Continuous Mortality Investigation

Critical Illness Committee

WORKING PAPER 43

CMI critical illness diagnosis rates for accelerated business, 1999-2004

The views expressed in this working paper are those of the members of the CMI Critical Illness Committee and do not necessarily represent the views of the CMI, the Actuarial Profession or the employers of Committee members. This paper is a discussion document and the Committee fully acknowledges that there may be other valid approaches to analysing the CMI's critical illness data. This paper does not provide any form of guidance and should not be relied on as such. The CMI and the Committee members accept no liability whatsoever for any direct or consequential loss arising from any use of this working paper or its contents.

February 2010

Note: this revised version of the Working Paper was released on 15 March 2010 and corrects some numbers in tables 3.16, C5 and C17.

EXECUTIVE SUMMARY

CMI Working Paper 43 presents claim diagnosis rates for accelerated critical illness insurance, on a 'lives' basis, using data for claims settled in 1999 to 2004. Four sets of rates are included in the paper: for males and females, and for non-smokers and smokers.

The derivation of these diagnosis rates builds on our previous work. This had progressed to 'adjusted' results, which properly match claims to exposure, but do so in terms of settled claims, not diagnosed claims.

In this paper, we derive diagnosis rates by adjusting an initial set of rates (CIBT02) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This was done in a pragmatic manner – for each gender/smoker dataset independently – to reach a reasonable fit, having regard to the data volumes.

These are the first results the CMI Critical Illness Committee has produced that relate to the date of diagnosis, when a critical illness claim is incurred. The selection patterns (based on curtate duration in years) inferred from the data vary between the four sets of rates, as follows:

Male Non-smoker:	0, 1-4, 5+
Male Smoker:	0, 1, 2+
Female Non-smoker:	0, 1, 2+
Female Smoker:	0, 1, 2-4, 5+

Three datasets show strong positive selection, with rates at duration 0 of 70-80% of the ultimate rates; however for male smokers, the rates at duration 0 are almost equal to the ultimate rates and higher than those for duration 1.

Although the diagnosis rates derived in this paper reflect our best estimate of experience by duration, it is important to recognise the sensitivity of the duration 0 rates to the claim development distribution (used to transform expected diagnosed claims to expected settled claims).

In addition to these durational features, the rates exhibit shapes by age which also differ significantly from currently available tables of critical illness rates. This paper includes comparisons with some of these tables to highlight these differences.

The principal rates cover "all-causes", but the paper also sets out the derivation of cause-specific rates for the main causes of claim for male non-smokers. These are not only of intrinsic interest but also provide useful corroboration of the all-causes rates.

Another interesting extension – given that we now have data for 2005 and 2006 – is that we have compared the claims that we expect to be settled in those years, arising from diagnoses in 2004 and before (assuming our diagnosis rates), with the actual claims settled. These results are encouraging.

The rates are by no means the only sets of rates that could have been derived from the data. Consequently the Committee is making available to member offices spreadsheets containing summarised data that will allow practitioners to experiment with alternative approaches.

Furthermore the Committee is not proposing the adoption of these rates as a formal table. Instead we intend to use the same methodology to produce diagnosis rates for 2003-2006 and hope this will lead to a formal table.

The Committee is not undertaking a formal consultation exercise on the rates derived in this paper but, as always, the Committee welcomes feedback. In particular a number of specific areas where views are invited are included at the end of the paper.

Continuous Mortality Investigation

Critical Illness Committee

WORKING PAPER 43

CMI critical illness diagnosis rates for accelerated business, 1999-2004

CONTENTS

Continuous Mortality Investigation

Critical Illness Committee

CMI critical illness diagnosis rates for accelerated business, 1999-2004

1. INTRODUCTION

1.1. This paper presents claim diagnosis rates for accelerated critical illness insurance, on a 'lives' basis, using data for claims settled in 1999 to 2004. Four sets of all-causes rates are included in the paper: for males and females, and for non-smokers and smokers.

1.2. The underlying data is consistent with that used for the 'All Office' results released to member offices for these six years and includes over 18,000 settled claims. Whilst this is a substantial dataset, and represents a large proportion of the entire market there are few claims outside of the age range 25 to 65. The rates in this paper are therefore limited to these ages.

1.3. The derivation of these diagnosis rates builds on our previous work. This had progressed to 'adjusted' results, which properly match claims to exposure, but do so in terms of settled claims, not diagnosed claims. Adjusted results therefore need careful interpretation, particularly in terms of results by duration.

1.4. In this paper, we derive diagnosis rates by adjusting an initial set of rates (CIBT02) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This was done in a pragmatic manner – for each gender/smoker dataset independently – to reach a reasonable fit, having regard to the data volumes.

The background to this paper

1.5. The derivation of these diagnosis rates builds on our earlier work. In particular:

- The CMI collects data on critical illness business on a calendar year basis. Given the often significant time-intervals between the date of diagnosis, when a critical illness claim is incurred, and the date of settlement, it would be impractical to wait for all the claims diagnosed in a particular calendar year to be settled before collecting and analysing the data. The CMI therefore asks for claims to be submitted on the basis of claims settled during the year. This results in a mis-match between the exposure and claims. Given the substantial growth in business volumes in the years to 2002, this mis-match is especially pronounced.
- The results that the CMI initially released ('unadjusted' results) provide ratios of actual settled claims to expected diagnosed claims and cannot therefore be considered a reliable guide to the true underlying experience. This and other issues with the data are discussed in Working Paper 14, which was published when the results for 1999-2002 were issued to member offices in May 2005.
- Working Paper 14 also introduced the concept of a 'grossing-up factor' which sought to provide an overall adjustment to the reported experience.

1.6. Working Paper 28, published in July 2007, outlined a new methodology intended to make better use of the data fields available and to reduce the uncertainty inherent in grossing-up factors. In essence this methodology involved:

- Using the known in force data to calculate the exposure during the 'investigation period', i.e. the calendar years for which we have settled claims.
- Estimating the in force in prior years to calculate the exposure before the investigation period. This estimation involved the use of 'off rates', to adjust for the business that had gone off the books before the investigation period.
- Multiplying the exposure by a set of claim rates to generate expected diagnosed claims.
- Transforming these expected diagnosed claims into expected settled claims using a 'claim development distribution', a model of the time-interval between diagnosis and settlement of a claim.
- Comparing the expected settled claims within the investigation period with the actual settled claims in that period. We refer to this comparison as 'adjusted' results.

1.7. Working Paper 33, published in July 2008, described a refined model of the claim development distribution and some further analysis of off rates. These revised assumptions, together with a more sophisticated implementation of the revised methodology, allowed us to produce results for accelerated critical illness experience on a lives basis for the years 1999-2004. Results for 1999-2002 were contained in Working Paper 33 and adjusted results for the individual years to 2006 have been sent to member offices.

1.8. In Working Paper 33, the Committee indicated an intention to use the revised methodology to generate claim diagnosis rates. These are the subject of this paper.

1.9. There are many areas of uncertainty underlying the diagnosis rates, arising from both the methodology and the assumptions required. Some have been explored in the earlier Working Papers, whilst others arise from the subsequent steps to derive diagnosis rates. Although the Committee considers the set of rates derived in this paper to be a reasonable estimate of the true underlying rates, it is by no means the only set of rates that could have been derived and other approaches may be equally valid. In particular our work does not (yet) have a robust statistical footing as has been developed over time for the other CMI investigations and this has prevented the use of more established statistical techniques, for example in relation to graduations. In addition, we are unable to show confidence intervals around the diagnosis rates. Consequently the Committee is making available to member offices spreadsheets containing summarised data that will allow practitioners to experiment with alternative approaches to deriving the rates.

1.10. One particular limitation of the data that the Committee has had to overcome in all its work is the absence of dates of diagnosis for a substantial proportion of the data. The Committee is pleased to note that the proportion of claims with date of diagnosis has increased significantly since the investigation began. In time, the Committee hopes that the methodology used to derive these rates will be superseded and that it will be able to use more conventional techniques – and use fewer assumptions – to produce future sets of diagnosis rates.

1.11. In the short term, however, the Committee intends to use the methodology described in this paper to produce diagnosis rates for 2003-2006. There are a number of advantages inherent in using the 2003-2006 dataset and the Committee hopes that it will be possible to produce formal tables from the 2003-2006 data. The timescales are as yet uncertain, depending in part on the extent to which analysis of the 2003-2006 dataset corroborates findings on the 1999-2004 dataset and the extent to which it highlights new issues that require further investigation.

1.12. Notwithstanding the limitations surrounding the rates derived in this paper, the Committee feels they will have considerable value in allowing comparison with the 2003-2006 rates and in capturing experience in the period 1999-2004 for future consideration of trends. In addition – and perhaps most importantly – producing these rates for the 1999-2004 dataset will assist us in assessing which features of the 2003-2006 dataset are genuine and which arise from random fluctuations.

The structure of this paper

1.13. In order to provide context to the rates derived in this paper, the Committee felt it would be useful to provide some background on the data underlying this analysis, and the UK critical illness market in general. This is contained in section 2.

1.14. Section 3 contains a short summary of the methodology described in Working Paper 28 and Working Paper 33 that was used to generate adjusted results. Most of the assumptions underlying this work were documented in Working Paper 33 and are not repeated in this paper. However some of the assumptions have been amended from the earlier work and these changes are summarised in this section. Section 3 concludes with a description and worked example of the subsequent steps we have used to produce the claim diagnosis rates.

1.15. Some of the issues encountered in deriving the diagnosis rates – and how these have been resolved – are addressed in section 4. These issues include the goodness of fit of the rates to the data, smoothness, dealing with the limited age range of the data, judging the shape of selection and the extent to which the smoker and non-smoker rates should be derived independently of each other.

1.16. The focus of this stage of the Committee's work has been to derive all-causes diagnosis rates. However the Committee was keen to investigate cause-specific claim rates, not only for their intrinsic interest but also because we felt that these provide useful corroboration for the all-causes rates. This desire was supported by the feedback we received on Working Paper 33. To date we have derived cause-specific rates for male non-smokers only; rates for the main causes of claim are contained in section 5. In particular, given the current interest in the UK market regarding TPD, in the light of the 2009 review of the ABI Statement of Best Practice for Critical Illness Cover, we have illustrated claim rates for TPD itself and also for all-causes excluding TPD.

1.17. The all-causes rates themselves are then discussed in section 6, including comparisons with existing tables of critical illness rates. The rates themselves are contained in Appendix D. For convenience, these rates are referred to as 'WP43 rates' within this paper.

1.18. The WP43 rates are based on the same dataset that was used in Working Paper 33, i.e. accelerated critical illness experience on a lives basis for claims settled in the years 1999 to 2004. Given that the CMI now also has data for 2005 and 2006, we have compared the more recent experience with the rates derived for 1999-2004. This comparison is contained in section 7 of this paper together with an indication of the change in experience over the period 1999 to 2004.

1.19. In section 8 we illustrate the sensitivity of the rates to the key assumption, the claim development distribution.

1.20. Section 9 summarises the content of this paper and outlines the further work that the Committee now plans to undertake. In particular we highlight the reasons for moving to the 2003-2006 dataset and producing diagnosis rates for the more recent data rather than progressing further using the current dataset.

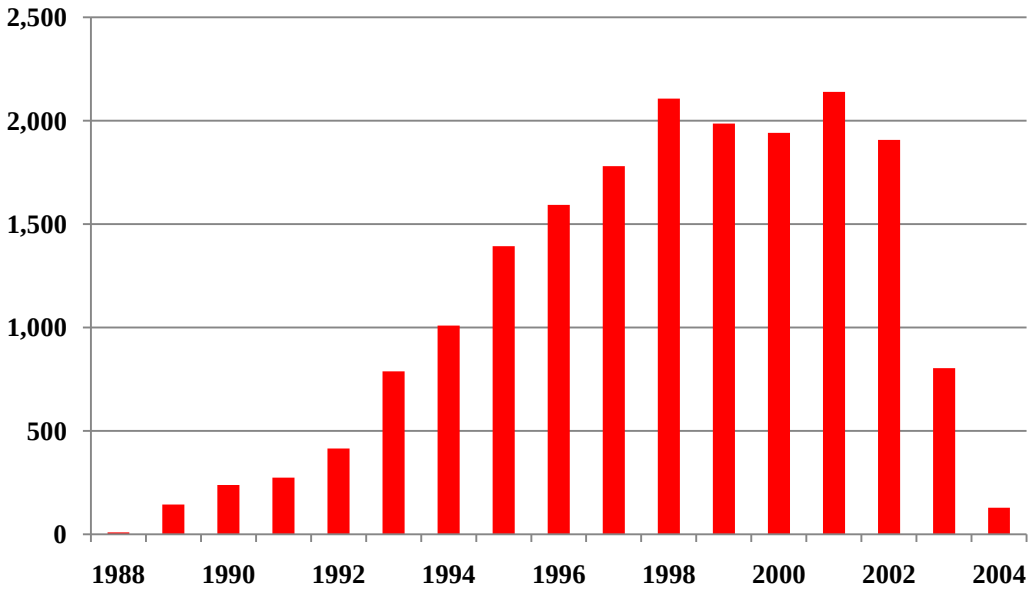
1.21. All feedback on this paper will be warmly welcomed by the CMI Critical Illness Committee. In particular a number of specific areas where views are invited are also included in section 9, together with details on providing feedback.

2. THE UK CRITICAL ILLNESS MARKET

2.1. In order to provide context to the rates derived in this paper, the Committee felt that it would be useful to provide some background on the data underlying this analysis, and the UK critical illness market in general. The market data used in this section has been obtained from various years' editions of Swiss Re Term & Health Watch; the Committee would like to thank Swiss Re for permission to publish these data. Note that the rates relate to accelerated critical illness policies only; the comments in this section are also intended to relate to accelerated cover, although Figure 2.5 shows all business (including stand-alone cover).

2.2. The rates derived in this paper are based on claims settled between 1999 and 2004 however the underlying policies relate to a longer period, starting significantly earlier. This is illustrated in Figure 2.1 which shows the actual settled claims in the 1999-2004 dataset by policy commencement year.

Figure 2.1: CMI critical illness claims settled between 1999 and 2004, by policy commencement year

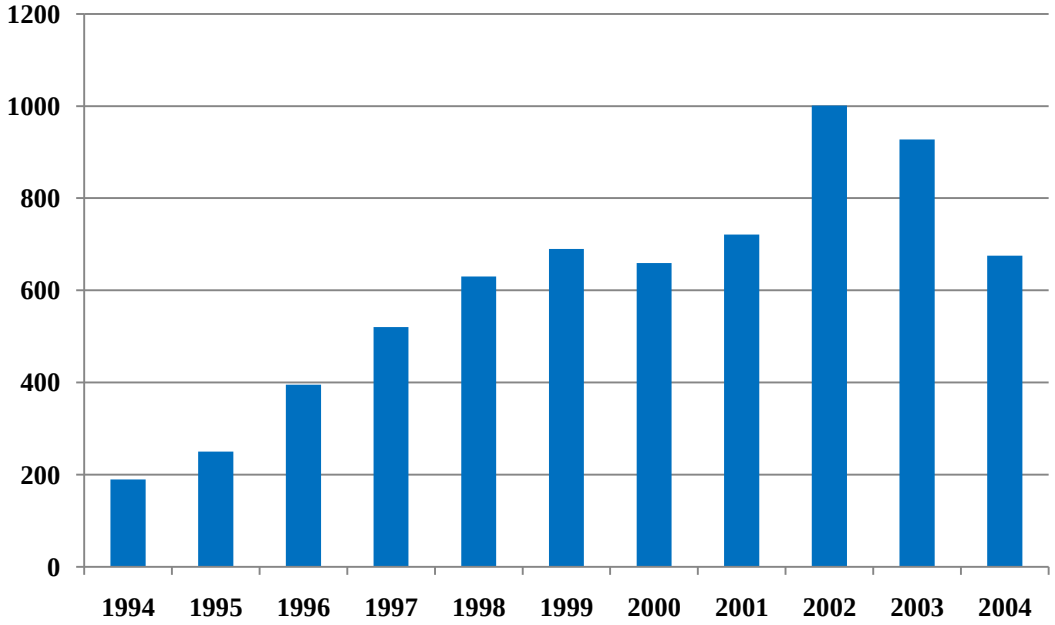


2.3. The market has changed significantly over this period in many ways, including distribution, underwriting and product design. All of these changes could clearly influence the rates derived and presented in this paper; not only in terms of their overall level but also the shape by both age and duration.

Sales Growth

2.4. The sales by year in the UK critical illness market for the extended period are illustrated in Figure 2.2. Rapid new business growth up to 1999 was followed by a plateau in 2000 and 2001. Sales peaked in 2002, when over one million accelerated critical illness policies were sold. The subsequent fall in sales in 2003 and 2004 was in part the result of restrictions in reinsurance capacity for critical illness cover on guaranteed rates, leading to price increases for consumers.

Figure 2.2: Accelerated critical illness sales by year, 000s, 1994-2004 (Source: Swiss Re Term & Health Watch)



2.5. Note that the rate of growth apparent in the CMI data (in Figure 2.1) is greater than in the market data. This is partly a consequence of offices starting to contribute data to the CMI but also because Figure 2.1 is based on settled claims and hence reflects a maturing portfolio by age and duration.

Market Coverage

2.6. The market coverage of the dataset used in this paper is difficult to determine as the Committee does not have definitive data for the size of the market. Comparisons are also complicated by a number of other factors: for example, CMI data relates to lives, whereas most other statistics relate to policies, and different companies follow different conventions when reporting critical illness products within their FSA Returns.

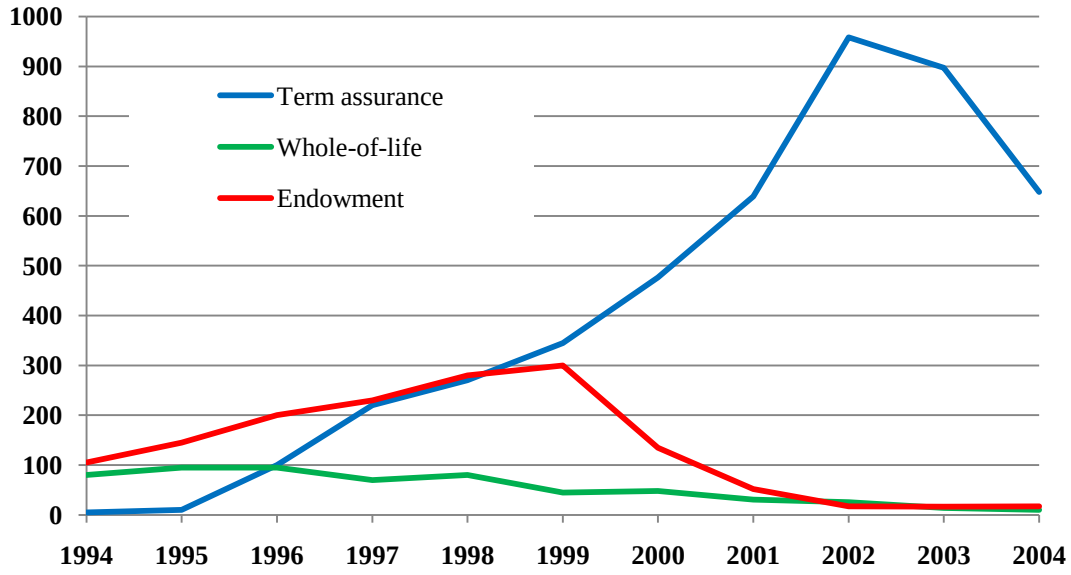
2.7. Based on the new business data in Swiss Re Term & Health Watch, the Committee estimates that the 1999 data used in this paper covered around a third of new critical illness policies, increasing to over a half by 2004. The increase arises primarily from companies starting to submit data to the CMI.

2.8. Note that a proportion of the market is unattainable, as data submitted to the CMI only covers non-rated policies.

Product Changes

2.9. Until the late 1990s, critical illness cover was frequently sold attached to whole-of-life or mortgage endowment products, both of which have a savings element. With the demise of the endowment market by 2001, Figure 2.3 shows that the product mix of new business has become increasingly term assurance dominated.

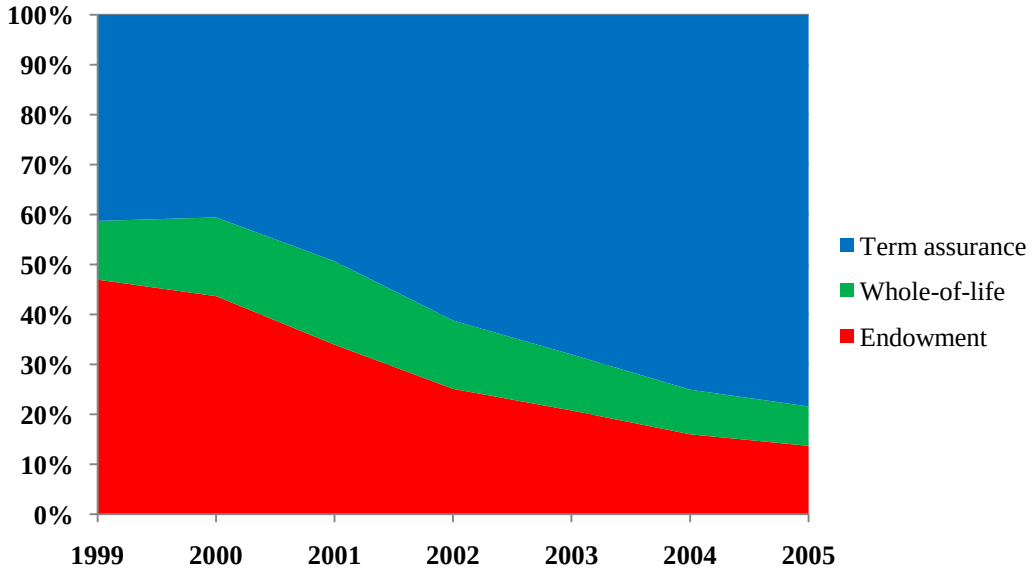
Figure 2.3: New Accelerated critical illness sales 1994-2004 by broad product type (Source: Swiss Re Term & Health Watch)



2.10. This change is also evident in the CMI in force data shown in Figure 2.4, which shows a reducing proportion of in force business arising from older whole-of-life and endowment products over the period. Note that Figure 2.4 relates only to around 80% of the total data, where the CMI has categorised the product type; the remainder of the data has yet to be categorised.

