newspapers, posters and flyers).
- Transportation Operating Costs
- Utilities
- Other Costs
- Building Capital Costs
- Transportation Capital Costs

None of these costs are calculated specifically for New Zealand, but rather for the "WPRO-A" Region (which includes the following high-income countries in the Western Pacific Region (WPR): Australia, Brunei, Japan, New Zealand, Singapore, and South Korea). This poses limitations because these other

WPRO-A countries are generally wealthier than New Zealand, and some have greater economies of scale (e.g., Japan and South Korea). Some of these countries also have lower cost IT systems, e.g., from lower broadband internet costs.

6.12.2.1 Use for NZACE-Prevention / BODE^3

Our suggested approach to costing intervention programmes will be as follows:

1) Attempt to identify if NZ-specific programmatic costing data are already available (e.g., for pre-existing interventions where scaling up is being considered). In some cases it may be plausible to extrapolate e.g., the costs of running a road safety media campaign (a well-established intervention in NZ) could be applied to a domain where public sector media campaigns have not been used recently, such as nutrition.
2) Perform an updated search for costing and cost-effectiveness studies in New Zealand and Australia on the topic of interest.
3) Failing obtaining quality data from the above steps, we will consider performing an updated search for WHO Choice publications on the topic of interest and review the latest details on the WHO Choice website.
4) If the above steps do not provide results of plausible relevance to New Zealand then we will consider performing specific costing studies ourselves. Indeed, this has already been performed by the BODE^3 team to determine the cost of a new statute or new regulation in the New Zealand setting (Wilson et al, *Bull WHO*[24]).

6.13 Cost calculations from other NZ research groups

Other cost-effectiveness analyses done in New Zealand can provide useful information for BODE^3 with regards to methods of calculating costs and what cost sources are available. A selection of relevant published studies are summarised in Table 15.

A 2008 report prepared for the MoH on screening for colorectal cancer[57] provides some useful estimates of the costs of setting up programmes, including the following components:

- Health promotion and education campaigns
- Development, running and maintenance of an IT population register for screening
- Quality and standards, evaluation and monitoring components
- Workforce development, programme staff and management
- Programme "hub" funding
- Advisory groups, ongoing research
- Costs of screening tests and follow-up investigations.

This report is a useful source for identifying the type and number of resources required in setting up and running a programme.

Table 15: Overview of selected New Zealand Cost-Effectiveness Analyses

Authors	Citation	Methods	Cost sources	Relevance/comments
Milne R.J., Vander Hoorn S.[58] University of Auckland	Burden and cost of hospital admissions for vaccine-preventable paediatric pneumococcal disease and non-typeable Haemophilus influenzae otitis media in New Zealand. Applied Health Economics and Health Policy. 8 (5) (pp 281-300), 2010	Cost analysis only	DRG/WIES	Useful example of use of casemix costing
Milne R.J., Grimwood K.[59] University of Auckland, Queensland	Budget impact and cost-effectiveness of including a pentavalent rotavirus vaccine in the New Zealand childhood immunization schedule. Value in Health. 12 (6) (pp 888-898), 2009.	Static equilibrium model Some societal costs	Hospital patient-level costing systems DRG/WIES GP capitation	Useful example of calculation of some societal costs, including caregiver time (but not lost income for caregivers) Example of use of casemix costing Mean GP visit under age 6 = $39.70 (2006) Still does not take into account some key issues (e.g., herd immunity, impact of nosocomial infections) and a state-of-the-art uncertainty analysis was not performed
Chapman R., Howden-Chapman P.,	Retrofitting houses with insulation: A cost-benefit analysis of a randomised	Cost-benefit analysis of RCT	Asthma burden of disease study	Methods for valuing benefits such as greenhouse gas emission savings

Viggers H., O'Dea D., Kennedy M.[60] OUW, Vic, MoH	community trial. Journal of Epidemiology and Community Health. 63 (4) (pp 271-277), 2009	Included time off school/work		$30 per tonne of CO_2 Estimate of adult hospital admission for asthma (2002): $740 day admission, $1480 overnight admission For 65y+ $1347 and $2694, respectively
BERL Slack, Nana, Webster, Stokes Wu	Costs of harmful alcohol and other drug use Report to MoH and ACC (2009)	Prevalence approach to estimate resources diverted in a given year due to the impacts of past and present harmful drug use Total social costs and govt costs	NZHIS DRG /WIES	Useful example of C2 Other Sector costs (e.g. welfare, crime, road crashes) Example of distinction between total and avoidable costs Discusses jointly attributable costs
Miller T., Blewden M., Zhang J.F.[61]	Cost savings from a sustained compulsory breath testing and media campaign in New Zealand. Accident, Analysis and Prevention. 36 (5) (pp 783-794), 2004	ARIMA time-series analysis Societal, government, drunk drivers and external costs	Police data LTSA reports Other specific sources	Useful example of costing breath testing, media costs, travel time, and alcohol-related road crashes. Also how to incorporate costs from fines and loss of right to drive
Gander P, Scott G, Mihaere K, Scott H[62]	Societal costs of obstructive sleep apnoea syndrome NZMJ 2010 Aug 27; 123 (1321): 13-23	Decision analysis model Societal QALYs	Expert opinion Human capital and WTP DRG/WIES ACC	Used a wide range of cost sources, some of which may be useful for $BODE^3$ ACC costs from ACC annual report and other reports