2.11. Unsurprisingly, the older product types represent a higher proportion of the CMI in force data, in Figure 2.4, than the new sales, illustrated in Figure 2.3.

Figure 2.4: CMI start-of-year in force data, 1999-2005 – percentage by broad product type



2.12. The rates derived in this paper are based on accelerated critical illness claims across all of the above products. Short durations (and younger ages) will be more heavily influenced by experience on term assurance, whereas durations 5+ (and older ages) will

have more significant volumes of whole-of-life and endowment policies. As the sales processes and target markets for each product will differ, this may affect the results.

2.13. Another key change in product design over the period has been in the number and scope of conditions covered. The first critical illness products launched in the UK market covered a limited range of conditions, whereas the scope of products available in the market today is much wider.

2.14. The definitions of the critical illness conditions have also varied considerably over the period. Until 1999, policy wordings were driven by market forces; the publication of the ABI Statement of Best Practice in that year sought greater standardisation between different providers' policy conditions. Since then there have been three updates to the Statement (in 2002, 2004 and 2006), extending the conditions covered and updating the wording for recent medical advances. For example, in 2002 the Heart Attack definition was amended to take account of advances in diagnostic techniques. No attempt has been made to adjust for such changes in our analysis.

Underwriting and Claims

2.15. With no information on rated policies available to the Committee, it is difficult to measure changes in underwriting practices over the period. However, it is thought that underwriting philosophies have become stricter over time and approaches to non-disclosure at claim stage have tightened. As the investigation contains sales from 1986-2004 it is clear that a wide range of underwriting practices will have contributed to the observed experience.

2.16. Claims practices will also have evolved, as experience of critical illness claims handling has developed; however these changes may be of less significance to the rates derived in this paper as we use claims settled in 1999-2004, whereas the underwriting practices relate to a longer period, starting significantly earlier, as illustrated in Figure 2.1.

Distribution

2.17. As with the changes already discussed, changes in distribution channel may affect the rates derived in this paper. The socio-economic mix of lives in each channel may be different, as well as sales processes and persistency experience.

2.18. The market share of Independent Financial Advisors (IFAs) has increased steadily over time, particularly as Direct Sales Forces began to fall out of favour in the 1990s. By 2004, IFAs accounted for almost half of new critical illness sales, as shown in Figure 2.5. (Note this shows all sales, as the Committee did not have access to market data on accelerated cover only by distribution channel; however accelerated cover provides the vast majority of sales).

2.19. This change is also evident in the CMI in force data displayed in Figure 2.6 (for accelerated cover only). (Note that Figure 2.6 excludes around 10% of data where the distribution channel is categorised as "other" or where it is unknown.)

Figure 2.5: Mix of CI sales by distribution channel 1995-2004 (Source: Swiss Re Term & Health Watch)

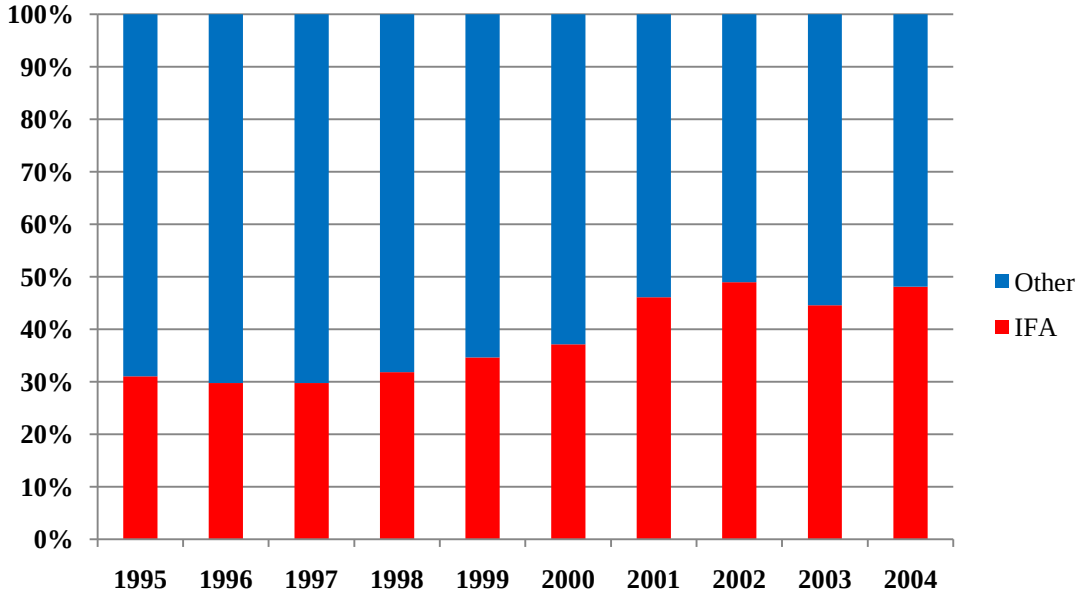
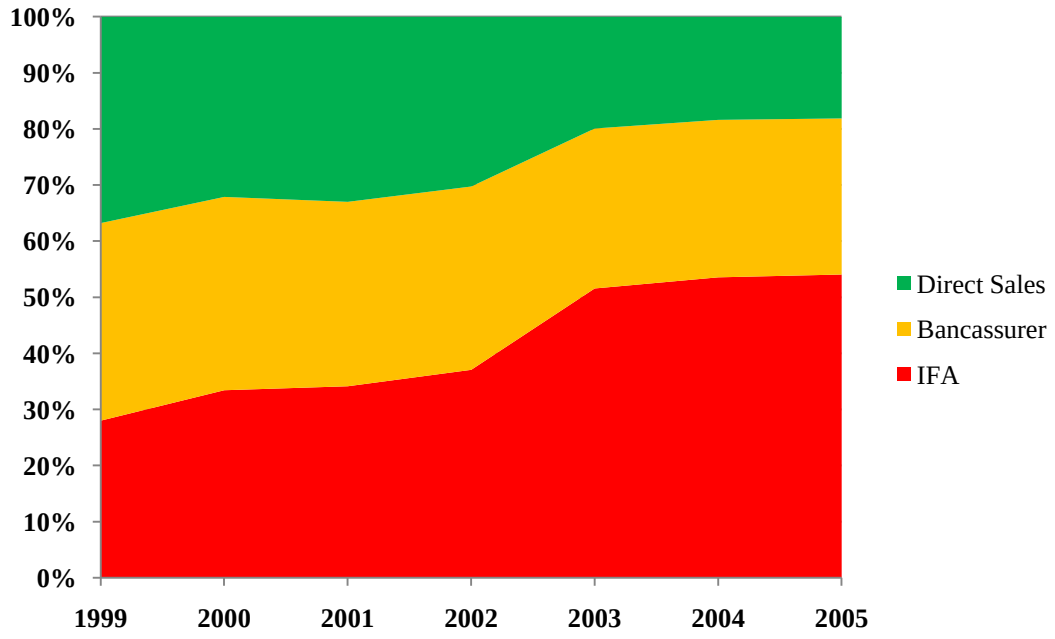


Figure 2.6: CMI start of year in force data, 1999-2005 – percentage by distribution channel



3. METHODOLOGY FOR DERIVING DIAGNOSIS RATES

3.1. In this section we summarise the methodology used to derive the diagnosis rates. This builds on the methodology described in earlier Working Papers up to and including Working Paper 33. Those unfamiliar with previous work are recommended to refer back to Working Papers 14, 28 and 33, although the first part of this section contains a brief summary of key aspects of the earlier work. The Committee has amended certain assumptions made in Working Paper 33 for practical reasons in the current work; these changes, and their impact, are described in the second part of this section.

3.2. The subsequent steps we have taken to produce the claim diagnosis rates are then described. In particular the derivation of the male non-smoker rates is described in some detail, with the other three datasets described more briefly. A number of practical issues arose in deriving the rates and these are described in section 4, with the rates themselves described in section 6 and contained in Appendix D.

A brief summary of earlier work

3.3. The CMI collects data on critical illness business on a calendar year basis. Given the often significant time-intervals between the date of diagnosis, when a critical illness claim is incurred, and the date of settlement, it would be impractical to wait for all the claims diagnosed in a particular year to be settled before collecting and analysing the data. The CMI therefore asks for claims to be submitted on the basis of claims settled during a calendar year but this results in a mis-match between the exposure and claims in that year. Given the substantial growth in business volumes in the earlier part of the analysis period, this mis-match is especially pronounced. The 'unadjusted' results that the CMI has released to member offices, providing ratios of actual settled claims to expected diagnosed claims, cannot therefore be considered a reliable guide to the true underlying experience. This and other issues with the data are discussed in Working Paper 14, which was published when the results for 1999-2002 were issued to member offices in May 2005.

3.4. Working Paper 14 also introduced the concept of a 'grossing-up factor' which sought to avoid the understatement (which was especially pronounced at that time) of the experience arising from comparing actual settled claims with expected diagnosed claims based on the exposure in the corresponding year.

3.5. The method used to derive grossing-up factors in Working Paper 14 required estimates to be made of the growth in expected claims. The approach used to do this was relatively crude and it was then difficult to produce grossing-up factors for subsets of the data. Furthermore, the methodology used to calculate the underlying claim development distribution was data-intensive, which also inhibited estimation of grossing-up factors for smaller subsets of the data.

3.6. In July 2007, the Committee published Working Paper 28 which outlined revisions to the previous methodology to make better use of the data fields available and to reduce the uncertainty inherent in the previous approach. In essence this methodology involved:

- Using the known in force data to calculate the exposure during the 'investigation period', i.e. the calendar years for which we have settled claims.

- Estimating the in force in prior years to calculate the exposure before the investigation period. This estimation involved the use of 'off rates', to adjust for the business that had gone off the books before the investigation period.
- Multiplying the exposure by a set of claim rates to generate expected diagnosed claims.
- Transforming these expected diagnosed claims into expected settled claims using a 'claim development distribution', a model of the time-interval between diagnosis and settlement of a claim.
- Comparing the expected settled claims within the investigation period with the actual settled claims in that period. We refer to this comparison as 'adjusted' results.

3.7. Working Paper 33, published in July 2008, described a refined model of the claim development distribution and some further analysis of off rates. These revised assumptions, together with a more sophisticated implementation of the revised methodology, allowed us to produce results for accelerated critical illness experience on a lives basis for the years 1999-2004. These were the first results that the Committee had calculated that properly match claims to exposure, but they did so in terms of settled claims, not diagnosed claims, and so needed careful interpretation. Results for 1999-2002 were contained in the paper and adjusted results for the individual years to 2006 have been sent to member offices.

Amendments to the assumptions used in Working Paper 33

3.8. The methodology and assumptions used in producing the adjusted results in Working Paper 33 are largely unchanged in this paper. In particular we have used:

- Off rates that vary only by calendar year, as set out in Table 8.2 of Working Paper 33 (with a single assumption of 9% pa applied to 1998 & prior); and
- The 'central' claim development distribution, derived in section 6 of Working Paper 33.

3.9. A full list of the assumptions used in Working Paper 33 was set out in paragraph 10.2 of that paper. One of these related to the time-intervals that were used in the calculations:

d) The current implementation of the methodology is not exact; in particular we have used time in months, age in years and duration in quarters. These were adopted to avoid excessive run times but have considerable significance when the claim development distribution is applied.

3.10. Subsequent consideration by the Committee concluded that different degrees of accuracy may be appropriate for this work from those used in Working Paper 33. In particular, the claim development distribution was applied on a daily basis, to transform the expected diagnosed claims into expected settled claims which provided spurious accuracy given the less precise assumptions used elsewhere in the model. We now apply the claim development distribution on a half-monthly basis, substantially reducing run-times.

3.11. In contrast, we have now grouped the exposure by age and duration in months, rather than in years and quarters respectively. This means that the translation of expected diagnosed claims to expected settled claims is more accurate in terms of age and

duration at settlement. In particular we felt this was important for the derivation of diagnosis rates, where we are producing rates by individual age.

3.12. This change affects a second assumption listed in Working Paper 33:

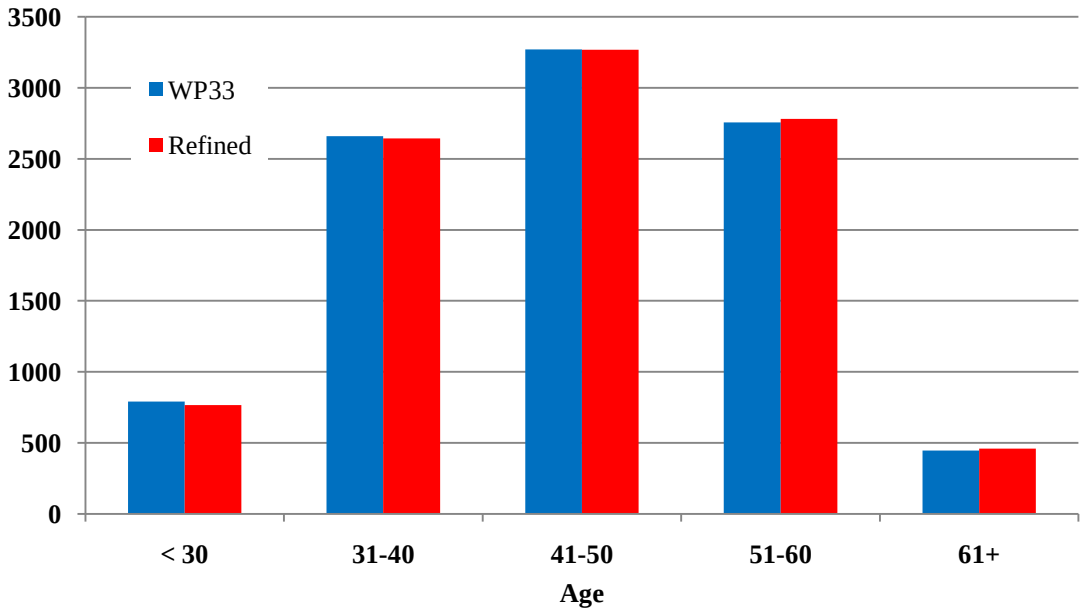
h) We have assumed that diagnoses occur on the 15th of the calendar month, on a birthday (as we are using age nearest) and at the mid-point of duration in quarter-years.

Although we are still assuming that diagnoses occur in the middle of each calendar month, age and duration are both now measured in (curtate) months. Note, measuring age in curtate months allows the data to be grouped by age nearest in years when this is required for the calculation of expected diagnosed claims.

3.13. The effect of the changes in assumptions on the adjusted results for 1999-2002, contained in Appendix C of Working Paper 33, is shown for male non-smokers in Appendix A of this paper. The first table is an updated version of Table C1 in Working Paper 33, reflecting the updated methodology but based on the same underlying data. The second table shows a direct comparison of the two sets of figures in the results that are affected by the changes: the expected diagnosed claims and the expected settled claims.

3.14. The effect of these changes by age band is illustrated in Figure 3.1. The overall effect is relatively small; for example, the total number of expected settled claims in 1999-2002 reduces by 5 (from 9,923 to 9,918).

Figure 3.1: Expected Settled Claims by age band under the Working Paper 33 assumptions and the revised assumptions described above; all durations combined.



3.15. Whilst the all-durations changes illustrated in Figure 3.1 appear small, there are more material changes for individual age/duration cells, with a tendency for the revised assumptions to increase the expected settled claims at shorter durations and at older ages. This effect is more marked where the exposure within a cell is not centred in mid-year; this can arise where data volumes are low, for example if products were launched late in a calendar year.

3.16. The second change in the current work is the base table used to calculate expected diagnosed claims. In Working Paper 33 (and in the results above and in Appendix A) we used CIBT93, which had been used as the principal comparison table in all the Committee's previous work.

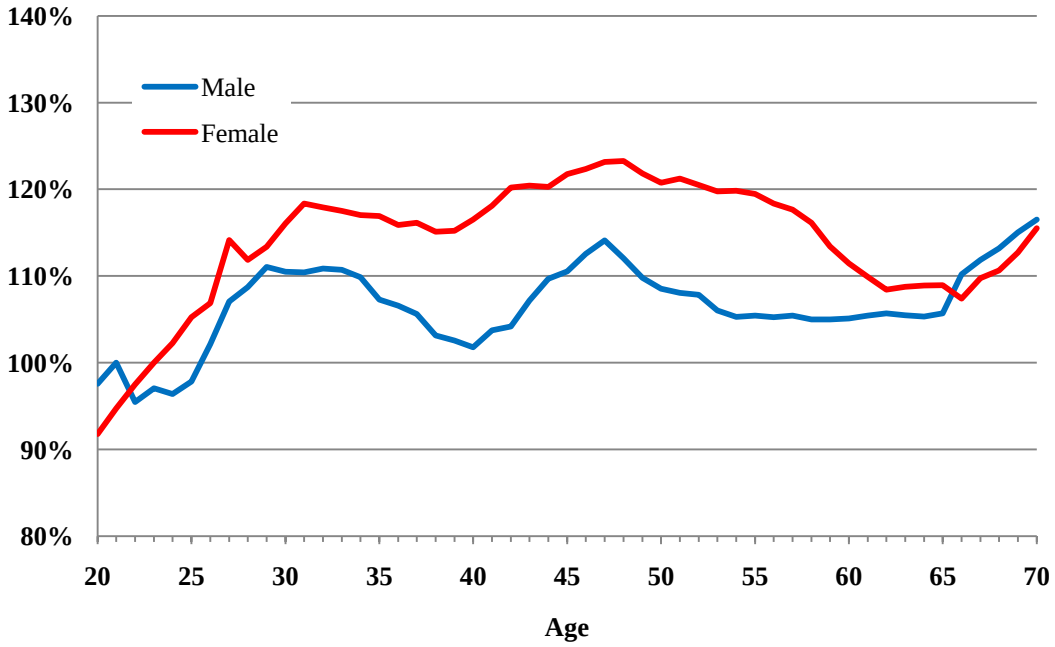
3.17. Although the use of a different table as the starting-point does not materially affect the final rates, the Committee decided that CIBT02 represented a more logical starting point for this work than CIBT93 for a number of reasons:

- CIBT02 is a more recent table and indeed applies to a similar time period to the rates we are deriving.
- The rates we derive at ages with less data are more likely to be influenced by the choice of starting rates than the rates at the ages where we have higher volumes of data. The use of the more up-to-date table is therefore appropriate.
- CIBT02 used a more sophisticated approach to smoothing. As the inherent smoothness of the starting rates helps smooth the Committee's derived rates, a technically smoother starting point may be beneficial.

(Brief summaries of CIBT93 and CIBT02 are included in Appendix E of this paper; more details are contained in "A Critical Review" [2000] and "Exploring the Critical Path" [2006], respectively.)

3.18. Figure 3.2 shows a comparison of the two tables, for males and females, for accelerated cover. Note that in this comparison, and elsewhere in the paper, we have used the 'Extended Cover' version of CIBT02, which covers a wider range of critical illness conditions than the 'Core Cover' version. It will be noted that CIBT02 is higher than CIBT93 at most ages, by between 5% and 10% for males and between 10% and 20% for females.

Figure 3.2: CIBT02 (Extended Cover) as a percentage of CIBT93, by age, accelerated cover



3.19. The difference between the tables is also apparent from Table 3.1 which shows the overall experience in 1999-2004 expressed in terms of both base tables. Note that the

purpose of Table 3.1 is to compare CIBT93 and CIBT02. The absolute A/E values are dependent on the age definitions of the two tables and, for computational convenience, we have treated both tables as if their rates applied to data grouped by age nearest birthday (in years) without adjustment. If we had used an age exact definition for either table, the values would be around 105% of those shown.

Table 3.1: Values of 100 x Actual Settled Claims / Expected Settled Claims (both based on age and duration at date of settlement); 1999-2004

	100xASC/ESC based on CIBT93	**100xASC/ESC based on CIBT02**
Male non-smoker	40%	37%
Male smoker	71%	66%
Female non-smoker	49%	41%
Female smoker	63%	54%

The approach used to produce claim diagnosis rates

3.20. In principle, the derivation of diagnosis rates is straightforward. As outlined in Working Paper 28 and summarised above, we have estimated the exposure for an extended period. The exposure has been multiplied by a set of claim rates to produce expected diagnosed claims and a claim development distribution applied to transform these expected diagnosed claims into expected settled claims. We then consider only the expected settled claims that fall during the years for which we have actual settled claims (i.e. the investigation period).

3.21. It follows that a set of diagnosis rates can be derived by adjusting the rates – in some way – such that the expected settled claims match the actual settled claims.

3.22. The Committee has experimented with several approaches to equating these two types of claims to satisfy ourselves that the results are not unduly influenced by the approach used. A brief consideration of different approaches, and the rationale for the one we have used, is provided in Appendix B.

3.23. Essentially, the approach used to derive the rates in section 6 involves adjusting the CIBT02 diagnosis rates to produce expected settled claims that are reasonably close to the actual settled claims, by both age and duration, in an intuitive manner. As will become apparent from the worked example for male non-smokers, the diagnosis rates are derived using three stages of adjustment:

i. An all-ages, all-durations adjustment is used to achieve an overall 100 A/E of 100.
ii. A re-shaping of the rates by age is applied using age-specific adjustments to achieve all-durations 100 A/Es of close to 100 for each age band.
iii. A re-shaping by duration is then applied to achieve all-ages 100 A/Es of close to 100 for each duration.

Note that after step iii, some further re-shaping by age is sometimes applied if the shape achieved by step ii is distorted by step iii.

3.24. Given the subjective way in which the rates are derived, members of the Committee experimented individually and the Committee satisfied itself that alternative approaches would not produce material differences. That said, different assumptions – for example,

with regard to selection effects – clearly did affect the rates. We have therefore sought to highlight these key assumptions and, in section 7, illustrate the fit of the rates to the experience to help actuaries assess the impact of alternative assumptions. In addition the Committee is happy to make available to member offices the spreadsheets used in deriving the rates.

3.25. Our "philosophy" in deriving the rates has been to follow the data as closely as possible even though this introduces the risk of over-fitting to the data (discussed further in section 4). Consequently the Committee sought to minimise the number of constraints. The only constraints that we have applied are:

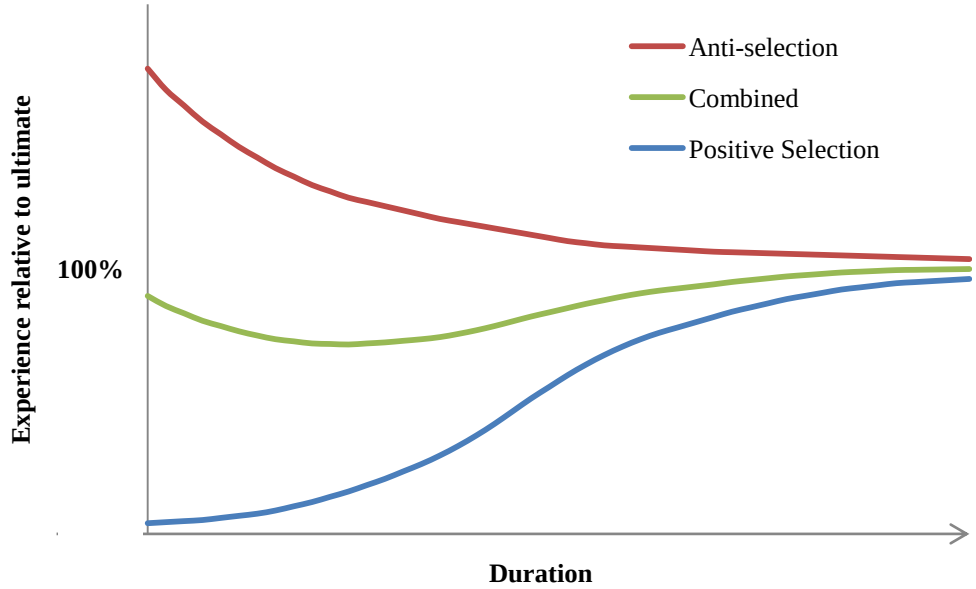
- Rates cannot reduce with age. (There is an exception to this constraint if one assumes that TPD ceases at a particular age, such as 65.)
- In general, rates cannot reduce with duration unless the data implies there could be anti-selection.
- There is an additional implicit constraint in that we have not considered results by individual duration within the 5+ category.

3.26. The second constraint warrants further comment. The Committee's *a priori* view of the impact of selection was that it would reflect the combined effect of two competing forces:

- Some degree of positive initial selection from medical underwriting and potential self-selection associated with house purchase; and
- Anti-selection, for example arising from non-disclosure of medical history, smoking status or family history.

These competing forces are illustrated in Figure 3.3. (For the avoidance of doubt, Figure 3.3 is illustrative and is not based on any "real" figures.)

Figure 3.3: Diagram illustrating the competing forces of selection



3.27. Although the impact of both the positive selection and the anti-selection reduce with increasing duration (in a smooth manner), the shape of the combined effect is not obvious. Consequently it was unclear what, if any, constraints might be appropriate to

reflect the combined effect of these competing forces. The second constraint in paragraph 3.25 is intended to allow for the possibility of anti-selection outweighing positive selection initially but – once this effect has worn off – rates can only increase with increasing duration. The Committee is conscious that the chosen constraint may not be appropriate; in particular:

- Although it appears reasonable for each individual cause, it is not obvious that aggregating different selection patterns across a number of diseases justifies the constraint at an all-causes level;
- Although it appears reasonable for one office/product (with a constant underwriting approach), it is not obvious it remains appropriate at an all-office level, given the changes to contributing offices and their relative weight.

3.28. Notwithstanding these concerns, the Committee required some constraints to produce an orderly progression of rates by duration and so we applied the stated constraint in the current work.

3.29. The Committee used the male and female CIBT02 (Extended Cover) tables as the sets of claim rates to produce the initial values of expected settled claims. These tables were adjusted by taking appropriate percentages – by age and duration – to produce amended values of the expected settled claims that were reasonably close to the actual settled claims. For computational convenience we have treated CIBT02 as if it were an age nearest table although the authors of "Exploring the Critical Path" intended the table to be used with an age definition of age exact. Note that the effect on the rates we derive is not material, though the percentage adjustments used to attain these rates would have been different if we had first adjusted the rates in CIBT02 to apply to age nearest.

3.30. The Committee derived four separate sets of rates – for males and females, non-smokers and smokers. The thought process followed by the Committee in deriving the rates for male non-smokers is described in some detail below, with the other three datasets described more briefly in the subsequent paragraphs.

The derivation of claim diagnosis rates: male non-smokers

3.31. In order to provide context to the subsequent description, the number of Actual Settled Claims for male non-smokers in 1999-2004 is shown in Table 3.2, by age band and duration. Unsurprisingly, there is little data at ages below 26 or above 65 with the former concentrated on the short durations and the latter on the long durations. The credibility of rates derived for these age ranges is therefore limited.

3.32. Note that there is a small amount of additional data outside the age range 20 to 70 that has been ignored in our analysis.

Table 3.2: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	42	48	33	9	5	1	**138**
26-30	88	146	91	78	50	63	**516**
31-35	149	192	162	123	106	196	**928**
36-40	128	243	186	132	97	344	**1,130**
41-45	113	220	203	155	96	413	**1,200**
46-50	104	181	164	150	82	455	**1,136**
51-55	96	169	172	158	118	493	**1,206**
56-60	69	120	135	98	87	375	**884**
61-65	19	32	39	37	30	171	**328**
66-70	1	4	6	7	8	49	**75**
ALL	**809**	**1,355**	**1,191**	**947**	**679**	**2,560**	**7,541**

3.33. Male non-smoker experience in 1999-2004 – in terms of 100xASCs/ESC – was 37% for all ages and durations combined. The first adjustment from CIBT02 (step i in paragraph 3.23) is therefore to replace 100% of the table with 37% at all ages and durations. This (obviously!) produces an overall 100A/E of 100%; the figures by age and duration are shown in Table 3.3.

3.34. It is important to note that although the adjustment has been applied to the diagnosis rates, Table 3.3 (and similar tables below) presents results in terms of Actual Settled Claims / Expected Settled Claims by age and duration at settlement.

Table 3.3: Values of 100A/E using 37% of CIBT02 at all ages and durations

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	136	151	195	122	169	58	**150**
26-30	97	122	103	138	141	149	**119**
31-35	107	96	101	109	127	115	**107**
36-40	77	100	93	93	90	116	**98**
41-45	65	85	93	100	81	107	**92**
46-50	66	75	80	100	70	107	**88**
51-55	74	81	91	109	103	112	**98**
56-60	97	99	116	103	112	110	**107**
61-65	104	92	104	110	108	120	**111**
66-70	81	102	101	104	125	144	**128**
ALL	**83**	**93**	**96**	**105**	**98**	**112**	**100**

3.35. Step ii seeks to remove the "U" shape, by age, in the all-durations results. In order to maintain a reasonably smooth shape to the rates, we used percentages of CIBT02 that are themselves smooth. As can be seen from Table 3.3, we need adjustments higher than 37% at younger ages and older ages, but lower at ages 36-55. The adjustments (expressed as a percentage of CIBT02) are shown below and the resulting 100A/E values are shown in Table 3.4:

Age	25	30	35	40	45	50	55	60	65
Percentage	46%	43%	38%	34%	34%	34%	38%	42%	44%

Note that in this paper, adjustments to CIBT02 are shown as whole percentages whereas the Committee used non-integral values in its work. In addition, although separate adjustments were applied at each age, only the adjustments at quinquennial ages are shown in the table above and subsequent tables of adjustments in this paper.

3.36. Note that with this revised shape of adjustments, the 100A/E values are now closer to 100 within each age band for all durations combined. The fit is less good at ages 20 to 25 and 66 to 70, but as noted previously there is little data in these cells. In particular, the adjustments at the younger ages have been constrained to avoid having diagnosis rates that reduce with increasing age.

Table 3.4: Values of 100A/E using above percentages of CIBT02 by age at all durations

Age	**Curtate duration at settlement**						
nearest at settlement	**0**	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	105	117	152	95	133	46	**117**
26-30	82	103	86	116	119	126	**100**
31-35	99	89	92	100	117	106	**99**
36-40	79	102	95	95	92	119	**100**
41-45	71	92	102	109	88	116	**100**
46-50	74	84	90	113	79	120	**99**
51-55	75	83	93	111	105	114	**100**
56-60	90	92	108	96	104	103	**100**
61-65	93	82	93	99	97	108	**100**
66-70	68	86	85	87	104	120	**107**
ALL	**82**	**92**	**96**	**105**	**98**	**113**	**100**

3.37. Further iterations could be undertaken to achieve diagnosis rates that match the experience more closely, e.g. a 100A/E of 100 at ages 31-35 instead of 99, if required. However the Committee felt a better overall fit would be achieved by reducing rates at duration 0 (and thereby reducing the expected settled claims at duration 0). Using 82% of the rates shown above at duration 0 produces the results in Table 3.5.

Table 3.5: Values of 100A/E using above percentages of CIBT02 by age at durations 1+ but 82% of these percentages at duration 0

Age	**Curtate duration at settlement**						
nearest at settlement	**0**	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	128	127	153	96	133	46	**128**
26-30	100	111	87	117	119	126	**107**
31-35	121	95	93	100	117	106	**103**
36-40	96	109	96	95	92	119	**104**
41-45	87	99	102	109	88	116	**104**
46-50	90	91	91	113	79	120	**102**
51-55	91	89	94	112	105	114	**104**
56-60	110	99	109	96	105	103	**103**
61-65	113	88	94	99	97	108	**102**
66-70	83	91	85	87	105	120	**108**
ALL	**100**	**99**	**97**	**105**	**99**	**113**	**104**

3.38. It is important to note that the alteration to the duration 0 diagnosis rates also affects the expected settled claims at duration 1 (and to a lesser extent, later durations). This is because Table 3.5 shows results expressed in terms of settled claims. The application of the claim development distribution to a different claim diagnosis rate at duration 0 produces a different number of settled claims at duration 0 but also, with reducing significance, at subsequent durations. (NB A similar effect occurs by age, with some of the claims diagnosed at one age being settled at higher ages. This is less visible from the tables in this paper than the corresponding durational effect because of the use of age bands.)

3.39. As a result the adjustment to the diagnosis rates at duration 0 appears to have produced a reasonable overall fit at duration 1, without any adjustment to the duration 1 rates themselves.

3.40. Indeed the shape by duration, up to duration 4, is now probably as good a fit as we are likely to achieve at an all-ages level because of the impact a change in rates at one duration has on the results at subsequent durations. One could seek to reduce the rates at durations 1 and 2 to achieve a closer fit, but this would also reduce the expected number of claims settled at duration 3 that were diagnosed at durations 1 and 2; an increase in the rates at duration 3 would then be required to compensate for this as well as to adjust for the A/E value of 105% in Table 3.5. The impact would be to increase the number of claims settled at duration 4 that were diagnosed at duration 3; a reduction in the rates at duration 4 would then be required to compensate for this as well as to adjust for the A/E value of 99% in Table 3.5 and the duration 3 rates would then significantly exceed those at duration 4.

3.41. The Committee did not consider this a plausible scenario and therefore, at this stage, we left the rates at durations 1 to 4 unchanged, noting that the rates appear to fit approximately for the combined durations. The rates for durations 5+ are clearly too low, however; Table 3.6 shows the effect of increasing the rates at durations 5+ by 16%. Note that Table 3.6 includes an additional column demonstrating that the rates applied to durations 1 to 4 combined produce an A/E of 100%.

Table 3.6: Values of 100A/E using above percentages of CIBT02 by age at durations 1-4 but 82% of these percentages at duration 0 and 116% at durations 5+

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	128	127	153	96	133	42	**128**	131
26-30	100	111	87	117	119	113	**106**	106
31-35	121	95	93	100	117	94	**101**	99
36-40	96	109	96	95	92	105	**101**	100
41-45	87	99	102	109	88	102	**100**	100
46-50	90	91	91	113	79	106	**98**	93
51-55	91	89	94	112	105	100	**98**	98
56-60	110	99	109	96	105	90	**97**	102
61-65	113	88	94	99	97	94	**95**	94
66-70	83	91	85	87	105	105	**100**	92
ALL	**100**	**99**	**97**	**105**	**99**	**100**	**100**	**100**

3.42. Note that the increase (of 16%) is higher than might appear necessary from Table 3.5. This is because some claims settled at durations 5+ arise from diagnoses at duration 4 and we have not adjusted the duration 4 rates, hence the need to overcompensate in the adjustment to the duration 5+ rates.

3.43. This completes step iii, however the fit by age that was previously achieved has now been lost, to some extent, due to the adjustments by duration. In particular, the reduction to the duration 0 rates has most impact at the younger ages whereas the increase to durations 5+ rates has most impact at older ages.

3.44. Table 3.7 shows the effect of increasing the rates at younger ages and reducing them at older ages. The adjustments to CIBT02 are shown in Table 3.8.

Table 3.7: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 3.8

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	115	113	137	85	119	37	**115**	117
26-30	95	105	83	111	114	108	**100**	100
31-35	119	94	92	99	116	93	**100**	98
36-40	95	108	94	94	91	103	**99**	98
41-45	87	99	103	109	88	103	**100**	101
46-50	92	92	92	115	80	107	**99**	95
51-55	93	90	96	114	107	102	**101**	100
56-60	115	103	114	100	109	94	**101**	107
61-65	118	92	98	103	101	98	**99**	98
66-70	88	97	90	92	111	111	**106**	98
ALL	**100**	**99**	**97**	**105**	**99**	**101**	**100**	**100**

3.45. Note that we were again unable to achieve an A/E of 100% at ages 20-25, given our constraint that diagnosis rates cannot reduce with increasing age, referred to above.

Table 3.8: Adjustments to CIBT02 by age and duration underlying the results in Table 3.7

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
20	48%	58%	58%	58%	58%	68%
25	42%	51%	51%	51%	51%	60%
30	36%	44%	44%	44%	44%	51%
35	32%	39%	39%	39%	39%	45%
40	28%	34%	34%	34%	34%	40%
45	27%	33%	33%	33%	33%	39%
50	27%	33%	33%	33%	33%	39%
55	31%	38%	38%	38%	38%	44%
60	32%	39%	39%	39%	39%	45%
65	34%	41%	41%	41%	41%	48%
70	36%	43%	43%	43%	43%	50%

3.46. The most significant area of "poor fit" apparent to the Committee in Table 3.7 relates to ages 36 to 55, in particular at duration 0 where the A/E values are all less than 100%. There may be good reasons for this; in particular heart attack and stroke are more significant causes of claim at these ages and the risk factors for these events – such as obesity, hypertension and angina – may be better detected by medical underwriting than those for, say, cancer.

3.47. Nevertheless it is important to recognise that reducing the rates at duration 0 would affect the rates at subsequent durations too, as discussed above. Given that the picture presented in Table 3.7 is one where the "light" experience at ages 36-45 exists for claims settled at duration 0 only, it is questionable whether this is a genuine feature. In contrast, at ages 46-55 the lighter experience appears also to persist for claims settled at durations 1 and 2 and correspondingly there is more consistently heavy experience at durations 3, 4 and 5+; hence the Committee considered this to be more credible. The Committee decided not to adjust the rates further at these ages; in part because of the weak evidence for such a feature found in the cause-specific analysis described in section 5. However an illustration of the further adjustment that might have been made is provided in section 4.

3.48. The description of the approach to "final" diagnosis rates for male non-smokers, above, has presented the approach in discrete steps, with each successive step justified by reference to the divergences between the actual settled claims and expected settled claims apparent in the various tables. No statistical justification has been presented, but we hope it is apparent that the goodness of fit has been improved without unduly worsening smoothness, by these successive steps. By applying reasonably smooth adjustments to the underlying table (CIBT02) we have sought to produce reasonably smooth rates; however we do not claim that the balance between goodness of fit and smoothness is optimal.

The derivation of claim diagnosis rates: male smokers

3.49. In order to provide context the number of Actual Settled Claims for male smokers in 1999-2004 is shown in Table 3.9, by age band and duration. In total, the number of claims is less than half that for male non-smokers, shown in Table 3.2; the credibility of these rates is consequently lower than that of the corresponding non-smoker rates.

Table 3.9: Actual Settled Claims in 1999-2004, male smokers by age band and duration

Age	**Curtate duration at settlement**						
nearest at settlement	**0**	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	18	12	9	5	0	0	**44**
26-30	45	46	31	24	14	14	**174**
31-35	53	97	77	51	47	46	**371**
36-40	83	115	85	74	51	100	**508**
41-45	82	113	97	66	37	138	**533**
46-50	90	121	106	88	68	176	**649**
51-55	69	96	93	75	62	166	**561**
56-60	31	49	56	48	41	131	**356**
61-65	3	6	19	7	6	39	**80**
66-70	0	0	1	1	0	4	**6**
ALL	**474**	**655**	**574**	**439**	**326**	**814**	**3,282**

3.50. Male smoker experience in 1999-2004 – in terms of 100xASCs/ESC – was 66% of CIBT02 for all ages and durations combined. Interestingly, the use of 66% of CIBT02 at all ages and durations did not produce the "U" shape observed for male non-smokers but an inverted "U" implying that adjustments lower than 66% are needed at younger ages and older ages, but higher at ages 46-60.

3.51. There are also less prominent features by duration than for male non-smokers; in particular there is no apparent select effect at duration 0 and an A/E of 100% for duration 0 could only be achieved by increasing the rates, relative to duration 1. This appears to imply that anti-selection outweighs positive selection for male smokers.

3.52. Later durations are again problematic, as noted for male non-smokers in paragraph 3.40 as the data implies rates at durations 2, 3 and 4 exceeding those at durations 5+; the Committee did not consider this plausible and therefore decided to combine durations 2, 3, 4 and 5+. This produced the results in Table 3.10 whilst the adjustments to CIBT02 are shown in Table 3.11 for quinquennial ages. Note that Table 3.10 includes an additional column demonstrating that the rates applied to durations 2+ produce an A/E of 100% on a combined basis.

Table 3.10: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 3.11

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**2+**
20-25	116	82	120	160	0	0	**104**	116
26-30	110	94	88	109	105	100	**100**	98
31-35	77	109	110	106	140	74	**100**	103
36-40	100	103	93	117	112	90	**100**	100
41-45	102	102	103	99	75	100	**99**	97
46-50	108	102	102	113	115	100	**105**	105
51-55	103	94	97	100	105	88	**96**	95
56-60	97	93	106	109	115	101	**103**	105
61-65	59	58	148	59	61	89	**85**	91
66-70	0	0	71	64	0	107	**67**	75
ALL	**100**	**99**	**102**	**106**	**106**	**94**	**100**	**100**

3.53. Note that we have again been unable to achieve an A/E of 100% at ages 20-25, given the constraint that diagnosis rates cannot reduce with increasing age, referred to above.

3.54. Note also that it was difficult to achieve a close fit to the data at all ages, whilst also using smooth adjustments (and therefore smooth rates). Consequently the rates are slightly higher than those implied by the data at ages 41-45 and 51-55 but lower at ages 46-50 and 56-60.