Scott G., Scott H., Turley M., Baker M.[63] ScottEconomics Ltd, MoH, UOW	Economic cost of community-acquired pneumonia in New Zealand adults. NZMJ 2004; 117 (1196): U933	Cost analysis only Societal perspective	DRG/WIES X-ray valued at that charged by private service Lab costs from Lab Claims Database Ambulance charges IRD mileage rates	Example of patient transport costs Example of production loss and leisure time foregone costs "Informal phone survey of GPs" for resource utilisation GP costs possibly only patient copayments - unclear
Bramley D., Graves N., Walker D.[64] University of Auckland, Queensland, London	The cost effectiveness of universal antenatal screening for HIV in New Zealand. AIDS. 17 (5) (pp 741-748), 2003	Simple decision analysis Health service costs	Auckland DHB Finance Department report	Example of cost of screening Used expert opinion
Lal A, Moodie M, Swinburn B Deakin University	Health care and productivity costs of overweight and obesity in New Zealand [Abstract] Obesity reviews 2011; 12 (Suppl 1): 67	Application of population-attributable fractions to total costs Direct and societal	NZ and Australian data (no further details)	
Mernagh P., Coleman K., Cumming J., Green T., Harris J., Paech D.,	Cost-effectiveness analysis of public health interventions to prevent obesity in New Zealand [Abstract].	Simulation model QALYs		Further detail required

Weston A. HTA Analysts Sydney, Victoria University, Canterbury University, MoH	Value in Health 2011;14 (7) (pp A382),			

6.14 Extrapolations from Australian data

The BODE^3 Programme has close ties to the Australia Assessing Cost Effectiveness in Prevention Programme,[10] from which NZACE-Prevention evolved. The fall-back position for BODE^3 is that where there are substantive difficulties with determining New Zealand costs, the costs will be extrapolated from the Australian ACE-Prevention cost data if possible.

However, in doing these adjustments there may be a need to consider differences in healthcare systems between the countries. In particular, Australian pharmaceutical costs should not be extrapolated for New Zealand use. Pharmaceutical costs in New Zealand are often driven down by PHARMAC's negotiating power and extensive use of generic agents, such that certain common pharmaceuticals can be substantially more expensive in Australia, while over-the counter products may be cheaper.

7 Uncertainty about direct costs

BODE^3 will model uncertainty about costs and effectiveness, and hence cost-effectiveness (and other summary measures such as net monetary benefit). This section describes a methodology and approach to estimate the uncertainty about the direct cost of the intervention, when the direct cost is the sum of unit resources multiplied by price per unit resource. This methodology provides guidance to what the minimum and maximum likely uncertainty is about a given total direct cost, as well as guidance about the best estimate.

Table 16 gives an example of 12 cost items that need to be quantified in a direct costing example. In turn, these 12 types of items are split equally between three domains (e.g. phases of a cancer treatment pathway, where one might expect uncertainty in estimation of units to be more correlated than between domains – see later). In total, across the 12 types of items there are 45 resource units in total; this number is meaningful if each item is measured in the same units such as hours (which we will assume).

For the purposes of explication, we have specified some 'dummy data':

- the expected value of the number of resource units for each item (a);
- the estimated standard deviation (s.d.) about the estimated number of units (b), which is equivalent to the *standard error of the mean* (note: this is not the standard deviation of the distribution of all individuals within the population)
- the estimated price per resource unit (e), and
- the estimated standard deviation about the price per unit (f), which is also equivalent to a standard error.

Note that all these estimates may be derived from empirical data (e.g. MoH Health Tracker data, or other sources as detailed in this Report), but they might also be elicited (at least partially) from experts or by assumption. If this is the case, it is critical to ensure that the s.d. estimates are elicited in such a way as to capture the estimated uncertainty about the parameter*, not* the actual variation at the individual-level in the population. Doing so will ensure that the derived uncertainty intervals are appropriate for parameter or second order uncertainty. (It may be important on occasion to parameterize the actual individual-level variability for stochastic variation in a micro-simulation model, but we do not consider that further here.)

The estimated variance of the number of resource units and price per unit are simply the square of the s.d.. To provide a guide to 'relative' uncertainty, we also give a column for the s.d. as a percentage of the estimated value. Thus, in this example, the s.d. values range from 2% to 20% of the estimated value for the number of resource units (an average of 10.2%) and from 5% to 17% for price per unit (an average of 9.8%).

The remaining data will be explained under the Scenarios that follow, describing different options for quantifying uncertainty about the total cost for inclusion in the economic decision modelling. In this example, the likely total direct cost of the intervention is estimated to be $3,250 per person or per person/month.