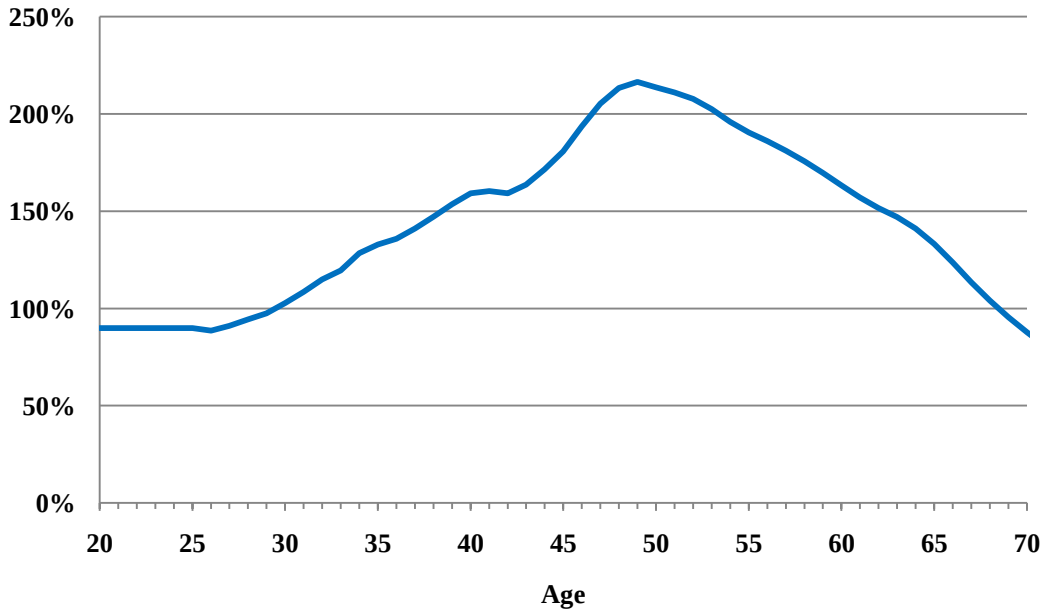
3.55. We were also unable to achieve an A/E of 100% at ages 61+ but the credibility of the underlying data is limited due to the low number of claims settled at these ages.

Table 3.11: Adjustments to CIBT02 by age and duration underlying the results in Table 3.10

Age nearest at diagnosis	Curtate duration at diagnosis					
	0	1	2	3	4	5+
20	60%	53%	61%	61%	61%	61%
25	53%	47%	54%	54%	54%	54%
30	51%	45%	52%	52%	52%	52%
35	59%	52%	60%	60%	60%	60%
40	62%	55%	63%	63%	63%	63%
45	69%	61%	70%	70%	70%	70%
50	81%	72%	83%	83%	83%	83%
55	81%	72%	83%	83%	83%	83%
60	73%	64%	74%	74%	74%	74%
65	62%	55%	64%	64%	64%	64%
70	43%	38%	44%	44%	44%	44%

3.56. Figure 3.4 compares the smoker rates with the non-smoker rates; the smoker rates are those applicable to durations 2+ and the non-smoker rates are those applicable to durations 5+.

Figure 3.4: Male smoker rates as a percentage of male non-smoker rates (ultimate)



3.57. The two sets of rates have been derived separately; i.e. the non-smoker experience has not informed the smoker rates or vice versa. The Committee was comfortable with the general shape of this curve for the ages where we have substantial data volumes, i.e. between ages 35 and 55. In particular, it is credible that smoking might have a limited impact on health at younger ages or that risks not related to smoking dominate at young and old ages. However, the Committee does not consider it plausible for smoker rates to be lower than non-smoker rates at any age. No such constraint has been applied to the smoker rates below age 30 or above age 69 in the current work, but the Committee

expects to amend this approach in its work on 2003-2006 rates, if the smoker experience again appears lighter than the non-smoker experience at any ages.

The derivation of claim diagnosis rates: female non-smokers

3.58. Again, in order to provide context, we start by showing the number of Actual Settled Claims for female non-smokers in 1999-2004 in Table 3.12, by age band and duration. In total, the number of claims is around 80% of that for male non-smokers, shown in Table 3.2.

Table 3.12: Actual Settled Claims in 1999-2004, female non-smokers by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	28	26	24	8	4	3	**93**
26-30	68	118	103	57	44	71	**461**
31-35	132	213	190	115	114	222	**986**
36-40	136	236	196	148	111	346	**1,173**
41-45	115	205	200	122	108	332	**1,082**
46-50	102	166	156	105	88	337	**954**
51-55	77	137	129	96	75	324	**838**
56-60	30	48	56	47	30	176	**387**
61-65	3	7	17	11	8	48	**94**
66-70	1	0	2	3	4	14	**24**
ALL	**692**	**1,156**	**1,073**	**712**	**586**	**1,873**	**6,092**

3.59. Female non-smoker experience in 1999-2004 – in terms of 100xASCs/ESC – was 41% for all ages and durations combined. Applying this adjustment to CIBT02 at all ages and durations produced A/E values that were reasonably flat by age and step ii was therefore not applied for this dataset.

3.60. The most prominent feature was a select effect at duration 0; at 16% lower than the duration 1 rates this is of similar magnitude to that observed for male non-smokers

3.61. As with the datasets considered above, later durations needed to be combined to produce plausible rates by duration; in this case the Committee combined durations 2, 3, 4 and 5+. To compensate for the reduction applied to the duration 0 rates, the rates at durations 2+ needed to be increased by 6% to maintain an overall A/E of 100%.

3.62. Some minor re-shaping by age was then undertaken to produce a closer fit; in the main, rates were reduced at ages up to 40 and increased at ages 56 and over. This produced the results in Table 3.13 whilst the adjustments to CIBT02 are shown in Table 3.14 for quinquennial ages. Note that Table 3.13 includes an additional column demonstrating that the rates applied to durations 2+ produce an A/E of 100% on a combined basis.

Table 3.13: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 3.14

Age nearest at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**2+**
20-25	100	83	122	84	94	137	**101**	110
26-30	86	98	103	85	100	123	**99**	102
31-35	102	101	102	86	115	102	**101**	101
36-40	97	101	94	98	95	104	**99**	99
41-45	99	103	109	91	104	97	**100**	100
46-50	105	100	100	89	94	102	**99**	98
51-55	106	104	100	94	90	107	**102**	101
56-60	111	91	100	99	75	105	**99**	99
61-65	67	71	145	100	86	99	**99**	104
66-70	279	0	110	150	225	127	**132**	138
ALL	**100**	**100**	**102**	**92**	**98**	**103**	**100**	**100**

3.63. Unlike the two male datasets, for female non-smokers we were able to achieve an all-durations A/E close to 100% at younger ages without relaxing the constraint that diagnosis rates cannot reduce with increasing age. However it was difficult to achieve a close fit to the data at all ages, whilst also using smooth adjustments (and therefore smooth rates). In particular, little credibility has been given to the experience at ages 66-70 given the low number of claims settled at these ages.

Table 3.14: Adjustments to CIBT02 by age and duration underlying the results in Table 3.13

Age nearest at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
20	31%	37%	39%	39%	39%	39%
25	34%	41%	43%	43%	43%	43%
30	37%	45%	47%	47%	47%	47%
35	38%	45%	48%	48%	48%	48%
40	34%	41%	44%	44%	44%	44%
45	32%	39%	41%	41%	41%	41%
50	35%	42%	44%	44%	44%	44%
55	34%	40%	43%	43%	43%	43%
60	30%	37%	39%	39%	39%	39%
65	26%	32%	33%	33%	33%	33%
70	31%	37%	39%	39%	39%	39%

The derivation of claim diagnosis rates: female smokers

3.64. The number of Actual Settled Claims for female smokers in 1999-2004 is shown in Table 3.15, by age band and duration. This is the smallest of the four datasets with around half the number of claims in the male smokers dataset.

Table 3.15: Actual Settled Claims in 1999-2004, female smokers by age band and duration

Age nearest at settlement	Curtate duration at settlement 0	1	2	3	4	5+	ALL
20-25	12	10	9	2	0	0	**33**
26-30	18	29	36	16	13	12	**124**
31-35	34	57	43	25	22	41	**222**
36-40	41	56	42	31	21	73	**264**
41-45	43	53	42	35	28	74	**275**
46-50	36	63	63	36	33	94	**325**
51-55	26	41	34	42	23	88	**254**
56-60	10	17	18	17	12	61	**135**
61-65	0	5	5	1	1	16	**28**
66-70	0	0	0	0	0	5	**5**
ALL	**220**	**331**	**292**	**205**	**153**	**464**	**1,665**

3.65. Female smoker experience in 1999-2004 – in terms of 100xASCs/ESC – was 54% for all ages and durations combined. Applying this adjustment to CIBT02 at all ages and durations produced A/E values that were below 100 at younger ages and above at older ages; step ii therefore involved reducing rates at younger ages and increasing rates at older ages.

3.66. Unlike the male smoker rates, there is a select effect at duration 0, similar to that for female non-smokers, with rates 16% lower than those at duration 1. As with the datasets considered above, later durations needed to be combined to produce plausible rates by duration; in this case the Committee combined durations 2 to 4. Rates at duration 1 then appear to be 5% lower than rates at durations 2-4 combined, whereas duration 5+ rates are 16% higher. This produced the results in Table 3.16 whilst the adjustments to CIBT02 are shown in Table 3.17 for quinquennial ages.

Table 3.16: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 3.17

Age nearest at settlement	Curtate duration at settlement 0	1	2	3	4	5+	ALL	2-4
20-25	118	86	133	63	0	0	**98**	98
26-30	74	86	140	98	124	86	**100**	124
31-35	95	109	102	87	108	91	**99**	99
36-40	105	96	88	96	88	111	**99**	90
41-45	117	93	87	104	111	96	**99**	98
46-50	103	112	127	98	117	103	**109**	115
51-55	97	89	77	121	84	91	**92**	93
56-60	102	89	91	103	87	107	**99**	94
61-65	0	174	141	30	35	110	**98**	72
66-70	0	0	0	0	0	296	**169**	0
ALL	**101**	**98**	**101**	**100**	**99**	**100**	**100**	**100**

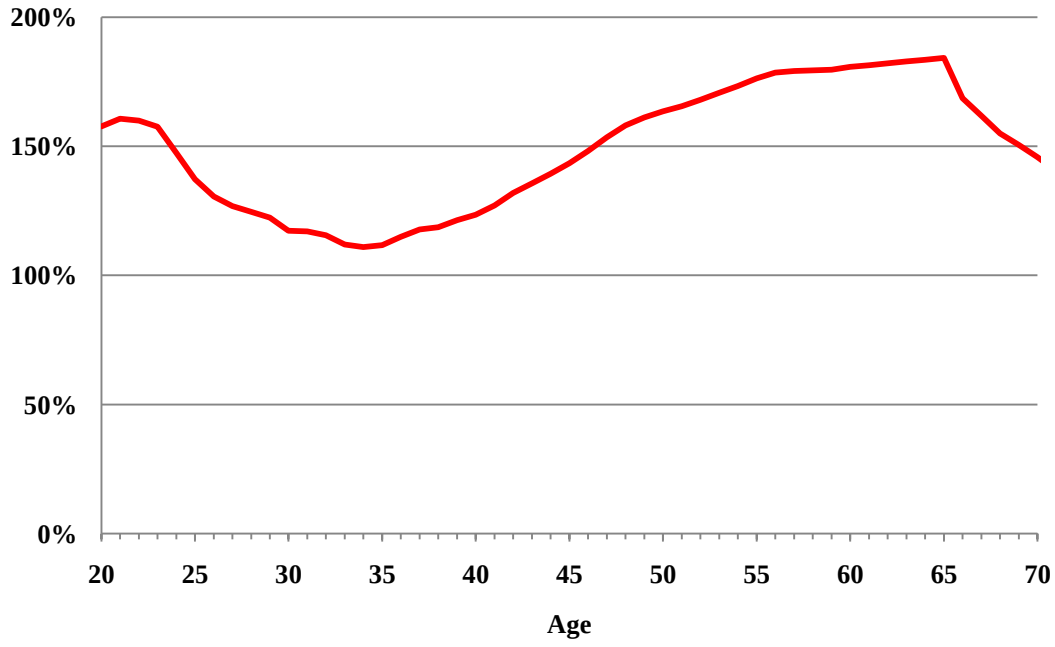
3.67. Note that we were again unable to achieve an A/E of 100% at ages 66+ without allowing diagnosis rates to reduce with increasing age.

Table 3.17: Adjustments to CIBT02 by age and duration underlying the results in Table 3.16

Age nearest at diagnosis	Curtate duration at diagnosis					
	0	1	2	3	4	5+
20	49%	52%	55%	55%	55%	61%
25	47%	50%	53%	53%	53%	59%
30	44%	47%	50%	50%	50%	55%
35	43%	45%	48%	48%	48%	53%
40	43%	46%	48%	48%	48%	54%
45	47%	50%	53%	53%	53%	59%
50	57%	61%	65%	65%	65%	72%
55	60%	64%	67%	67%	67%	75%
60	55%	59%	62%	62%	62%	70%
65	49%	52%	55%	55%	55%	61%
70	46%	49%	51%	51%	51%	57%

3.68. Figure 3.5 compares the smoker rates with the non-smoker rates; both sets of rates are those applicable to durations 5+.

Figure 3.5: Female smoker rates as a percentage of female non-smoker rates (ultimate)



3.69. The shape of the smoker/non-smoker ratio by age is relatively smooth at the ages where we have significant data volumes and is never lower than 100%. The shape is quite different from that for males shown in Figure 3.4. Whereas the differential for males peaks at around age 50, the female differential continues to increase with age from about age 35, except at the oldest ages where there is very limited smoker data.

3.70. Although the ultimate female smoker rates always exceed the corresponding non-smoker rates, this is not the case at durations 2 to 4 where the smoker rates are slightly lower at age 34. This arises from the choice of different select patterns between the female non-smoker and female smoker datasets (0, 1, 2+ compared with 0, 1, 2-4, 5+),

however at an all-durations level, the two sets of rates are very close in the 30s. This may mean that the higher ratios at younger ages are implausible but, as shown in Table 3.15, the number of smoker claims at these ages is small.

4. ISSUES ENCOUNTERED IN DERIVING DIAGNOSIS RATES

4.1. The previous section described the approach adopted in deriving the diagnosis rates. A number of practical issues arose, some of which were referred to at the appropriate point in the previous section. These issues are discussed more fully in this section.

Goodness of fit

4.2. As noted in paragraph 3.48, the Committee has not included any statistical justification for the goodness of fit of the diagnosis rates to the underlying data.

4.3. In its work the Committee used a simple measure of goodness of fit, i.e.:

$$(\Sigma[\text{Actual-Expected}]^2/\text{Expected})$$

Where a more traditional approach is taken, using graduation by mathematical formula, such a measure can be considered to be a statistic having a χ^2-distribution; and a value of this measure close to the number of degrees of freedom in the distribution implies a good balance between goodness of fit and smoothness of the graduated rates. Given the Committee's approach to deriving diagnosis rates, no such statistical interpretation was possible; nevertheless, aiming to produce a value of this measure similar to the number of cells data were grouped into was still considered a useful indicator. The Committee did not seek to minimise this measure, however, as it was conscious of the risk of over-fitting the rates to the data and producing rates that lack smoothness.

4.4. In addition to the risk of losing smoothness through over-fitting, the Committee was also mindful that over-fitting might result in the rates reflecting transient features in the data that arose solely from stochastic variability. This was especially true as there is little or no prior work against which the Committee could compare its insured diagnosis rates. This is one reason for the Committee's decision to use the 2003-2006 dataset for its future work as features of the 1999-2004 experience that recur in the 2003-2006 experience can be incorporated into formal tables of diagnosis rates with greater confidence.

4.5. An example of where the Committee was conscious of the risk of over-fitting is the decision not to adjust the male non-smoker rates at ages 46 to 55, discussed in paragraphs 3.46 and 3.47. The Committee debated whether or not to increase the degree of selection at short durations for these ages – and consequently to increase the rates at the longer durations – thereby improving the goodness of fit of the rates to the observed data. Whilst a possible rationale for this feature can be advanced, the Committee would have felt much more comfortable had a similar feature been observed in the other datasets, in rates derived for an earlier period or even in rates from another territory. Indeed the Committee looked to recent CMI Life Office Mortality experience for affirmation, but data volumes for term assurances at these ages and durations are lower than in this investigation. In addition, as discussed further in section 5, there was only qualified support for this feature from our cause-specific analysis; hence the Committee's decision not to adjust the rates for this feature.

4.6. Finally, under this heading, we repeat our earlier statement that the approach taken to deriving the diagnosis rates means that the final goodness of fit may not be optimal, although we hope it is reasonable. As noted earlier, the spreadsheets used to produce

these rates are being made available to CMI member offices wishing to investigate alternative fits.

Age range

4.7. In section 3 we attempted to derive rates for ages 20 to 70 for each of the four datasets (by gender and smoker status). It will be evident from the numbers of actual settled claims, shown in Tables 3.2, 3.9, 3.12 and 3.15, that there are few claims at ages below 25 and above age 65. The credibility of any rates outside the main region of the data is therefore limited as illustrated by the difficulty of deriving plausible rates at older ages for several of the gender/smoker datasets.

4.8. Note that the lack of data above age 65 does not just arise from the immaturity of the dataset; as illustrated in Figure 2.4, most of the data relates to term and endowment assurances which infrequently continue beyond age 65.

4.9. Consequently in Appendix D we have shown rates for ages from 25 to 65 only. The Committee recognises that a formal published table should aim to cover the full range of ages for which critical illness diagnosis rates may be required and that further work will be required to derive plausible rates, perhaps in relation to the population table CIBT02, if a formal published table – covering the full range of ages – is produced for 2003-2006.

4.10. These issues are compounded when deriving cause-specific rates (see section 5), which the Committee has restricted to ages 30-60 in the current work.

Selection patterns

4.11. The Committee's previous work had not provided evidence on the pattern of selection in diagnosis rates; indeed this issue was a key driver for the current work.

4.12. In the current work, the Committee has not altered the differentials between the rates at different durations by age (other than where differences have arisen as a result of rounding); i.e. the rates at duration 0 are the same percentage of the rates at duration 1 at all ages, within each gender/smoker dataset. This has been done for simplicity; in practice the differentials can be expected to vary by age, according to the effectiveness of medical selection and the varying mix by cause of claim.

4.13. The Committee was keen not to impose any *a priori* assumptions on duration beyond the practical constraint that we did not sub-divide the durations 5+ experience. However we did impose the constraint that, in general, rates cannot reduce with duration unless the data implies there could be anti-selection. As noted in paragraph 3.27, it is by no means obvious that this constraint is reasonable at an all-causes level and all-office level, but has been used in the current work.

4.14. One consequence of these constraints was a need to group some durations, for example durations 1 to 4 for male non-smokers. This is analogous to the grouping of durations in graduations by mathematical formula, and to construct rates for these durations separately would have produced rates by duration that the Committee considered implausible. The select periods adopted for the rates in Appendix D were:

Male Non-smoker	0, 1-4, 5+
Male Smoker	0, 1, 2+
Female Non-smoker	0, 1, 2+
Female Smoker	0, 1, 2-4, 5+

4.15. It is unsurprising that the selection patterns differ between the four datasets. The impact of selection is likely to vary by cause and the all-causes rates are a weighted average of the cause-specific rates. Since the underlying causes have different weights by gender and smoker status, it is understandable that the select patterns in the all-causes rates differ by gender and smoker status.

4.16. Whilst the Committee considers these groupings to be reasonable patterns to apply to the data, other groupings could have been chosen and we decided it would be appropriate to illustrate one example.

4.17. For male non-smokers, the pattern adopted (in section 3) was to derive three sets of rates for duration 0, durations 1-4 combined and durations 5+; an alternative that could reasonably have been chosen was to derive four sets of rates for duration 0, duration 1, duration 2 and durations 3+ combined. The adjustments at duration 0 have been left unchanged, but:

- The adjustments applied at duration 1 are now 98% of those used previously (for durations 1-4 combined),
- The adjustments applied at duration 2 are now 96% of those used previously (for durations 1-4 combined),
- The adjustments applied at durations 3 and 4 are 96% of those used previously (for durations 5+); this is equivalent to approximately 111% of those used previously (for durations 1-4 combined), and
- The adjustments applied at durations 5+ are 96% of those used previously (for durations 5+).

The resulting A/E values are shown in Table 4.1.

Table 4.1: Values of 100A/E for male non-smokers using percentages of CIBT02 by age and duration shown in Table 3.7, but adjusted as described in paragraph 4.17

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**3+**
20-25	116	115	141	82	108	37	**115**	82
26-30	94	106	85	106	103	109	**100**	106
31-35	120	96	95	94	105	94	**99**	97
36-40	96	110	97	90	82	106	**100**	97
41-45	87	100	106	104	80	105	**100**	100
46-50	92	93	95	110	73	110	**99**	104
51-55	93	92	99	109	97	105	**101**	104
56-60	115	104	117	96	99	96	**101**	96
61-65	118	93	101	98	92	101	**100**	99
66-70	88	98	93	87	100	114	**106**	109
ALL	**100**	**100**	**100**	**101**	**90**	**103**	**100**	**100**

4.18. Note that in this alternative fit the constraint on duration (see paragraph 3.25) has not been applied and the rates at duration 1 exceed those at duration 2.

4.19. This alternative fit gave a higher value for the goodness of fit statistic referred to in paragraph 4.3 than was obtained for the durational grouping described in section 3 (i.e. indicative of a less-close fit to the data). This should not be regarded as conclusive evidence that combining durations 1-4 is appropriate, however, since further refinement of the rates derived using the "3+ approach" by age might produce a better fit (as well as the lack of statistical foundation underlying this work meaning that this statistic is, at best, a guide).

4.20. Whichever grouping is adopted, the resulting rates contain a "step", by duration that the Committee suspects may not exist in practice. If increasing rates by duration arise from the diminishing impact of initial selection, then one would expect a more gradual trend (at least at a cause-specific level). In the durational grouping described in section 3, the step between duration 4 and durations 5+ (where rates increase by around 16%) probably over-states the true position; however the "3+ approach" produces a similar step, but between duration 2 and durations 3+. It should be noted that this comparison is based upon rates by duration derived from the whole 1999-2004 period rather than following consistent cohorts.

Anti-Selection in male smoker rates?

4.21. In terms of durational patterns, perhaps the most interesting feature to emerge from this work was the apparent anti-selection for male smokers. Analysis of subsequent data may, of course, suggest this is the result of random fluctuation, rather than a genuine effect. However until other evidence becomes available, the Committee felt it was important to highlight this apparent feature.

4.22. The Committee has not yet derived cause-specific rates for male smokers (see section 5), which might provide clues on whether this feature results from stochastic volatility or is a genuine feature of the experience. However cursory examination of the settled claims by duration, for the main causes of claim, indicates that the apparent anti-selection arises from deaths and heart attacks, rather than cancer. As death claims may include sudden deaths from heart attacks, it is possible that the apparent anti-selection arises solely from cardiovascular disease.

4.23. Unfortunately there is little more that can be done to test this assumption other than to see whether it persists in the 2003-2006 dataset.

Additional selection in male non-smoker rates?

4.24. As noted in paragraph 3.46, the most significant area of "poor fit" apparent to the Committee in the all-causes male non-smoker rates related to ages 36 to 55 and, more particularly, ages 46-55 where there appears to be additional selection to that allowed for at an all-ages level. This is discussed further, in relation to the cause-specific rates in section 5, but the Committee thought it may be helpful to provide an illustration of the further adjustment that might have been made, had the Committee decided it were appropriate to do so.

4.25. A revised set of adjustments to CIBT02 is shown in Table 4.2. Note that revised adjustments are only shown for ages 50 and 55, as these are the only ages that have been altered (of those shown in Table 3.8).

Table 4.2: Adjustments to CIBT02 by age and duration underlying the results in Table 4.3

Age nearest at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
50	24%	28%	28%	35%	35%	41%
55	30%	37%	37%	38%	38%	44%

4.26. The resulting values of Actual Settled Claims / Expected Settled Claims are shown in Table 4.3. Again, these are only shown for the age bands 46-50 and 51-55 (and "All Ages"), as these are the ages that have been affected by the alteration (of those shown in Table 3.7).

Table 4.3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 4.2

Age nearest at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
46-50	98	98	98	114	76	102	**99**	98
51-55	100	98	105	116	104	98	**102**	105
ALL	**102**	**101**	**99**	**105**	**98**	**99**	**100**	**101**

The derivation of smoker rates

4.27. In section 3, the derivation of non-smoker and smoker rates was undertaken separately for each of the datasets. It will be apparent that this can give rise to rates that are implausible when the smoker and non-smoker rates are compared (see Figure 3.3 for males, in particular). This is especially true where the volumes of data are limited, at younger and older ages at an all-causes level, or more generally if cause-specific rates are derived for both smoker statuses.

4.28. Alternative approaches that could have been employed are:

- To derive aggregate rates, based on the combined smoker and non-smoker datasets, and then deduce sensible adjustments from the aggregate rates to the smoker-differentiated rates; and
- To derive smoker rates in a similar manner to that described in section 3, but starting from expected settled claims based on the non-smoker experience (rather than CIBT02) and then applying smooth smoker/non-smoker differentials.

4.29. The Committee will consider this issue further in relation to the 2003-2006 dataset.

A discontinuity at age 65

4.30. In section 3, we noted that by applying reasonably smooth adjustments to CIBT02 – which is itself smooth by age – the rates derived are themselves reasonably smooth (although not necessarily to the same degree that graduation by mathematical formula produces smooth rates). There is, however, a discontinuity in CIBT02 (and, indeed, CIBT93) as Total and Permanent Disability (TPD) was assumed to cease at age 65.

4.31. In our current rates, this potential discontinuity has been ignored. TPD often ceases on the 65th birthday in which case it would cease to contribute to all-causes rates at that age; however there may also be policies where TPD ceases at a different age or continues beyond age 65, on an Activities of Daily Living definition, or indeed without

TPD altogether so that there would be a less abrupt discontinuity within an All Offices dataset. Given the lack of credible data at these ages, the Committee was unable to determine the size of any discontinuity and has decided to consider this issue further if we seek to produce rates at older ages for all causes including TPD from the 2003-2006 dataset.

4.32. One option is to follow the approach used in CIBT02 and incorporate a discontinuity into our rates. The scale of the discontinuity can be assessed by seeking smooth rates in the area of age 65 for "all-causes excluding TPD" rates. However such a discontinuity would prevent interpolation of the rates for use with an alternative age definition.

4.33. An alternative – given the uncertainty surrounding the TPD rates themselves, discussed in the following section – is to restrict the main set of all-causes rates to exclude TPD.

5. DIAGNOSIS RATES BY CAUSE

5.1. In this section we illustrate diagnosis rates for the main causes of claim. The Committee was keen to investigate cause-specific claim rates, not only for their intrinsic interest but also because these should provide useful corroboration for the all-causes rates. In particular, the shape of selection may be expected to vary considerably between different causes. Since the composition of the rates by cause varies considerably with age and between the gender/smoker datasets, analysis by cause may inform the selection that is allowed for in the all-causes rates.

5.2. The Committee is also conscious of the current interest in the UK market regarding TPD, in the light of the 2009 review of the ABI Statement of Best Practice for Critical Illness Cover. Further consideration is therefore given to rates for all-causes excluding TPD in the final part of this section.

5.3. This analysis is limited to male non-smokers only; the reasons for this are explained below.

5.4. The methodology used to derive cause-specific rates is identical to that used for the all-causes rates, with the following exceptions:

- The Expected Diagnosed Claims are calculated using the cause-specific rates from the CIBT02 table, rather than the all-causes rates;
- The Expected Settled Claims are calculated from the Expected Diagnosed Claims using a cause-specific claim development distribution (CDD); and
- The Actual Settled Claims are those for the particular cause of claim only.

5.5. Table 5.1, below, shows the number of claims available in the 1999-2004 dataset for the main causes of claim.

Table 5.1: CMI accelerated critical illness claims, 1999-2004, for the main causes of claim.

	Male		**Female**	
	Non-smoker	**Smoker**	**Non-smoker**	**Smoker**
Death	1,898	951	713	331
Heart Attack	1,032	848	114	107
Breast Cancer	2,818	813	1,014	188
Other cancers			3,103	664
Stroke	412	193	228	103
Coronary Artery Bypass Graft	272	94	26	13
Multiple Sclerosis	205	101	405	129
Total and Permanent Disability	256	89	229	65
Sum of above	6,893	3,089	5,832	1,600
Total claims	**7,557**	**3,283**	**6,098**	**1,667**
% covered by above	91%	94%	96%	96%

5.6. Note that Table 5.1 shows the total number of claims for each cause; in order to develop a cause-specific claim development distribution we also need both date of diagnosis and

date of settlement, limiting the number of causes for which we have credible volumes of data.

5.7. For males, the Committee decided that there were sufficient claims to attempt to produce rates for death, heart attack, cancer, stroke, coronary artery bypass graft (CABG) and total and permanent disability (TPD) for non-smokers. We did not attempt to produce rates for multiple sclerosis (MS) or any other cause. Given the significantly lower number of claims for smokers than non-smokers, we have restricted the analysis to non-smokers at this stage.

5.8. For females the numbers of claims might appear to justify analysis of death, breast cancer, other cancers and MS (for non-smokers at least); however there is an important issue to note regarding analysis by any sub-division of cancer. We request that cancer claims are split by site but for around 56% of the total cancer claims the site is not specified. The figures for "Other cancers" above include all cancers, other than those specified to be breast cancer. As a result any rates derived for "female breast cancer" would understate the true rates if a significant number of female breast cancer claims were included under site not specified. The Committee considered that it would have to combine all the cancer claims and treat this as a single cause, as has been done for males, which would considerably curtail the value of producing rates by cause for females. Hence we have also restricted the analysis to males at this stage.

5.9. Note that a similar issue arises with claims that are reported to the CMI as "unknown cause", since these may include claims for the main causes. This issue is of much lower magnitude, though, as the claims of "unknown cause" only account for 0.7% of the total claims.

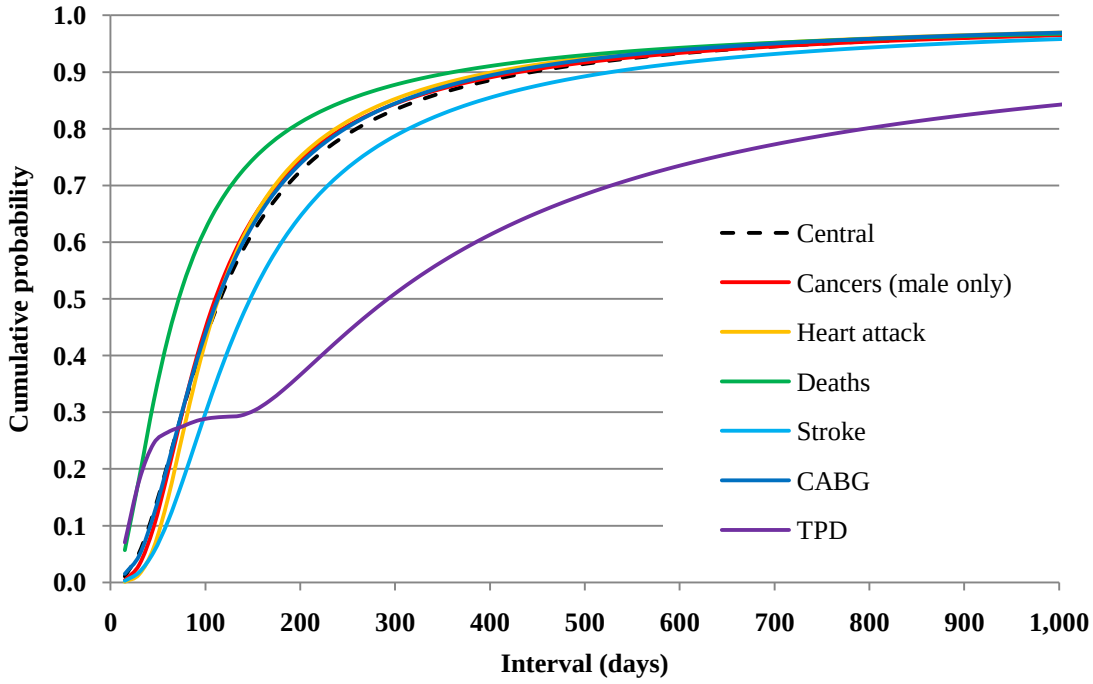
5.10. The cause-specific claim development distributions used in this analysis are illustrated in Figure 5.1. Note that most of these distributions have been derived from all four gender/smoker datasets combined. The Committee sees no reason why these distributions should vary materially between the datasets for a cause such as heart attack, and hence opted for the greater credibility afforded by combining the datasets. This is not necessarily true of other causes, such as death and cancer, where the mix of underlying causes may be quite different between males and females and between smokers and non-smokers; however the analysis in Working Paper 33 illustrated that any differences were not substantial and hence this assumption has been used for death in this work. The distribution used for cancer is based only on male claims (but uses both smoker and non-smoker data). The Committee intends revisiting variations in these functions within the 2003-2006 dataset.

5.11. Each of the cause-specific claim development distributions used has been truncated by extrapolating to unity over the period from the end of year 3 to the end of year 7 from diagnosis, as described in section 5 of Working Paper 33 (and as applied to the central distribution).

5.12. A different mix of underlying claims may also affect TPD, but data volumes mean that investigating the distribution for specific gender/smoker datasets is unlikely to be feasible. The difficulties in fitting a Burr distribution for TPD were noted in Working Paper 33 and the Committee has not sought an alternative distribution for the current work. Instead the claim development distribution for TPD has been derived to reflect

the "difference" between the claim development distributions for all-causes and for all-causes excluding TPD, with manual adjustments to ensure the cumulative distribution function was monotonically increasing. The unusual nature of the claim development distribution for TPD is apparent from Figure 5.1.

Figure 5.1: Cumulative claim development distributions, by cause



5.13. Although Figure 5.1 clearly shows the distribution for death "lying to the left" and those for stroke and TPD (generally) "lying to the right" of the central distribution, the remaining cause-specific distributions are difficult to distinguish from each other and from the central distribution that has been used in the all-causes work. This demonstrates the relative lack of variation between causes.

The derivation of cause-specific rates for male non-smokers

5.14. Tables corresponding to those in section 3, for all-causes rates, are contained in Appendix C for the separate causes considered. For each cause of claim, we have shown:

- The Actual Settled Claims;
- Adjustments to the cause-specific rates from the CIBT02 table for quinquennial ages (again using CIBT02 as if it were an age nearest table); and
- The Actual Settled Claims / Expected Settled Claims values using the adjusted rates.

5.15. The tables of Actual Settled Claims cover the same age range (20 to 70) as the earlier tables; however because of the low numbers of claims at either end of this age range, the tables of adjustments and the fit of the cause-specific rates to the data cover ages 30 to 60 only.

5.16. In order to allow easier comparison of the cause-specific rates with the all-causes rates, the Committee opted to combine durations 1 to 4 for each cause, irrespective of whether this particular approach appeared to be implied by the data; differences are then apparent in the tables of Actual v Expected and are considered further below.

5.17. Appendix C also contains high-level accompanying notes illustrating the derivation of the rates for each cause.

Cause-specific rates

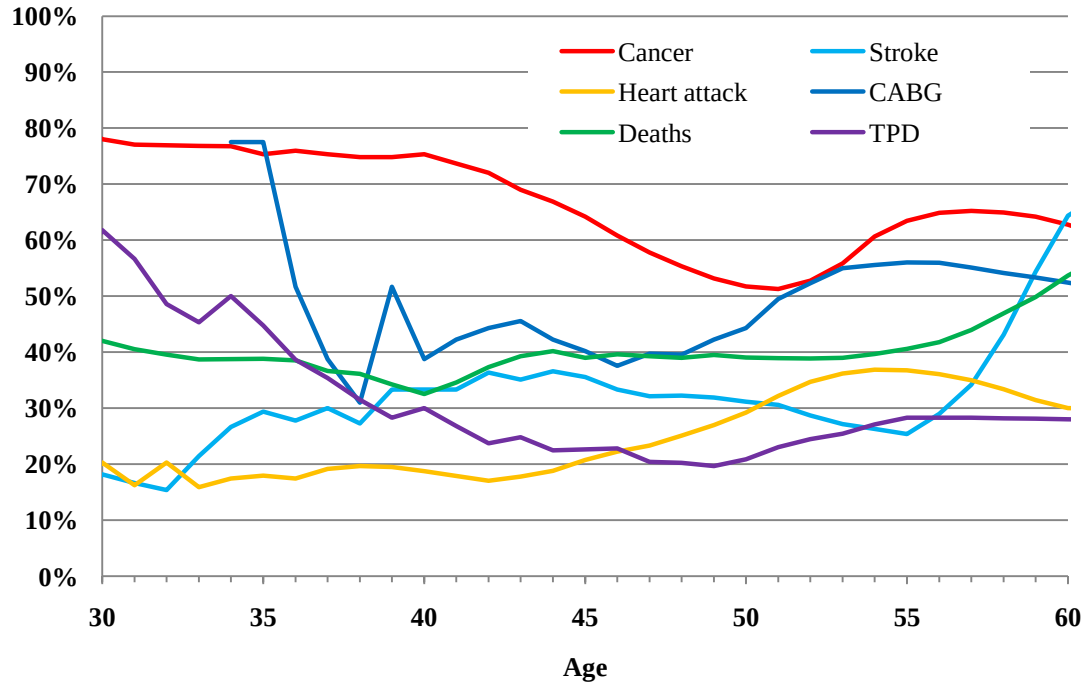
5.18. Table 5.2 shows the overall percentages of the relevant cause-specific rates from CIBT02 that are required to equate the Actual Settled Claims with the Expected Settled Claims for all durations combined. Compared to the overall all-causes adjustment (of 37%), a lower percentage adjustment to the CIBT02 table is required for most of the causes considered to arrive at insured experience; this is especially so for heart attack and TPD. The exception is cancer, where the insured experience is a much higher percentage of the population experience.

Table 5.2: Percentage of the relevant cause-specific rates from CIBT02 to equate ASC and ESC

Cause	**% of CIBT02**
Cancer	59%
Heart Attack	23%
Death	33%
Stroke	30%
CABG	35%
TPD	17%

5.19. Considerable variation in the adjustments exists by age, as shown in Figure 5.2. For certain conditions – heart attack and CABG – our rates increase more steeply with age than the cause-specific CIBT02 rate; in contrast, cancer reduces with age until the early 50's.

Figure 5.2: Cause-specific diagnosis rates relative to CIBT02 by age, male non-smokers, durations 5+



5.20. Note that the apparent volatility in the rates we have derived relative to CIBT02, for example for CABG from age 36 to 47, reflects the very low absolute values of these rates. (Adjustments below age 35 are not shown for CABG as they are off the scale; this results from very low absolute rates and rounding.)

5.21. The low absolute numbers of claims for some causes create considerable uncertainty in the cause-specific rates for certain causes, particularly Stroke, CABG and TPD.

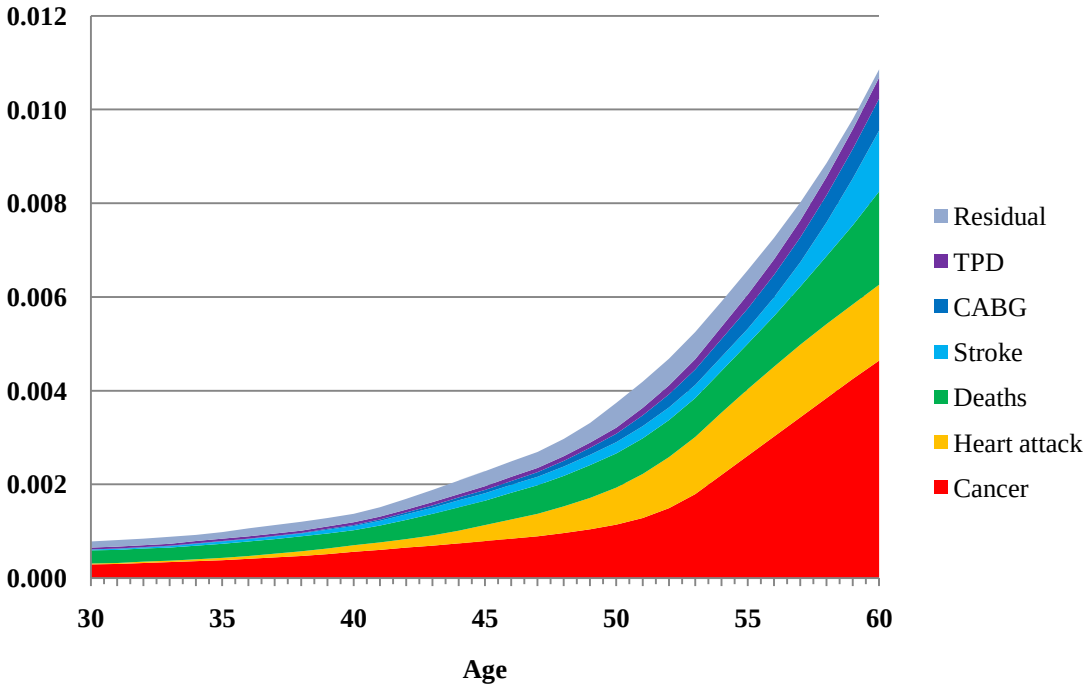
5.22. The TPD rates also suffer from other sources of uncertainty, including:

- We have not adjusted the exposure (underlying the Expected Settled Claims) for policies that do not include TPD;
- Products use different definitions of TPD – these rates are effectively a composite across these definitions; and
- Offices may have different approaches to defining the data of diagnosis.

Comparison of cause-specific rates with all-causes rates

5.23. Figures 5.3 and 5.4 illustrate the cumulative cause-specific rates, in absolute terms and as a percentage of the all-causes rates. The rates shown are those for durations 1 to 4 combined. Both figures also show the residual rate; note that this has been derived as the difference between the sum of the cause-specific rates and the all-causes rates, not as a separate "other causes" category.

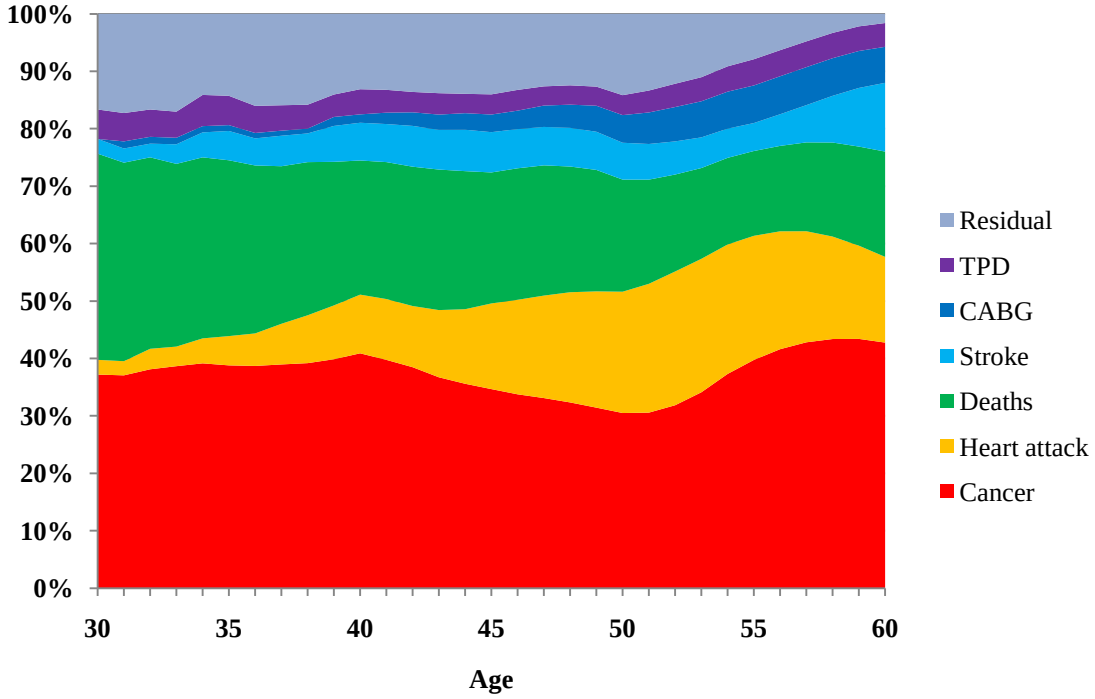
Figure 5.3: Cumulative cause-specific diagnosis rates by age, male non-smokers



5.24. Across the age range 30 to 60, the sum of the rates by cause varies between 83% and 98% of the duration 1 to 4 all-causes rates derived earlier, increasing with age. The average residual, across these ages, is 12%, which is consistent with the percentage of the total claims that these "other" causes represent.