Table 16: Example of resource units, price per unit and cost to demonstrate options for specifying uncertainty about the total direct cost of an intervention (dummy data)

		Number of resource units				Price per resource unit				Cost	If only uncertainty in number of units			If uncertainty in both number of units and price/unit		
Item type ID	Dom-ain	Exp value	Est s.d.	Est var	s.d. as % exp value	Est value	Est s.d. price/unit	Est var price/ unit	s.d. as % exp value	Item cost (no. units x price per unit)	Var of item cost	S.d. of item cost	S.d. as % exp value	Var of item cost	S.d. of item cost	S.d. as % exp value
		a	b	c=b^2	d=b/a	e	f	g=f^2	h=f/e	i	j	k=j^0.5	l=k/i	m	n=m^0.5	o=n/m
1	1	2	0.2	0.04	10%	$50	$5	25	10%	$100	100	$10	10%	201	$14.18	14%
2	1	6	0.5	0.25	8%	$60	$10	100	17%	$360	900	$ 30	8%	4,525	$67.27	19%
3	1	3	0.5	0.25	17%	$40	$5	25	13%	$120	400	$ 20	17%	631	$25.12	21%
4	1	8	1.0	1.00	13%	$100	$10	100	10%	$800	10,000	$100	13%	16,500	$128.45	16%
5	2	4	0.3	0.09	8%	$30	$4	16	13%	$120	81	$ 9	8%	338	$18.40	15%
6	2	1	0.1	0.01	10%	$70	$4	16	6%	$70	49	$ 7	10%	65	$8.07	12%
7	2	4	0.2	0.04	5%	$200	$20	400	10%	$800	1,600	$ 40	5%	8,016	$89.53	11%
8	2	5	0.1	0.01	2%	$100	$5	25	5%	$500	100	$ 10	2%	725	$26.93	5%
9	3	4	0.5	0.25	13%	$60	$5	25	8%	$240	900	$ 30	13%	1,306	$36.14	15%
10	3	4	0.6	0.36	15%	$10	$1	1	10%	$40	36	$ 6	15%	52	$7.24	18%
11	3	3	0.1	0.01	3%	$90	$5	25	6%	$270	81	$ 9	3%	306	$17.50	6%
12	3	1	0.2	0.04	20%	$100	$10	100	10%	$100	400	$ 20	20%	504	$22.45	22%

Sum	**45**	**2.35**		**$3,520**	**14,647**	**33,171**		
Average	**3.75**	**0.36**	**10.2%**	**$75.83**	**$7**	**9.8%**	**$293**	**10.2%**			**14.6%**

Est = estimated; exp = expected; s.d. = standard deviation (of the mean or expected value, so actually an estimate of the standard error); var = variance (of the mean or expected value).

7.1 Scenario 1: Uncertainty in estimation of number of resource units (but none in price per unit), and zero correlation of uncertainty across items

Often it will be appropriate to assume there is no uncertainty in the data on price per unit. For example, the cost per unit of drug, or when good data exists on price per night in hospital. However, it is almost inevitable that there will be some uncertainty about the expected value of the number of actual units, by type of unit. If these estimations of number of resource units are independent (i.e. there is little reason to believe that if the true value for one type of item is higher than the mean or expected value that this 'aberration' predicts whether the true value for other types of items is likely to be higher or lower than their expected values), then we assume no correlations in uncertainty across items.

The item cost (i in Table 14) is simply the product of the number of units (X) and price per unit (Y). Given the assumptions above, the variance of the item cost is the sum of the scale variances, where the 'scaling factor' is the square of the price per unit (a^2 in the formula below; price per unit has no variance/ uncertainty):

$$Var(aX) = a^2 Var(X)$$

Thus the variance of the cost of item 1 in Table 16 under this scenario is $50^2 \times 0.04 = 100$ as shown in the column labelled 'j'. The variance of the total cost is the sum of all "j" values = 14,647. The s.d. of the total cost is the square root of the variance of the total cost. Therefore, the s.d. is \$121.02 about the estimated total cost of \$3520 – or 3.4% of the total cost which is considerably less than the average 10.2% by type of item. Intuitively, as one adds up the units the 'under and overs' due to (uncorrelated) uncertainty for each item cancel out to a degree.

Scenario 1 is shown as the bold estimate in Table 17a below.

7.2 Scenario 2: Uncertainty in estimation of number of resource units and price per unit, but still no correlated uncertainty across items

In this Scenario, there is now reason to posit uncertainty in the price per unit. For example, maybe the data systems are not sufficient for exact pricing of the resource units used in an intervention. However, we still assume no correlation in uncertainty across types.

The formula for the variance of the item cost, being the product of the two variables X (the number of units) and Y (the price per unit), is:

$$Var(XY) = [E(X)^2 Var(Y) + E(Y)^2 Var(X) + Var(X)Var(Y)]$$

Thus for our two variables of number of units and price per unit for item type 1 this gives:

$$(2^2 \times 25) + (50^2 \times 0.04) + (0.04 \times 25) = 201$$

As we are just summing the products of number of units and price per unit for each item, then the total variance is the sum of these 12 variances, or \$33,171 which gives an s.d. of \$182.13 (the square root

of the variance). This is now equivalent to 5.2% of the total cost of $3520, consistent with uncertainty in both number of units and price per unit increasing uncertainty about the total cost.

Scenario 2 is shown as the bold estimate in Table 17b below.

7.3 Scenario 3: Uncertainty in estimation of the number of resource units (but none in price per unit), and correlation of uncertainty across items

Assume as in Scenario 1 that there is no uncertainty in estimation of price per unit, but there is now a correlation in uncertainty in estimation of the number of resource units across items. The variance of a sum of correlated variables is given by the equation:

$$Var\left(\sum_{i=1}^{n} X_i\right) = \sum_{i=1}^{n}\sum_{j=1}^{n} Cov(X_i Y_j)$$

The equation for the covariance is:

$$Cov(XY) = Cor(X,Y) \times [s.d.(X)s.d.(Y)]$$

Note that when i=j, the covariance is just variance at the level of X. Note also that in our example the price per unit is acting as a constant scalar.