5.25. The residual percentage is slightly higher than these figures at duration 0 and lower at durations 5+. In particular – as the rates have currently been derived – at durations 5+ the sum of the cause-specific rates actually marginally exceeds the all-causes rates at ages 59 and 60.

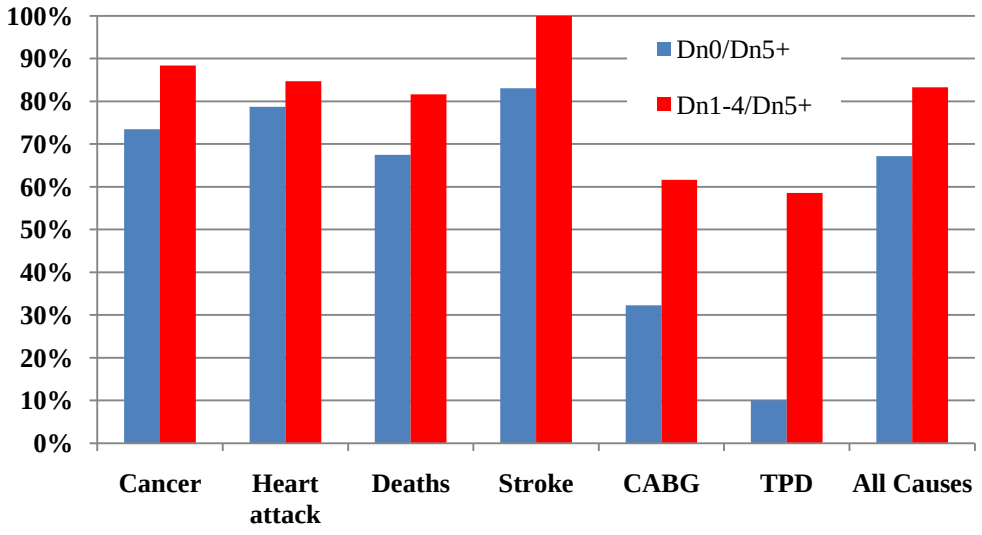
Figure 5.4: Cumulative cause-specific diagnosis rates as a percentage of the all-causes rates, by age, male non-smokers



Selection

5.26. As noted above, the cause-specific rates have been derived assuming that the rates are constant for durations 1 to 4. Figure 5.5 shows the ratio of the rates at durations 0 and 1-4 to the ultimate duration 5+ rates. In these rates, these ratios do not depend on age (other than from the rounding of rates).

Figure 5.5: Diagnosis rates at durations 0 and 1-4 as a percentage of the durations 5+ rates, by cause



5.27. It is clear that some select effect is evident in the rates for each of the causes considered, but to varying magnitudes. The three largest causes of claim exhibit reasonably similar patterns, with stroke showing the weakest pattern (with the durations 1-4 rates equal to the durations 5+ rates) and a stronger select pattern for CABG and TPD.

All-causes rates re-visited

5.28. As noted in paragraph 3.46, the most significant area of "poor fit" apparent to the Committee in the all-causes male non-smoker rates related to ages 46 to 55, where there appears to be greater selection than at other ages.

5.29. If this were a genuine feature, as opposed to a random variation within this dataset, then the Committee anticipated that it would also be reflected in the cause-specific experience for one or more of the significant causes. The Committee considered the evidence for this being a genuine feature to be weak, in particular:

- The number of actual settled claims at ages 46-50 and duration 0 for cancer appears surprisingly low in comparison with surrounding values (see Table C1). This partially causes the feature in the all-causes rates and, given the seemingly isolated occurrence in the cancer claims, the Committee suspects that this element arises from random variation.
- Whilst the feature appears present in heart attack data at ages 51-55, there is no evidence of it in the earlier 5-year age band. Indeed, if the feature were a result of medical underwriting detecting cardiovascular disease at these ages, one might have expected to observe the feature more strongly in the heart attack data than at an all-causes level.

5.30. The Committee therefore concluded that the evidence (from the cause-specific rates) warranting the incorporation of extra selection at ages 46-55 in the all-causes rates was weak and decided not to make further adjustment to the rates. However we intend to consider this again, at both an all-causes and a cause-specific level, as part of the derivation of 2003-2006 rates.

Rates for All-causes (excluding TPD)

5.31. The Committee is also conscious of the current interest in the UK market regarding TPD, in the light of the 2009 review of the ABI Statement of Best Practice for Critical Illness Cover and has therefore also derived diagnosis rates for all-causes excluding TPD. This analysis is again limited to male non-smokers only.

5.32. The methodology used to derive these rates is identical to that used for the all-causes rates, with the following exceptions:

- The Expected Diagnosed Claims are calculated using the adjustments to the CIBT02 (Extended Cover) table, derived for the all-causes rates, summarised in Table 3.8. This presumes that the all-causes rates are a better starting point for deriving these rates than unadjusted CIBT02;
- The Expected Settled Claims are calculated from the Expected Diagnosed Claims using a claim development distribution derived excluding the TPD claims; and
- The Actual Settled Claims exclude those for TPD.

5.33. Table 5.3 shows the 100A/E values; the overall A/E value of 96% compares to 100% before TPD was removed (as shown in Table 3.7). At an all-durations level, this reduction is reasonably uniform except above age 65 where the removal of TPD has minimal impact. (The small differences in some cells at ages 66-70 arise from the use of a different claim development distribution.)

Table 5.3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 3.8

Age nearest at settlement	Curtate duration at settlement 0	1	2	3	4	5+	ALL	1-4
20-25	114	113	132	85	119	37	**113**	115
26-30	94	101	80	111	111	96	**97**	98
31-35	119	93	89	95	106	85	**95**	94
36-40	95	105	89	91	87	98	**96**	95
41-45	86	96	101	105	85	97	**96**	98
46-50	90	91	89	109	77	103	**96**	92
51-55	91	88	93	111	102	97	**97**	97
56-60	112	101	110	96	101	89	**97**	103
61-65	117	91	97	100	98	94	**96**	97
66-70	164	91	86	88	104	103	**101**	93
ALL	**99**	**97**	**94**	**102**	**94**	**96**	**96**	**96**

5.34. Rates for all-causes excluding TPD were produced by reducing the rates at duration 0 by 1% and those at other durations by 4% for all ages up to 65. This produces the A/E values shown in Table 5.4. The low reduction at duration 0 is consistent with the very low diagnosis rates for TPD at that duration illustrated in Figure 5.5.

Table 5.4: Values of 100A/E using adjusted percentages of CIBT02 by age and duration shown in Table 3.8 as described in paragraph 5.34

Age nearest at settlement	Curtate duration at settlement 0	1	2	3	4	5+	ALL	1-4
20-25	116	116	138	89	124	39	**116**	119
26-30	94	104	83	115	116	100	**100**	101
31-35	120	95	93	99	110	89	**99**	98
36-40	96	109	93	94	90	102	**99**	98
41-45	87	99	105	109	89	101	**100**	101
46-50	91	94	92	114	80	108	**99**	95
51-55	92	91	97	115	106	101	**100**	101
56-60	113	105	114	100	105	92	**100**	106
61-65	118	94	101	104	102	98	**100**	100
66-70	164	92	87	89	105	104	**101**	93
ALL	**100**	**100**	**98**	**106**	**98**	**100**	**100**	**100**

5.35. The fit of these rates is comparable to that achieved for all-causes, as shown in Table 3.7.

5.36. It is worth noting that the overall reduction in rates of 4%, for male non-smokers, reflects a combination of different TPD definitions (including own occupation, any occupation and Activities of Daily Working) as well as policies with no TPD cover at all. The composition of our dataset will reflect the different products offered in the market (over an extended period, as noted in paragraph 2.2) and also the underwriting approach, which might lead to a stricter definition being applied in place of own occupation cover in some cases. The implied reduction of 4% suggests that a comprehensive TPD definition will account for more than 4% of claims and as such is worthy of the consideration given to it by the ABI.

6. ALL-CAUSE DIAGNOSIS RATES

6.1. This section first sets out key features of the all-causes diagnosis rates and then compares these rates to other published tables.

6.2. The rates themselves are contained in Appendix D to this paper. For convenience, these rates are referred to in this paper as "WP43 rates". Note that the rates in Appendix D have been rounded to 5 decimal places and some additional smoothing has been applied (where the "relatively smooth adjustments to CIBT02" referred to in paragraph 3.48 did not produce smooth rounded rates).

The scope of the diagnosis rates

6.3. Key features of the WP43 rates are listed below. A number of these are then discussed further in the subsequent paragraphs:

- Annual rates;
- Accelerated cover (see 6.4);
- The rates relate to a variety of product types, including term, endowment and whole-of-life assurances;
- The rates are calculated on a "lives" basis (see 6.5);
- The rates are based on claims settled in 1999-2004 (see 6.6);
- The rates are based on the experience of all offices that contributed data in any of the six calendar years (see 6.7);
- Although described as "all-causes", the rates have not been adjusted for any limitations in the scope of particular products (see 6.9);
- The rates are on an age exact basis (see 6.10);
- The rates apply to business accepted on "standard rates" and include "normal claims" only (see 6.11 and 6.12); and
- Some approximations are made in the calculation of exposure; in particular these mean it is unclear whether the rates are "initial" or "central" rates (see 6.13).

6.4. The CMI collects data for both Stand-Alone cover where the benefit is paid on diagnosis of critical illness, and Full Accelerated cover, where the entire benefit is payable on the diagnosis of critical illness or death, whichever occurs first. The WP43 rates are based on Full Accelerated business only; throughout the paper we abbreviate this to "accelerated".

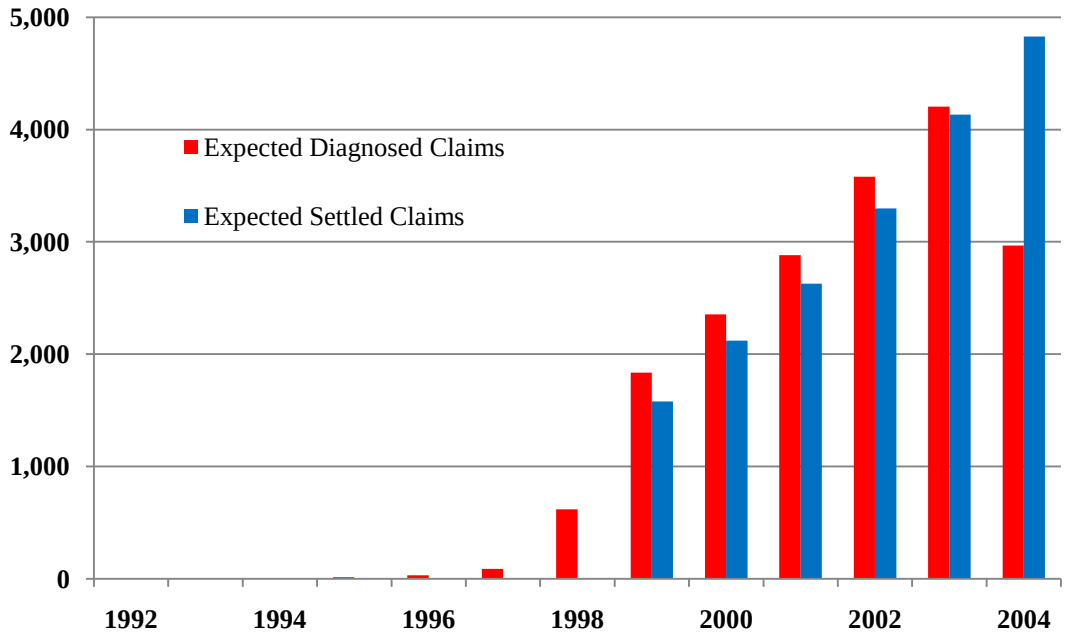
6.5. Although these rates are described as being on a "lives" basis, they are, in reality, a mixture of "lives" and "policies". Offices are asked to combine multiple policies into a single policy where they arise from one underwriting process (e.g. automatic increments) but to submit a separate record if new underwriting is involved. Even if offices are able to submit data on this basis, this will mean that a "life" may feature several times in the analysis. No attempt has been made to allow for this.

6.6. The WP43 rates are based on claims settled in 1999-2004. The rates do not simply apply to the mid-point of this period, because:

- The volumes of business changed over the period, and
- The rates relate to claims settled in this period, so will have been diagnosed in a slightly earlier period.

The total expected settled claims in 1999-2004 are shown by calendar year of settlement in Figure 6.1. The growth over this period is evident. Also shown are the expected diagnosed claims corresponding to these settled claims, by calendar year of diagnosis. In total, the two are equal but it will be observed that the diagnosed claims relate to an earlier period, starting as far back as 1992 (because the claim development distribution is limited to seven years). Overall the weighted mid-point of the diagnoses appears to be end-2001 (i.e. the rates apply on average to exposure in the year from mid-2001 to mid-2002).

Figure 6.1: Expected settled claims (ESC) in 1999-2004, by calendar year of settlement, and the corresponding expected diagnosed claims (EDC), by calendar year of diagnosis



6.7. The rates are based on the experience of all offices that contributed data in any of the six calendar years from 1999 to 2004 inclusive. Although the number of offices in each year is relatively little changed over the period, this is not a consistent group. In particular, there were significant movements between 1999 and 2000 (when several offices started submitting data) and between 2002 and 2003 (when one large office ceased submitting, but another started). As well as these changes, the growth in data volumes over the period varied considerably between offices.

6.8. The Committee has not undertaken any analysis for individual offices at this stage, so cannot provide any indication of the degree of variability in the rates by office. In particular, to be meaningful, such analysis would need to use office-specific claim development distributions. The Committee will consider the feasibility of undertaking such analyses for selected large offices for the 2003-2006 dataset.

6.9. Although described as “all-causes”, the rates have not been adjusted for any limitations in the scope of particular products. All policies included in the analysis should cover cancer, heart attack, stroke and death and hence the exposure can reasonably be assumed to be accurate for these causes. However for any critical illness event that is only covered by some products, the actual settled claims only arise under that event if it is explicitly covered. The Committee did not attempt to adjust the exposure (and the

expected settled claims) accordingly, as the products with fewer explicit events may incur higher numbers of claims under events such as death and TPD, so that the all-causes rates remain broadly appropriate. Furthermore such an adjustment is unlikely to be accurate and is beyond the level of detail justified by the other assumptions in our work; the Committee expects such differences to be a source of less variation than, say, varying experience between offices arising from differences in business mix, underwriting standards and claims assessment practices.

6.10. The exposure in our analysis was calculated using age in months. In multiplying the exposure by CIBT02, to calculate expected diagnosed claims, the data was grouped by age nearest birthday (in years). As a result, the rates that have been generated relate to the year from age x - ½ to age x + ½. For the purposes of generating rates at integral ages on an age exact basis, as is customary for CMI Life Office Mortality tables, we have simply interpolated between the rates at age x - ½ and at age x + ½. The rates in Appendix D therefore relate to age x, i.e. they are appropriate for the age interval from exact age x to exact age $x+1$. A more accurate approach is envisaged for the production of rates for 2003-2006.

6.11. The WP43 rates should apply to business accepted on "standard rates" only. Offices are asked not to submit data for policies subject to additional premiums or restricted cover, for medical or other reasons, but the CMI has no way of checking this has been done accurately.

6.12. The rates should reflect only those claims accepted within the terms of the contract; offices are asked to exclude *ex gratia* claims. Claims accepted during a "Free Cover period", between the submission of a proposal and policy commencement, should also be excluded from the definition of "settled claims" as there is no exposure corresponding to these claims.

6.13. The CMI receives individual records for each critical illness benefit in force at the start and end of each calendar year, including the date of policy commencement. Within this work the actual date of commencement is used in calculating exposure. However for the data from which these rates are derived the CMI does not receive any information on the date of exit (for exits other than claims) to allow a fully accurate calculation of exposure; for all exits (including claims), exposure is calculated on a "census" basis, assuming that exits occur in the middle of the year. Note also that:

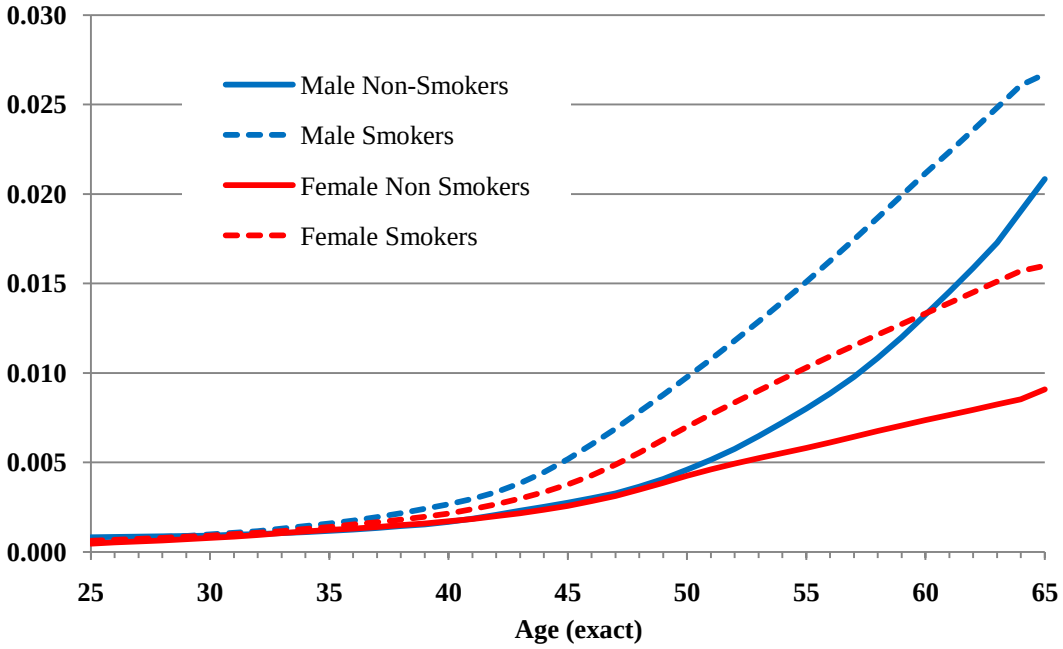
- For claims, exposure stops mid-year in the year of settlement, not at the date of diagnosis, meaning that, on average, there is a slight over-statement of exposure compared to central exposure; and
- The exposure makes no allowance for policies entering and exiting within a calendar year. This will result in an under-statement of exposure – and a corresponding over-statement of diagnosis rates – at duration 0.

As noted in Working Paper 33, the first of these means the definition of our exposure calculation is indeterminate between initial and central, even though we made no explicit allowance for exposure after the date of diagnosis for claims. More complete details of the exposure calculations are contained in section 7 of Working Paper 33.

The all-causes diagnosis rates

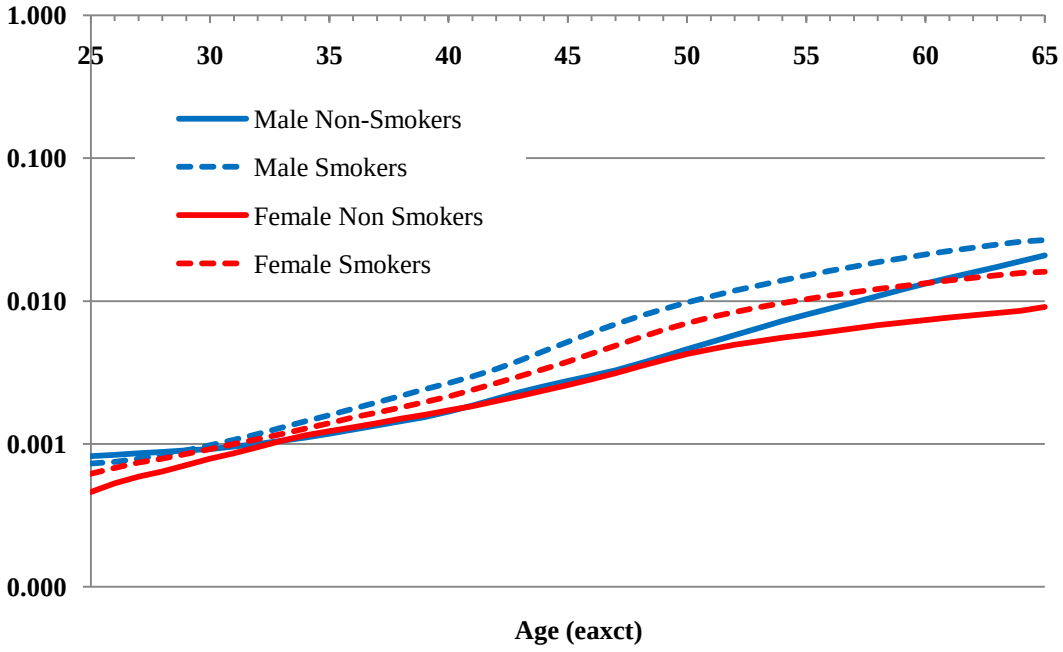
6.14. The four sets of rates are illustrated in Figure 6.2. This shows the ultimate rates, i.e. durations 5+ for male non-smokers and female smokers, but durations 2+ for male smokers and female non-smokers. It will be observed that the two sets of male rates increase much more rapidly with increasing age beyond around age 50.