If the correlation of uncertainty across all items is 0.5 (i.e. both within and between domains), then in Scenario 3 the s.d. about the total cost of $3250 is $222.85, or 6.3% of the total cost. This result, and those for correlations of 0.25, 0.75 and (perhaps rather preposterously) 1.0 across all items, are shown in the diagonal of Table 17a below. Expressed as a percentage of the total cost, results when the correlation between domains is less than that within domains are shown above and to the right of the diagonal in Table 17a.

What can we make of this? Recall from Table 16 that the average s.d. for the number of resource units at the item level, across all items, was 10.2%. Thus, even in the most extreme (and virtually impossible situation) of a correlation of 1.0 across all items, the s.d. of the total cost is 8.3% of the total. But for a more realistic (but still highly structured) example of 0.5 across all items, the s.d. of the total cost is 6.3%. And for what might be a more realistic scenario – a correlation of 0.5 within domains, and 0.25 between domains, the s.d. is 5.5% of the total cost, or just over half of the average percentage across items of 10.2% in Table 16.

Thus, we now have some general guidance for specifying uncertainty about the total cost in the economic decision model when we believe there is uncertainty only in the estimations of the number of resource units:

- It will be less than the average s.d. as a percentage of the estimated values across items – probably considerably so.
- For no correlation across items, it could be as low as a third of the average across items (i.e. 3.4% in Table 17a).

- For a moderate amount of correlated uncertainty, the uncertainty about the total direct cost might be plausibly specified with an s.d. of about 55% of the average across items, perhaps with sensitivity analyses setting this at 35% and 75% for lower and upper ranges.

That said, as demonstrated above it will be possible to work up likely estimates, making assumptions that the distributions are normal (see comments below) and specifying best estimates of the s.d. about each type of resource unit.

Table 17: Standard deviation of total cost as a percentage of total cost, for data shown in Table 16 and varying combinations of correlations of items, within and between domains

a. Uncertainty in estimation of number of resource units only (Scenarios 1 (bold) and 3)

Correlation of items within domains

Correlation of items between domains	0	0.25	0.50	0.75	1
0	**3.4%**	4.0%	4.4%	4.9%	5.3%
0.25		5.1%	5.5%	5.8%	6.1%
0.50			6.3%	6.6%	6.9%
0.75				7.4%	7.6%
1					8.3%

b. Uncertainty in estimation of both number of resource units and price per unit (Scenarios 2 (bold) and 4)

Correlation of items within domains

Correlation of items between domains	0	0.25	0.50	0.75	1
0	**5.2%**	6.1%	6.8%	7.5%	8.2%
0.25		7.9%	8.5%	9.1%	9.6%
0.50			10.0%	10.5%	10.9%
0.75				11.6%	12.1%
1					13.1%

7.4 Scenario 4: Uncertainty in estimation of both number of resource units and price per unit, and correlation of uncertainty across items

We now combine the set of assumptions in both Scenario 2 and 3. The results are shown in Table 17b. The uncertainty – expressed as the s.d. percentage of the total costs – increases by about 50% compared to Scenario 3. However, the exact increase will be situation specific, so it is unwise to make generalisations. Table 17b and the equations above, however, do demonstrate that it is feasible to make informed specifications about total cost uncertainty for a range of scenarios.

7.5 Concluding remarks

The above workings all assume a normal distribution. This is not unreasonable given that they are population-level parameters which means – technically at least – that the central limit theorem should apply, even if the underlying number of resource unit and price per unit distributions are, say, gamma distributions. But given the tenuous nature of many costings, the assumptions, and the (appropriate) conflation of systematic and random error in specification of uncertainty in costing, it still seems sensible to use the above deductions to specify the s.d., but probably convert to a gamma distribution (using the s.d. above) for actual specification in economic decision modelling.

Second, the 'art' in this specification and the component that influences the final uncertainty the most is the amount of uncertainty we specify about each estimated number of resource units (and in some cases price per unit). It is critical to retain focus that it is the s.d. about the mean or expected value of these population parameters that we are specifying, not the s.d. about the individual-level distribution.

Third, the above scenarios are for roughly similar sized s.d.values across units (and price per unit). If one s.d. is considerable greater, the overall s.d. can increase. For example, if the s.d. about the resource units for item 4 was 4.0 (i.e. half of the expected value, rather than 13% as shown in Table 16) then the s.d. about the total cost (still $3,250) becomes $405.77 (or 11.5% of the total), compared to $121.02 (or 3.4% of the total). Thus, considerably greater uncertainty in the s.d. for one item may have a much greater influence on overall uncertainty.

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Appendix 1: Cost Domains and Sources for Costs