Figure 6.2: All-causes WP43 diagnosis rates, ultimate



6.15. Whilst the shape of the male non-smoker rates appears similar to diagrams of mortality rates at these ages, those for the other three sets of rates appear flatter (and more consistent with each other).

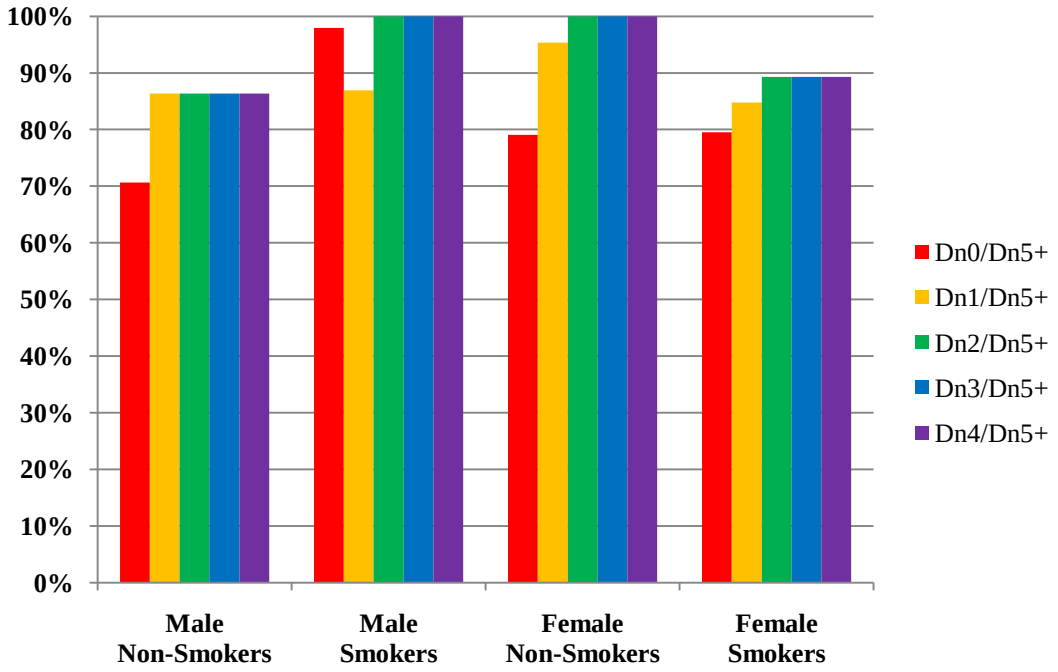
Figure 6.3: All-causes WP43 diagnosis rates, ultimate (logarithmic scale)



6.16. The rates are also shown in Figure 6.3 using a logarithmic scale. This shows the similarity of the male and female non-smoker rates from age 33 to age 41. At some ages in this range the ultimate female rates are higher than the corresponding male rates; indeed, given the greater selection in the male non-smoker rates, this is a general feature of the short duration rates.

6.17. The relative select patterns in the four sets of rates are illustrated in Figure 6.4. The lack of selection in the male smoker rates at duration 0 is apparent, with the rates close to those at durations 2+.

Figure 6.4: All-causes WP43 diagnosis rates, rates by duration as a percentage of those at durations 5+



Features not reflected in the diagnosis rates

6.18. As noted in sections 3 and 4, in deriving the WP43 diagnosis rates the Committee had to make a number of decisions, including the balance between smoothness of the rates and goodness of fit to the underlying data. Given the subjective nature of these decisions, it is important that any actuary using the rates understands where the rates fit closely to the experience, and where they do not. Hence in this section, we highlight features of the data that we have NOT reflected in the rates, some of which have been referred to in the earlier sections; note that this list is not intended to be comprehensive.

6.19. The first point to note is that we have used a single select pattern across all ages within each of the gender/smoker datasets. In some cases, this means that the shape of the rates does not appear to closely fit the experience. A good example in the male non-smoker rates is apparent by considering broader age groups than those shown in Table 3.7:

- At duration 0, the WP43 rates are too low (compared to the data) for the up to 35 age band and for the over 55 age band, but too high for the intermediate age band (35 to 55).
- In contrast, at durations 5+, the WP43 rates are too high (compared to the data) for the up to 35 age band and for the over 55 age band, but too low for the intermediate age band (35 to 55).

A closer fit to the data could have been obtained had we derived the rates by age for each duration separately, but the Committee felt this might be spurious accuracy.

6.20. A specific example where the Committee opted not to fit the rates more closely to the data is the possible increased selection at ages 46-55 and, to a lesser extent, ages 36-45 for male non-smokers discussed in paragraph 4.21. Lower rates might have been chosen at shorter durations (and higher rates at longer durations).

6.21. The first constraint noted in paragraph 3.25, that rates cannot reduce with age, has only a limited effect on the WP43 rates. An example where this arose in section 3 is at younger ages for male non-smokers – evidenced by the all-durations A/E of 115% at ages 20-25 in Table 3.7 – but the Committee's decision to restrict the WP43 rates to ages 25 to 65, as the data outside this age range lack credibility, means that this constraint had minimal impact.

6.22. The second constraint, regarding rates by duration, has a greater impact. An example where this arose, again for male non-smokers, is the uneven fit by duration within durations 1 to 4. At an all-ages level, the rates are higher than implied by the experience at durations 1, 2 and 4, but lower at duration 3, evidenced by an all-ages A/E of 105% in Table 3.7. Note that the fit by age at durations 3 and 4 is poor even at ages 31-55, where we have most settled claims. Similar features apply in the other datasets – for example, for female non-smokers, the fit for durations 2+ is not close at each duration. As will be observed from Table 3.13, the all-ages A/Es at durations 3 and 4 are 92% and 98%, whereas the A/E at duration 2 and durations 5+ are 102% and 103%.

6.23. The fit of the rates to the data is generally less close for the smoker datasets than the corresponding non-smoker rates; for example, Table 3.10 shows all-durations A/Es for male smokers of 105%, 96% and 103% at ages 46-50, 51-55 and 56-60 respectively. A closer fit to the data would have resulted in less smooth rates.

6.24. The male smoker rates exceed the rates for male non-smokers at the youngest and oldest ages in the dataset (although only up to age 28, at duration 1 and durations 5+, in the age range for which we have included rates in Appendix D). This resulted from the Committee's decision not to impose any constraints between the two sets of rates, as discussed in paragraph 4.27. This question did not arise with regard to the female rates.

6.25. Note that in addition to the factors listed above, there are a number of decisions that affect the adjusted results issued by the Committee, as well as all four sets of WP43 rates. These include:

- The use of a single claim development distribution, derived from claims data for all four gender/smoker subsets, at all ages and durations within each set of rates.
- The simple model of off rates assumed in order to estimate prior years' exposure.
- The timing assumptions made to avoid excessive run times.

Comparison with other tables

6.26. In this section we compare the WP43 diagnosis rates with those from existing tables that may be in use in the UK, namely two population-based tables, CIBT93 and CIBT02, and two tables that have been adapted from population data to represent insured experience, IC94 and CIIT00.

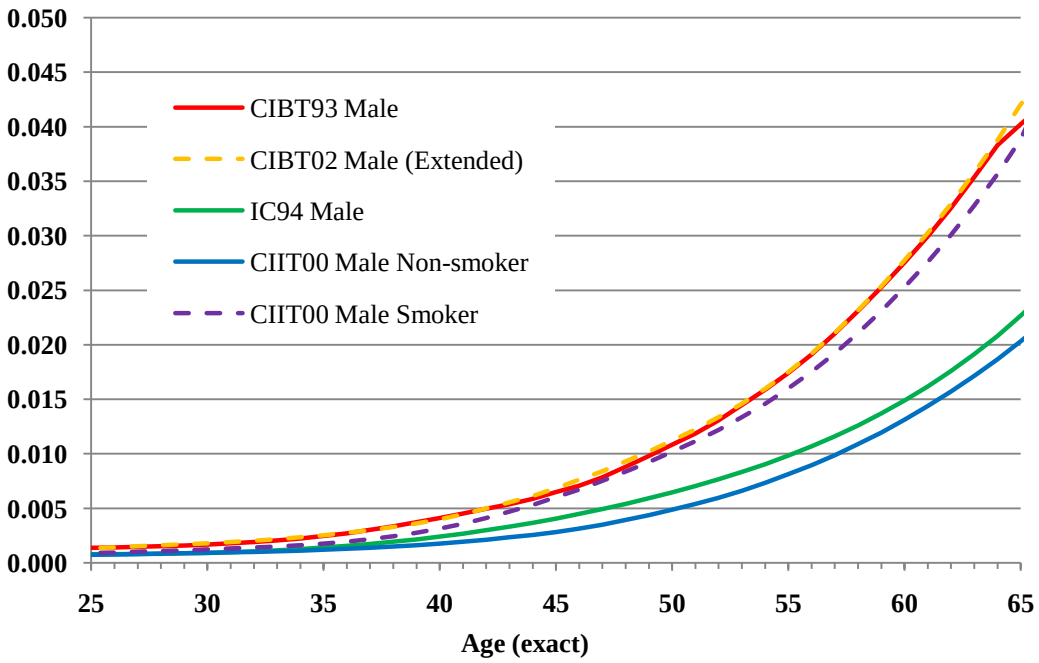
6.27. A brief summary of the Committee's understanding of each of these tables is contained in Appendix E, together with a brief comparison of the WP43 rates against each of the first three tables. A more detailed comparison with CIIT00 is included later in this section.

6.28. It is hoped that these comparisons will be useful to actuaries using the existing tables, for example as part of a valuation basis. With this in mind, we have restricted the comparisons to all-causes rates and have not compared the cause-specific rates for male non-smokers in section 5 with the other tables. Note that we are seeking to compare the WP43 diagnosis rates with these other tables but not necessarily seeking to explain the differences, which can arise from features of the other tables.

6.29. The various tables are depicted in Figures 6.5 and 6.6, for males and females respectively, for the age range covered by the WP43 rates. Key features apparent from these graphs are:

- The male rates are generally higher than the female rates (note the different scales of the two graphs).
- The rates in the two population-based tables are generally higher than the tables that include an adjustment to insured experience.
- The differential between population and insured is greater for males than for females.

Figure 6.5: Male rates from various existing tables



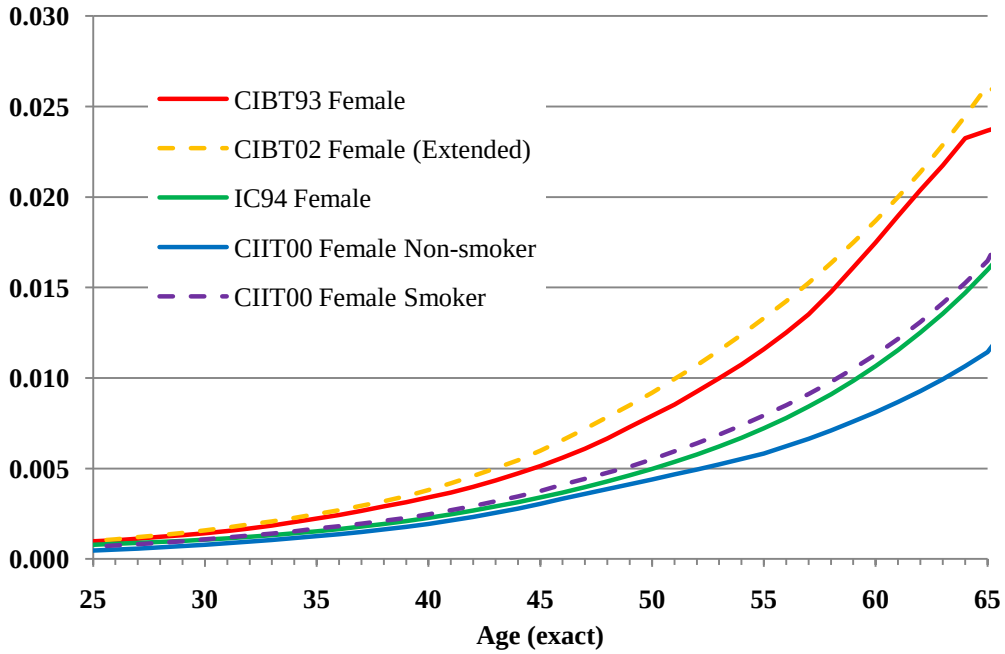
6.30. The shapes of the various sets of male rates are similar at these ages:

- The two sets of population rates are very close to each other;
- The CIIT00 smoker rates are also close to the two sets of population rates; and
- The (aggregate) IC94 rates are a similar shape to, but higher than, the CIIT00 non-smoker rates.

6.31. The pattern in the various sets of female rates is different; in particular:

- There is a greater differential between the two sets of population rates;
- There is an increasing differential with age between the IC94 rates and the CIIT00 non-smoker rates; and
- The CIIT00 smoker rates are significantly lower than the two sets of population rates. In particular comparison of Figures 6.5 and 6.6 shows that the smoker differentials in the CIIT00 rates are much smaller for females than for males.

Figure 6.6: Female rates from various existing tables



6.32. Given the similarity in shape between the four tables, for males in particular, we focus on comparing the WP43 rates with the CIIT00 rates in the remainder of this section. In addition, it is the most recently-developed table of the four and it may be considered the closest comparator, as the authors used CMI data (for 1999-2002) to adjust the population data to insured experience.

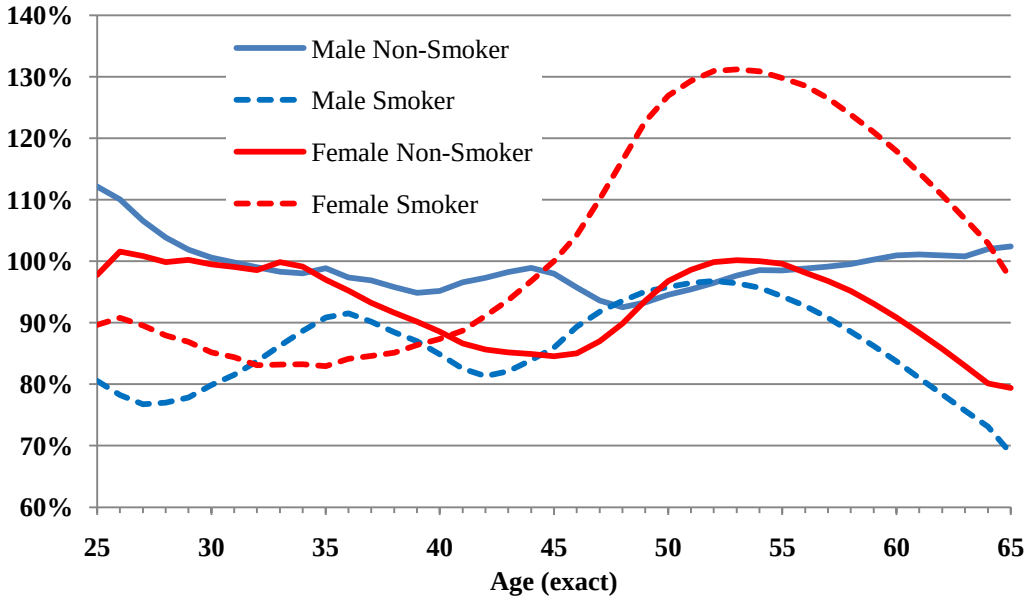
6.33. Figure 6.7 shows the ultimate WP43 rates as a percentage of the ultimate rates from CIIT00 for each of the four gender/smoker datasets. Only the ultimate rates are compared in Figure 6.7, but note that the definitions of "ultimate" are different in the two tables.

6.34. Apart from female smokers, the WP43 rates are between 80% and 100% of those in CIIT00 for the age range with the most credible volumes of data (ages 35-55).

6.35. A difference of this order may simply be the result of the different time-periods – the Committee has used 1999-2004 data, whereas the 1999-2002 CMI data was used for CIIT00 – given that experience appears to be lower in 2003 and 2004 than in the earlier years (see section 7).

6.36. In addition there are numerous other differences in the construction of the two tables; these are summarised in Appendix E.

Figure 6.7: Ultimate WP43 diagnosis rates as a percentage of CIIT00



6.37. Notwithstanding the general lack of credibility in the female smoker dataset, the difference between the two sets of female smoker rates warrants additional consideration since the "hump" between ages 45 and 65 is probably the most conspicuous feature of Figure 6.7 and it takes the comparison of the two sets of rates outside the range of what one might reasonably expect, given that both have been adapted from CIBT02 using CMI data.

6.38. The Committee does not consider that the upward slope of the hump indicates any issues with the WP43 rates, noting that a similar feature is also apparent in the comparisons of the WP43 rates with the other three tables, in Figures E1, E2 and E3. A similar – though less pronounced – feature is also present in the male smoker and female non-smoker rates. We considered this upward slope might be expected when comparing the WP43 rates against population tables (CIBT93 and CIBT02) if insured lives' and population experience converge with increasing age, whilst:

- An overall adjustment from population data was applied in IC94, so the features should be similar; and
- The shape of CIIT00 was adjusted from population data (CIBT02) only where felt to be justified by credible volumes of insured data. Since the 1999-2002 dataset was around half the size of the 1999-2004 dataset, and within this, female smokers had the least credible volumes, these are likely to have resulted in less adjustment to the shape of the rates.

6.39. The downward slope of the hump at older ages – present in the male smoker and both sets of female rates – is consistent with the flatter shape in these rates noted in paragraph 6.15. This aspect of the rates seems counter-intuitive but the Committee notes that this occurs at ages where the data are less credible. The Committee will consider this feature further if it is also apparent in the diagnosis rates derived from 2003-2006 data.

7. COMPARISON OF EXPERIENCE AGAINST DIAGNOSIS RATES

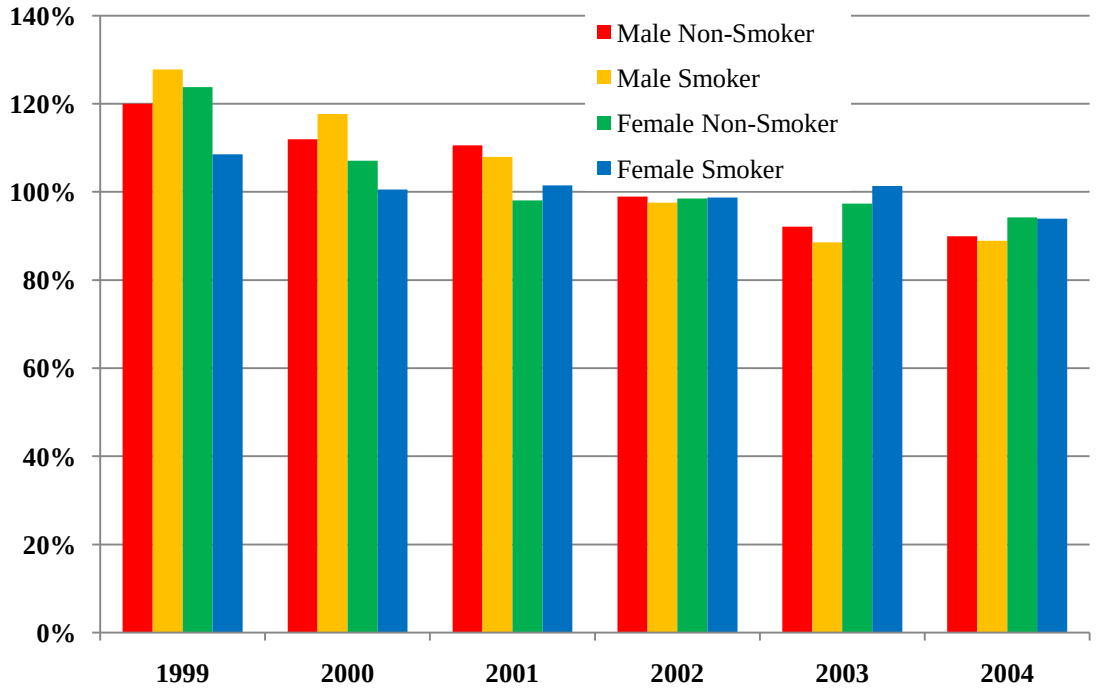
7.1. In this section we consider expected settled claims calculated using the diagnosis rates derived in this paper. This is done for two distinct purposes: firstly to consider the experience by year over the period 1999-2004; and secondly to look at the claims that we expect to be settled after 2004.

Experience by Calendar Year

7.2. Earlier in this paper we showed the actual settled claims in 1999-2004 as a whole compared to the expected settled claims (for example, Table 3.7 for male non-smokers). Here, we sub-divide the 1999-2004 experience in order to assess the variation in experience over the period.

7.3. Figure 7.1 shows the experience for each of the four gender/smoker datasets for all-ages and all-durations combined, by calendar year.