Table 18: Cost domains and data sources: screening

Domain: Screening			
Subdomain	**Examples of items**	**Comments**	**Data sources**
Set-up and training costs	Screening register set-up	The costing report on colorectal screening may be useful.[57]	Refer to section 6.13
	Standards development	The costing report on colorectal screening may be useful.[57]	Refer to section 6.13
	Workforce development	Initial training of staff to administer the new intervention is included, and ongoing training of staff is included if it is not absorbed back into 'routine' continuing professional development and staff training The costing report on colorectal screening may be useful.[57]	Refer to section 6.13
	Capital investment	Capital is included where it is intervention specific and not included in overheads Consider annuitisation	Refer to BODE^3 protocol[3] and section 2.3
Programme running	Admin staff	Potentially WHO Choice data could be used.	Refer to sections 6.12.2 and 6.13

costs	Support staff (e.g. IT) Managers	The costing report on colorectal screening may be useful.[57] PHARMAC unit costs and/or MECAs can be used for estimating salaries of health professionals	PHARMAC unit costs[7,36]: refer to section 0 MECAs are available at G:\Data\Direct costs of interventions\Cost resources Refer also to section 6.8.1
Overheads		Incremental changes in overhead costs resulting from the intervention are included. Default of 50% of salaries[7] Otherwise potentially WHO Choice data could be used.	Refer to section Overheads on page 11
Marketing and media costs	Development of materials Media time Advertising space Printing costs Distribution costs	The costing report on colorectal screening may be useful.[57] If no local data are available, then potentially WHO Choice data could be used.	Refer to sections 6.12.2 and 6.13
Legislative costs		Methods as developed by Nick Wilson	Refer to article on cost of a new law (Wilson et al. WHO Bull[24]) See also Section 6.12.2 on WHO Choice
Key intervention components	Communication	Including consumables and postage to contact target population, notification etc.	Based on 2011 New Zealand market prices

	Screening kit/procedures	The costing report on colorectal screening may be useful.[57]	Refer to section 6.11
	Sample testing	Laboratory testing (e.g. blood and urine tests, faecal tests, cytology, histology etc) based on actual cost claimed or average price from bulk funding	Obtain from the MoH Price of Cancer report[8] (section 6.2)
	Referral	Cancer-related outpatient visits and procedures can be based on DHB contracted purchase unit prices	Obtain from the MoH Price of Cancer report[8] (section 6.2)
	Follow-up investigations		
Monitoring/quality assessment		Potentially WHO Choice data could be used.	Refer to section 6.12.2
Patient travel		National Travel Assistance	Refer to section 6.8.5 and the MoH Price of Cancer report[8] (section 6.2)
MECA = (DHB) Multi-Employer Collective Agreement			

Table 19: Cost domains and data sources: treatment

Domain: Treatment			
Subdomains	Examples of items	Comments	Data sources
Set-up and training costs	Research	Research and development by universities and private industry are not included unless inherently recovered in the market price (e.g. pharmaceuticals)	
	Workforce development	For example, training in use of a new technology, or if demand for services increases due to availability of new technology	
	Capital investment	Included where intervention specific and not included in overheads Consider annuitisation	Refer to section 2.3
Overheads		Incremental changes in overhead costs resulting from the intervention are included where not already included in item cost. Overheads are included in WIES funding for inpatient events. Overheads are also included in the DHB contracted purchase unit price for outpatient services. If not included elsewhere, use default position of 50% of salaries[7]	Refer to section Overheads on page 11

Key intervention components	Consultation(s) for diagnosis, initiation of treatment and follow-up	Healthcare personnel	PHARMAC unit costs and/or MECAs can be used for estimating salaries of health professionals, including private specialists	PHARMAC unit costs[7,36]: refer to section 0 MECAs: refer to G:\Data\Direct costs of interventions\Cost resources Refer also to section 6.8.1
		GP visits	Average portion of capitation funding plus patient copayment	Refer to section 6.4
		Outpatient specialist consultation	DHB contracted Purchase Unit price Cost private consultations separately with PHARMAC unit costs	Obtain from the National Purchase Unit price list (see section 6.4) or the MoH Price of Cancer report[8] (section 6.2) PHARMAC unit costs[7,36]: refer to section 0
	Diagnostic and monitoring tests	Laboratory tests (including cytology, histology etc)	Community: Actual cost claimed or average price from bulk funding Hospital: included in WIES funding	Obtain from the MoH Price of Cancer report[8] (section 6.2) or other sources in section 6.8.3.
		Radiology (x-ray, CT, MRI)		
		Biopsy		
	Treatments and procedures	Pharmaceutical acquisition costs	Pharmaceutical Schedule Cancer drugs (PCT) costs are	Refer to BODE^3 Pharmaceutical Costing Protocol[25] and section 6.7

			included in the Pharms database. Other pharmaceuticals administered during inpatient stay or outpatient attendance are covered in WIES casemix funding or Purchase Unit prices for outpatient activity, respectively	
		Inpatient costs	WIES casemix funding	Refer to section 0
		Outpatient costs	DHB contracted Purchase Unit price for outpatient activity Outpatient cost for chemotherapy infusion from Purchase Unit cost or PHARMAC unit costs	Obtain from the National Purchase Unit price list (see section 6.4) or the MoH Price of Cancer report[8] (section 6.2) PHARMAC unit costs[7,36]: refer to section 0
		Allied health professionals		
Patient travel		National Travel Assistance		Refer to section 6.8.5 and MoH Price of Cancer report[8] (section 6.2)
Patient accommodation		National Travel Assistance		Refer to section 6.8.6
Palliative care		Inpatient palliative care: WIES funding Community hospice: MoH Estimate		Obtain from the MoH Price of Cancer report[8] (section 6.2)

Residential care		Includes care at the “rest home” and “hospital” level	Obtain from Aged Residential Care Service Review[40]
MECA = (DHB) Multi-Employer Collective Agreement			

Appendix 2: Examples of event pathways

Generic Event Pathways for Drug Treatment

Cancer Drugs for ABC-CBA

A possible event pathway for intravenous cancer drugs for ABC-CBA modelling is outlined in Figure 3. The event pathway aims to capture the resources used during chemotherapy. Costs should be applied to each component of the event pathway using the methods and sources described earlier in this protocol.

This is an example only, and components may need to be added or removed for individual interventions. For instance, the event pathway for an orally administered drug would be much simpler. This example assumes that the event pathway starts after cancer (or recurrent/metastatic disease) has been diagnosed because all activities around diagnosis would be the same regardless of whether treatment with the study drug or the current standard of care is planned. However, this will not be the case for all interventions.

If an Outpatient Purchase Unit (see section 6.4) or Inpatient case-mix funding unit (section 0) can be applied to the event pathway, costs for the individual components included within the unit cost do not need to be included in the event pathway for costing. These aggregate unit costs include all activities related to the outpatient or inpatient event, such as (as appropriate) "hotel" costs for hospitalisation and related capital costs, administration, nursing and physician time, tests and pharmaceuticals (noting that costs of cancer pharmaceuticals are not included).

Initial consultation and eligibility

The event pathway will include identification of the number of general practitioner or oncology specialist (or other health professional) consultations to determine suitability of the study drug for the "average" patient.

- Diagnostic costs to establish the stage of disease can be excluded if costs would be the same whether or not the patient received the study drug.
- Only appointments specifically to assess the suitability of the study drug for the patient are included.
- For targeted drugs, there may be costs associated with additional tests to determine the suitability of the patient for the drug, e.g. testing for HER2 receptors prior to treatment with trastuzumab (Herceptin ®)

Dosage and duration of treatment

The mean cost of drug treatment will be partly determined by the dosage and the duration of treatment for the "average patient". Methods to determine dosage are given in section 6.7.1.1.

The duration of treatment may be determined from the mean or median number of cycles delivered in relevant clinical trials. Or if a cancer drug is continued until disease progression, the median time to progression will need to be estimated (along with uncertainty; see full BODE^3 protocol[3])

Drug and Material Costs

To cost the drug component of the event pathway, it needs to be identified how the drug is funded and subsidised, and whether it is administered in the community or hospital/outpatient setting. Methods are provided in section 6.7 and the related protocol.[25] As well as acquisition and dispensing costs, materials used in the administration of the drug may need to be identified and costed (e.g. infusion sets) if they are a significant contributor to total drug-related costs.

As well as the cancer drug itself, the event pathway should include an additional step to identify what other drugs are given to support the cancer drug. This may include premedication given prior to chemotherapy to avert or minimise side effects or hypersensitivity, e.g. antiemetics, dexamethasone, antihistamines etc, or dugs given as haematological support (e.g. granulocyte-stimulating factors).

Pre-dose testing

Routine laboratory (blood, urine etc) or other testing may be done prior to treatment to ensure that the patient can tolerate the drug and dose (e.g. testing for thrombocytopenia, neutropenia, anaemia). Blood levels of the drug may be monitored to ensure they remain in the therapeutic window and are not reaching toxic levels.

Hospital Admission

Most cancer drugs will require inpatient, outpatient or day stay admission, unless orally administered. The number and duration of these admissions for the "average patient" must be estimated. For outpatient or day patient treatment, we need to take into account time for the administration of premedications, the duration of the chemotherapy infusion itself and any additional monitoring or recovery time needed.

Patient travel and accommodation

The cost of travel (but not time travelling) is included (see section 6.8.5).

Follow-up visits and monitoring

Patients will require follow-up visits to determine effectiveness of treatment, remission or progression of disease, adverse effects etc.

- The average number and type (specialist, GP, nurse etc) of such visits will need to be estimated
- For some drugs, the number of follow-up visits will be, at least in part, determined by the monitoring regimen necessitated by the adverse effects associated with the drug; recommendations for such follow-up may be part of the prescribing information of the drug

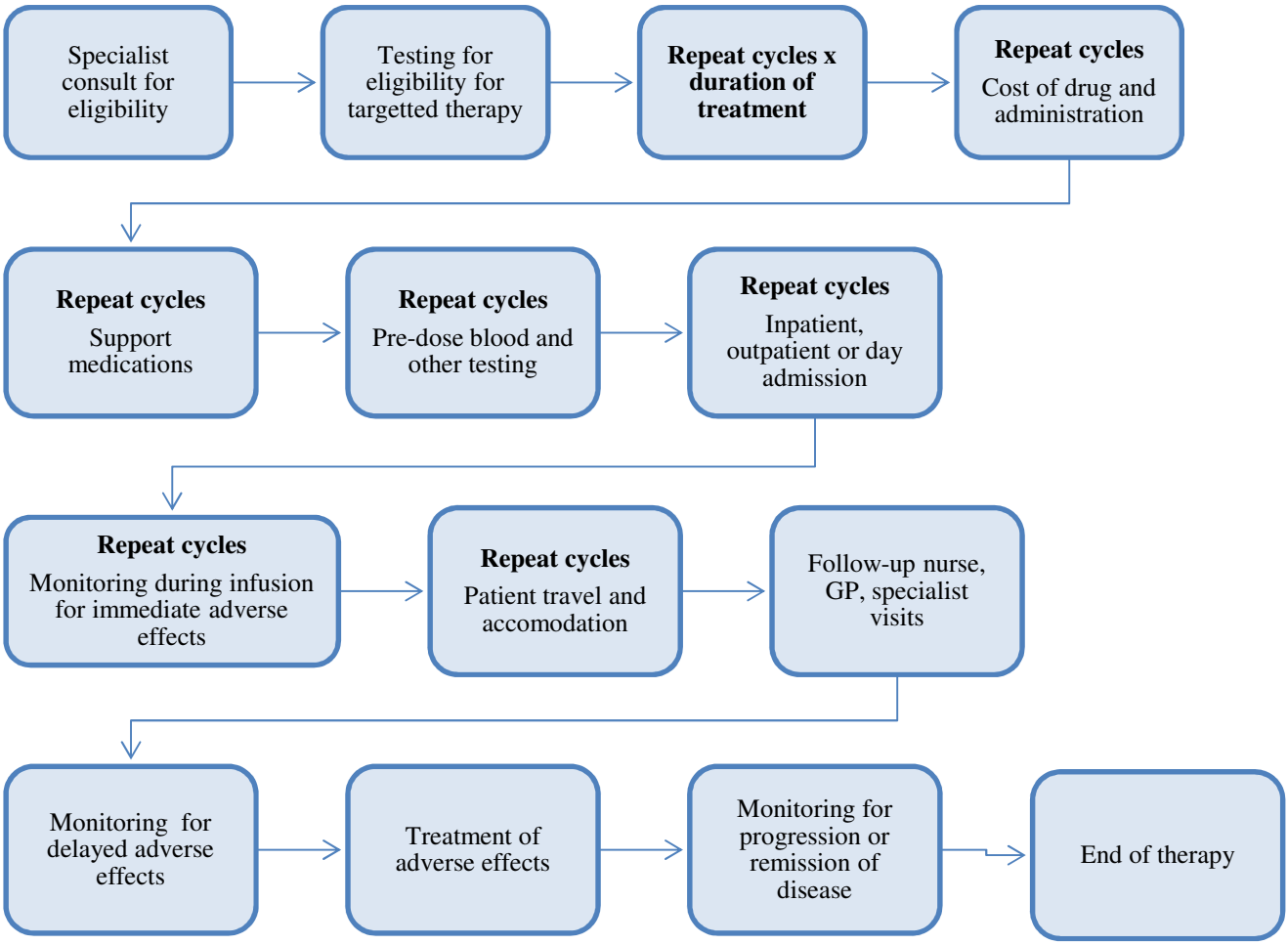
Routine monitoring for response and/or delayed adverse effects can be considered as a separate event where the cost falls outside of follow-up visits, e.g. blood tests. Certain events affecting only a proportion of patients may necessitate additional procedures, such as x-rays or scans; for instance if progression or a specific adverse effect is suspected.

Treatment of adverse effects

Treatment of adverse effects can be considered as a separate event when it incurs costs beyond follow-up visits

- Drugs, procedures or other treatments to manage adverse side effects
- Which adverse effects are most common and their incidence can be obtained from the prescribing information and/or relevant clinical trials

Figure 3: Example event pathway for an intravenously administered cancer drug



Preventive Drugs for NZACE-Prevention

The following outlines a generic event pathway for the activities relating to intervention with prescribed preventive oral medications; this pathway can then be individualised according to the activities involved in any specific intervention. The event pathway begins from the point in time of a decision being made to implement the intervention by Government.[3] Note that the event pathway described here relates only to prescription of a preventive drug; additional components of an intervention such as an educational programme to support appropriate use of the drug would require additional steps in the event pathway.

Initial consultation(s)

Preventive interventions may include one or more consultations to establish the patient's risk for the disease of interest, need for preventive intervention, and the suitability of the study preventive drug. The event pathway must identify the number and type of such consultations (e.g. general practitioner, nurse, or other health professional).

Drug costs

Methods for calculating the costs of pharmaceuticals are provided in section 6.7 and the related protocol.[25] Most preventive drugs will be fully or partly funded as Community Pharmaceuticals. If the drug is not fully subsidised, the patient is required to pay the difference (including pharmacy mark-ups). Some drugs may not be subsidised at all, and the patient pays the full cost.

The dosage and duration of treatment should generally be those used in clinical trials (see section 6.7.1.1). Most community pharmaceuticals will not require additional materials for administration (e.g. syringes or inhalers), but these costs should be included if relevant.

Monitoring and follow-up visits

In general, monitoring and follow-up will be less intense than for cancer drugs, but patients may require follow-up visits to determine effectiveness of treatment, changes in health status, adverse effects etc. The principles outlined in the section above on cancer drugs above still apply.

Patient travel

The cost of travel (but not time travelling) is included. This may include travel:

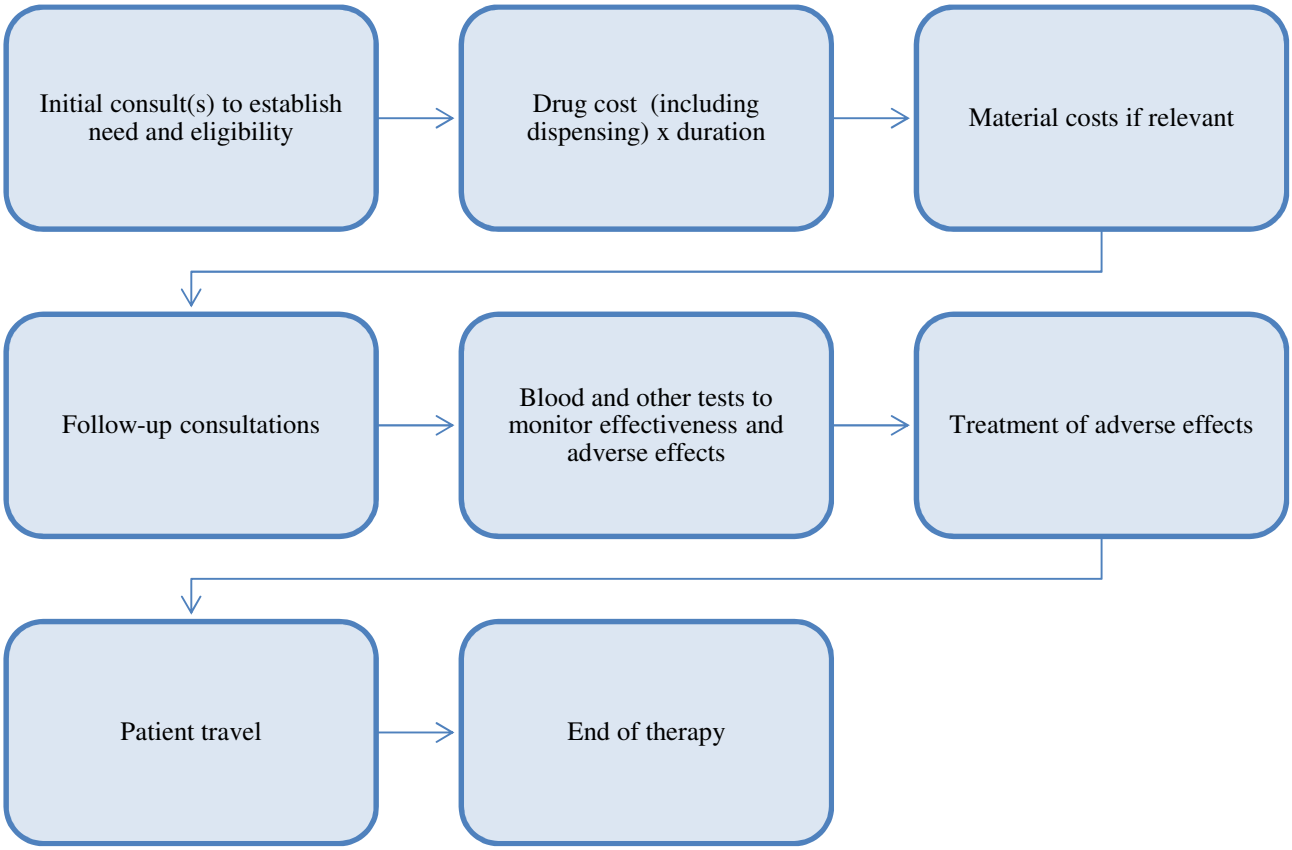
- to and from initial and follow-up consultations
- to and from pharmacies to collect medication.

Example event pathway diagram

Shown below (Figure 4) is an example of how an event pathway for a preventive drug that is prescribed in the community could be devised. The pathway framework strives to flag all possible events associated with prescribing a preventive drug. The event pathway can be individualised to the

specific drug(s) under study by excluding any irrelevant steps, and altering the quantity and type of events (e.g. consultations, blood tests).

Figure 4: Generic event pathway for an intervention with a preventive drug



Appendix 3: Ministry of Health Price of Cancer Report

The Ministry of Health report "The Price of Cancer: The public price of registered cancer in New Zealand" has a range of unit costs that are potentially of use for BODE^3 modelling.[8]

Cancer costs were based on cancer registrations for 2003-2008. Cancer registrations were included if they were the first registration for the person in the period, or they followed a previous registration for the same person by more than five years. The volume and price data from the selected data sources were used, where available, for the period 1 July 2006 to 30 June 2009.

Key points on methods:

- Ministry of Health perspective (vs BODE^3 health system perspective)
    - Excluded rehabilitation and disability support, NGO costs, private insurance and patient OOPs .
    - Excluded prevention and early detection
- Aimed to cover only costs wholly attributable to cancer (BODE^3 includes both related and unrelated future costs incurred/averted).
- Included costs of testing, treatment and travel to care
    - Excluded rehabilitation and disability support, NGO costs, private insurance and patient OOPs .
    - Excluded prevention and early detection (e.g. screening, tobacco control, HPV vaccination)
- Costs in 2008/2009 values.

Costs included were:

- Travel
    - National Travel Assistance Scheme claims, costed as the claim value paid
- Outpatient costs
    - Volume of visits from NNAPC
    - Cost per visit from DHB contracted price purchase units
- Community laboratory tests
    - Volume from Laboratory Claims Warehouse
    - Actual price of claim, or contracted price divided by the contracted volume for bulk contracted tests
- Community and hospital pharmacy dispensing
    - Volume and type from Pharmacy Claims Warehouse
    - Excluded palliative and pain medications
- Public hospital discharges
    - Discharge data from NMDS
    - WIES funding
    - Palliative care calculated separately
- Primary care consultations
    - Cost weight applied to capitation payments
- Private Hospital Discharges

    - Discharge data from NMDS
    - Costed using WIES
- Hospice costs
    - No unit data available
    - Applied the 70% of the operating budget of hospices that is funded by MoH
    - Estimated 90% of hospice patients have cancer, and applied incidence rates by cancer site to get cost per patient.