Figure 7.1: Values of 100A/E by calendar year where expected settled claims are calculated using WP43 rates



7.4. Across all four datasets, there appears to be a reduction in experience over the six years, with experience closest to expected, based on the WP43 diagnosis rates, in 2002. This is broadly consistent with the comment, in paragraph 6.6, that the weighted mid-point of the diagnoses appears to be end-2001. At the end of the period, in 2004, experience is around 90% of expected for both male datasets and 94% for both female datasets.

7.5. It should be noted that this is not necessarily a reliable measure of the true underlying trend, since a single claim development distribution, derived from the 1999-2004 data (using data from both genders and both smoker statuses), has been used throughout.

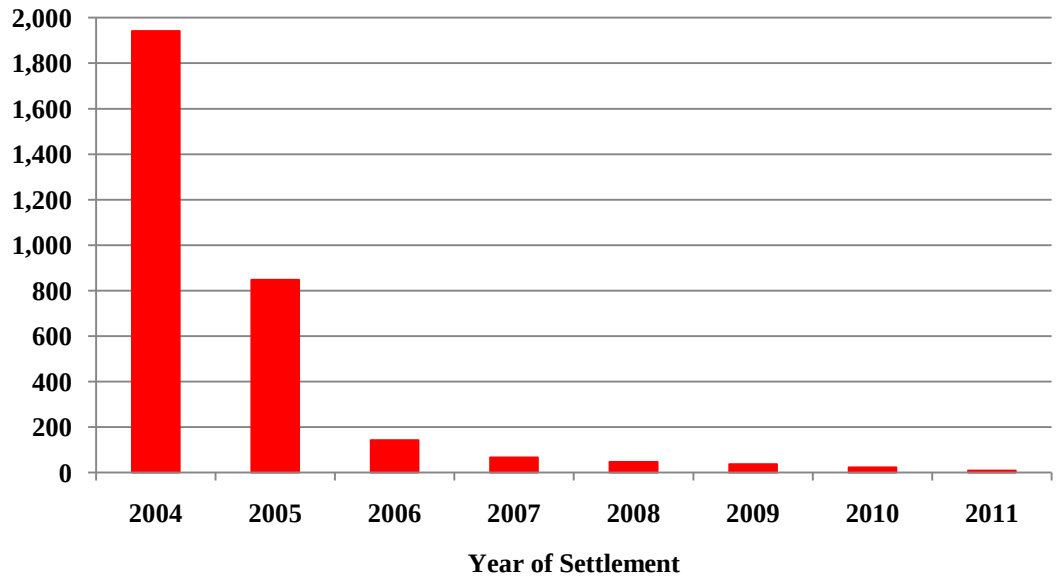
7.6. In addition there are changes in the offices contributing data during this period (and in the relative volumes each contributes); for example large offices started contributing data in 2000 and in 2003 which may, at least partly, explain the reduction from the apparently heavy experience in 1999 (although 1999 is also the least credible of the six years, in terms of data volumes).

Expected Settled Claims after the investigation period

7.7. In addition to considering the expected settled claims in 1999-2004, as we have done in all the other parts of this paper, we can also consider the expected settled claims after the investigation period.

7.8. Figure 7.2 shows, for all-ages and all-durations combined, by calendar year for the period 2005-2011, the expected settled claims that arise from diagnoses in 2004 and prior years. The expected settled claims in 2004 are also shown, for comparison. Figure 7.2 shows claims for male non-smokers only, however the corresponding charts for the other three datasets are almost identical in terms of the proportion of claims settled in each calendar year.

Figure 7.2: Expected settled claims from exposure in 2004 and prior years for male non-smokers by calendar year where expected settled claims are calculated using WP43 rates



7.9. Given that data collection for 2005 and 2006 is now "complete" and noting the increased proportion of dates of diagnosis that have been submitted to the CMI in recent years, the Committee compared the expected settled claims in 2005 and 2006 diagnosed in 2004 and earlier years with the actual settled claims submitted to the CMI with diagnosis date in 2004 and earlier. (Note that the CMI does not have reliable data from a small number of offices for 2005 and 2006 that had submitted data for the earlier years. The expected settled claims for these offices have been excluded, for consistency with the actual settled claims.)

7.10. The proportions of claims settled in 2005 and 2006 for which we did not have a date of diagnosis were 15% and 17% respectively, for male non-smoker data. A simple assumption was made whereby the number of claims diagnosed in each prior year was

uplifted by these percentages in order to provide a comparison with the expected claims. These are referred to as 'adjusted actual settled claims' below.

7.11. Table 7.1 compares the adjusted actual settled claims to the expected settled claims for years of settlement 2005 and 2006 and years of diagnosis 1997 to 2004, inclusive, for male non-smokers.

7.12. Note that since the central claim development distribution restricts the interval between diagnosis and settlement to a maximum of seven years, the earliest expected settled claims in Table 7.1 relate to diagnoses in 1998. In practice, there are a few actual settled claims, in both 2005 and 2006, with diagnosis dates in 1997 or earlier.

Table 7.1: Actual and expected settled claims for male non-smokers by year of diagnosis and year of settlement (All-ages, all-durations combined)

	Year of settlement					
	2005			**2006**		
Year of diagnosis	**Adjusted Actual Settled Claims (AASC)**	**Expected Settled Claims (ESC)**	**100 AASC / ESC**	**Adjusted Actual Settled Claims (AASC)**	**Expected Settled Claims (ESC)**	**100 AASC / ESC**
1997 & prior	2.3	-	-	3.6	-	-
1998	4.7	2.5	191	2.4	-	-
1999	2.3	5.9	40	3.6	3.1	118
2000	8.2	7.4	111	4.8	7.4	66
2001	9.4	9.2	102	3.6	9.2	39
2002	20.0	20.3	98	7.3	11.7	62
2003	73.9	77.3	96	20.6	24.3	85
2004	606.8	724.4	84	75.1	86.8	86
All years	**727.7**	**847.0**	**86**	**121.1**	**142.5**	**85**

7.13. Clearly the majority of the "prior year" claims settled in 2005 and 2006 were diagnosed in 2004 and there is considerable volatility in the A/Es for the earlier years of diagnosis.

7.14. Table 7.2 compares the adjusted actual settled claims to the expected settled claims for the four gender/smoker datasets. Note that the uplift to the actual settled claims differs between the four datasets, as the proportions of claims settled in 2005 and 2006 for which we did not have a date of diagnosis were slightly different in each case.

Table 7.2: Actual and expected settled claims by year of settlement (All-ages, all-durations combined)

	Year of settlement					
	2005			**2006**		
Gender / Smoker dataset	**Adjusted Actual Settled Claims (AASC)**	**Expected Settled Claims (ESC)**	**100 AASC / ESC**	**Adjusted Actual Settled Claims (AASC)**	**Expected Settled Claims (ESC)**	**100 AASC / ESC**
Male Non-Smokers	727.7	847.0	86	121.1	142.5	85
Male Smokers	355.5	357.4	99	56.9	60.5	94
Female Non-Smokers	732.8	703.8	104	121.8	117.4	104
Female Smokers	215.8	185.6	116	43.9	31.2	141
ALL	**2,032.0**	**2,093.8**	**97**	**343.6**	**351.6**	**98**

7.15. There are many reasons why the adjusted actual settled claims would differ from the expected settled claims according to the WP43 diagnosis rates:

- Changing experience over time. The WP43 diagnosis rates are an average, based on claims settled in 1999-2004, but – as is apparent from Table 7.1 – it is diagnoses in 2004 that dominate the 2005 and 2006 settled claims. Figure 7.1 suggests that diagnosis rates, particularly for males, have reduced over the period 1999-2004, so that values below 100 might be expected.
- We used a single claim development distribution, derived from the 1999-2004 data (using data from both genders and smoker statuses), throughout. This may have changed over the period.
- There are some changes in the offices contributing data and also changes in relative data volumes. These may mean that the "average" office underlying the 1999-2004 diagnosis rates does not correspond with the "average" office contributing actual settled claims in 2005 and 2006.
- The adjustment for unknown dates of diagnosis, referred to in paragraph 7.10 may be inaccurate.

7.16. The Committee found the strong correlation between the AASC/ESC values for 2005 and 2006 for each of the four datasets in these results surprising, as more random variation might have been expected. The greatest divergence between the 2005 and 2006 occurs for female smokers, where relatively small numbers of claims are involved.

7.17. It is possible that the differences between the four gender/smoker datasets arise from our use of a single claim development distribution, given that these values are largely dependent on the tail of the distribution for which such an assumption may not be valid. Even then, the Committee would not have expected the consistency between years shown in Table 7.2.

7.18. The Committee anticipates that the higher proportion of dates of diagnosis within the 2003-2006 dataset may remove the need for the assumption of a single claim development distribution and will be interested to see whether future analysis indicates differences in the tail of the distribution.

7.19. Notwithstanding these limitations, the Committee is encouraged that the emerging experience appears to be broadly in line with that anticipated by our work.

8. SENSITIVITIES IN THE RESULTS

8.1. In Working Paper 33, we illustrated the sensitivity of the adjusted results to two assumptions: off rates and the claim development distribution (CDD). Within that paper we were able to demonstrate that the adjusted results are relatively insensitive to off rates, and we have not sought to demonstrate that again in this paper in the context of diagnosis rates. However we also demonstrated that they are sensitive to the claim development distribution used, hence in this section we illustrate a number of alternatives; in particular using the 'mid-short' and 'mid-long' distributions depicted in Figure 6.9 of Working Paper 33.

8.2. These sensitivities are illustrated for male non-smokers only. Note that we have sought to follow a similar approach to that described in section 3 to derive the rates in this section but, given the discretion involved in deriving the diagnosis rates, they may not be entirely consistent. Note that the expected diagnosed claims are calculated using the adjustments to the CIBT02 table, summarised in Table 3.8, as the starting point for deriving these rates (rather than unadjusted CIBT02). Hence the adjustments derived in this section apply to age nearest and can be directly compared with those in section 3.

The mid-short claim development distribution

8.3. Table 8.1 shows the 100A/E values using the mid-short CDD; the overall A/E value of 98% compares to 100% using the central CDD (as shown in Table 3.7).

8.4. The impact of using a shorter CDD is that the claims settled in 1999-2004 will relate to slightly later diagnosis dates than using the central CDD. In general, the impact is to reduce the 100A/E values as business volumes have increased. However it will be observed in Table 8.1 that in some cells the 100A/E values increase slightly, indicating reduced volumes in those cells.

8.5. At an all-durations level, the reduction in 100A/E values is reasonably uniform across the ages; however the impact by duration is more significant.

Table 8.1: Values of 100A/E using the mid-short CDD and the WP43 diagnosis rates

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	106	109	135	85	119	37	**110**
26-30	87	101	82	110	114	109	**97**
31-35	110	91	91	98	115	93	**97**
36-40	89	104	93	93	90	104	**98**
41-45	80	96	101	108	87	102	**98**
46-50	85	89	90	114	80	107	**97**
51-55	86	87	94	113	107	102	**99**
56-60	106	99	112	99	108	93	**100**
61-65	109	88	96	103	101	98	**98**
66-70	82	93	89	92	111	112	**106**
ALL	**92**	**95**	**95**	**104**	**99**	**101**	**98**

8.6. Revised rates using the mid-short CDD are produced by reducing the WP43 rates at duration 0 by 8%. As noted in paragraph 3.38, this also affects the A/E value at duration 1, increasing it to 98%. Some further refinement of these rates could be undertaken – in particular the rates at durations 1 and 2 could be reduced by 3-4%, and those at latter durations increased – but the degree of fit of these rates is comparable to that achieved for the WP43 rates, as shown in Table 3.7. For completeness, the revised fit is shown in Table 8.2, including the fit at durations 1 to 4 combined.

Table 8.2: Values of 100A/E using the mid-short CDD and the WP43 diagnosis rates, but reduced by 8% at duration 0

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	116	113	135	85	119	37	**114**	116
26-30	95	104	82	110	114	109	**100**	100
31-35	120	93	91	98	116	93	**99**	97
36-40	97	107	93	93	90	104	**99**	97
41-45	87	98	101	108	88	102	**99**	99
46-50	92	91	90	114	80	107	**98**	94
51-55	93	89	95	113	107	102	**100**	99
56-60	115	102	112	99	108	93	**101**	105
61-65	118	91	96	103	101	98	**99**	98
66-70	89	96	89	92	111	112	**106**	97
ALL	**100**	**98**	**96**	**105**	**99**	**101**	**100**	**99**

The mid-long claim development distribution

8.7. Table 8.3 shows the 100A/E values using the mid-long CDD. As one might expect, the results are the mirror-image of those using the mid-short CDD; the overall A/E value is now 102% with a reasonably uniform increase across the ages but a more significant impact by duration.

Table 8.3: Values of 100A/E using the mid-long CDD and the WP43 diagnosis rates

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	124	118	140	86	119	37	**120**
26-30	101	109	84	112	114	108	**103**
31-35	128	98	94	100	116	92	**102**
36-40	103	113	97	95	91	104	**102**
41-45	94	103	105	111	89	103	**102**
46-50	98	96	94	116	81	108	**101**
51-55	100	94	98	116	108	103	**103**
56-60	123	107	116	102	110	94	**103**
61-65	126	95	100	104	102	98	**100**
66-70	89	96	89	89	107	96	**95**
ALL	**107**	**103**	**99**	**107**	**100**	**101**	**102**

8.8. Revised rates using the mid-long CDD are produced by increasing the WP43 rates at duration 0 by 7%. Again, this increases the A/E value at duration 1, to 100%, and the degree of fit of these rates is comparable to that achieved for the WP43 rates. For

completeness, the revised fit is shown in Table 8.4, including the fit at durations 1 to 4 combined.

Table 8.4: Values of 100A/E using the mid-long CDD and the WP43 diagnosis rates, but increased by 7% at duration 0

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	116	115	139	86	119	37	**116**	119
26-30	95	106	84	112	114	108	**101**	102
31-35	120	96	94	100	116	92	**100**	99
36-40	97	110	96	95	91	104	**101**	100
41-45	87	101	105	111	89	103	**101**	102
46-50	92	94	94	116	81	108	**100**	96
51-55	93	92	98	116	108	103	**102**	102
56-60	115	105	116	102	110	94	**102**	108
61-65	118	93	100	104	102	98	**100**	100
66-70	84	94	89	89	106	96	**95**	95
ALL	**100**	**100**	**99**	**107**	**100**	**101**	**101**	**101**

8.9. These two examples are consistent with the results of the sensitivity tests in Working Paper 33, with the alternative CDDs primarily affecting the rates at duration 0.

A combination of claim development distributions

8.10. The Committee was conscious, though, that both of the sensitivity tests considered above altered the distributions as a whole; hence we also investigated a further scenario.

8.11. In this scenario:

- The mid-long distribution is applied to claims diagnosed at duration 0,
- The central distribution to claims diagnosed at durations 1 to 4 inclusive, and
- The mid-short distribution to claims diagnosed at durations 5+.

The rationale for this scenario is based on insurer behaviour, and the possibility that claims diagnosed soon after policy commencement are, on average, subject to greater scrutiny by claims assessors, whereas those at longer durations may generally be settled sooner after diagnosis. (Note, though, that the claim development distribution reflects the interval between diagnosis and notification – dependent on policyholder behaviour – as well as that between notification and settlement. Note also that we observed only limited differences in the fits of the Burr model by duration, see Figure 6.3 of Working Paper 33.)

8.12. Table 8.5 shows the 100A/E values using this combination of CDDs. Overall, the combination is little different from the central CDD; the overall A/E value is 100% and at an all-durations level the fit by age remains good, but some adjustment by duration is clearly required.

Table 8.5: Values of 100A/E using a combination of CDDs and the WP43 diagnosis rates

Age nearest at settlement	Curtate duration at settlement 0	1	2	3	4	5+	ALL
20-25	124	113	135	85	118	36	**117**
26-30	101	104	82	110	113	104	**100**
31-35	128	94	91	98	115	90	**99**
36-40	103	108	93	93	90	101	**99**
41-45	94	99	102	109	88	100	**99**
46-50	98	92	91	114	80	105	**99**
51-55	100	90	95	113	107	100	**100**
56-60	123	103	113	100	108	92	**100**
61-65	126	91	97	103	101	97	**98**
66-70	94	96	89	91	110	110	**105**
ALL	**107**	**98**	**96**	**105**	**99**	**99**	**100**

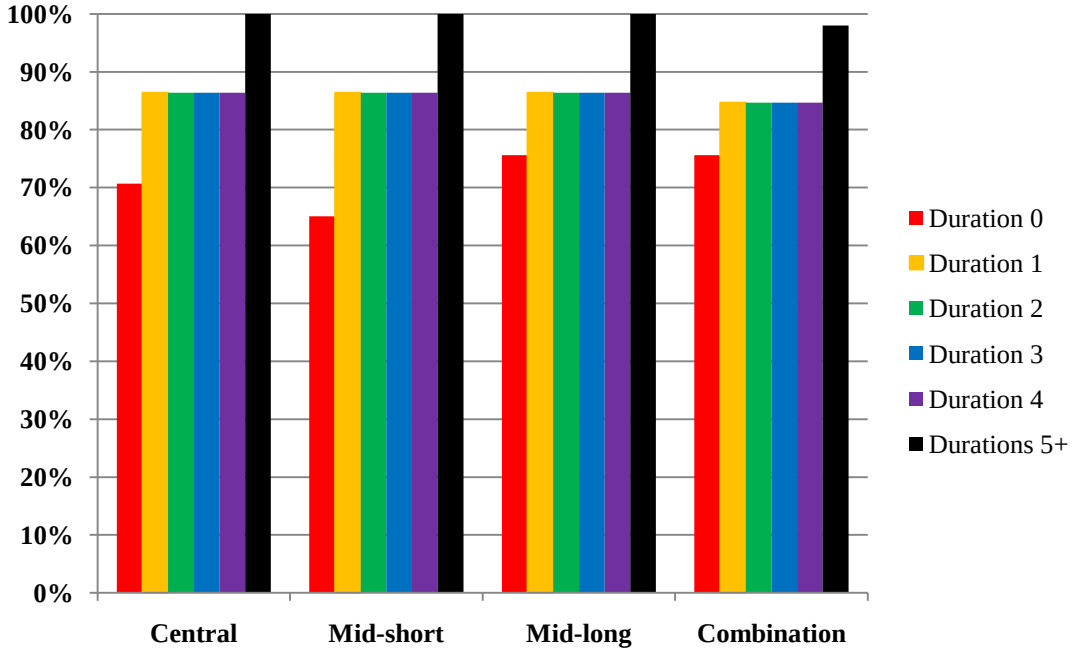
8.13. Revised rates using the combination of CDDs are produced by increasing the WP43 rates at duration 0 by 7% (as for the mid-long CDD) and reducing the rates at all other durations by 2%. The revised fit is shown in Table 8.6, including the fit at durations 1 to 4 combined.

Table 8.6: Values of 100A/E using a combination of CDDs and the WP43 diagnosis rates, but increased by 7% at duration 0 and reduced by 2% at all other durations

Age nearest at settlement	Curtate duration at settlement 0	1	2	3	4	5+	ALL	1-4
20-25	116	112	137	86	120	37	**114**	116
26-30	95	103	83	112	115	106	**100**	100
31-35	120	93	93	100	117	92	**99**	98
36-40	97	107	95	95	92	103	**100**	98
41-45	87	98	103	111	89	102	**100**	101
46-50	92	91	92	116	81	107	**99**	95
51-55	93	89	97	116	109	102	**100**	101
56-60	115	102	114	102	110	93	**101**	107
61-65	118	90	98	105	103	98	**100**	99
66-70	88	95	91	93	112	112	**107**	98
ALL	**100**	**97**	**98**	**107**	**101**	**101**	**100**	**100**

8.14. All three sensitivity tests above demonstrate the importance of the CDD to the rates by duration – as indeed, was demonstrated for adjusted results in Working Paper 33 – with the different distributions primarily affecting the rates at duration 0. The different select patterns are illustrated in Figure 8.1 (similar to Figure 6.4).

Figure 8.1: Male non-smoker diagnosis rates using various CDDs, rates by duration as a percentage of those at durations 5+ under the central CDD



8.15. Note also that the rates derived under all three sensitivity tests share the areas of poor fit in the WP43 rates, derived using the central CDD, noted in paragraph 6.18.

9. SUMMARY AND FUTURE WORK

9.1. This paper presents claim diagnosis rates for accelerated critical illness insurance, on a 'lives' basis, using data for claims settled in 1999 to 2004 (the "WP43 rates"). Four sets of rates are included in the paper: for males and females, and for non-smokers and smokers. The rates cover ages 25 to 65.

9.2. The derivation of these diagnosis rates builds on our previous work. This had progressed to 'adjusted' results, which properly match claims to exposure, but do so in terms of settled claims, not diagnosed claims.

9.3. In this paper, we derive diagnosis rates by adjusting an initial set of rates (CIBT02) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This was done in a pragmatic manner – for each gender/smoker dataset independently – to reach a reasonable fit, having regard to the data volumes.

9.4. These are the first results the CMI Critical Illness Committee has produced that relate to the date of diagnosis – when a critical illness claim is incurred – and therefore provide the first indications of a best estimate of experience by age and duration.

9.5. The selection patterns (based on curtate duration in years) inferred from the data vary between the four sets of rates, as follows:

Male Non-smoker:	0, 1-4, 5+
Male Smoker:	0, 1, 2+
Female Non-smoker:	0, 1, 2+
Female Smoker:	0, 1, 2-4, 5+

9.6. Three datasets show strong positive selection, with rates at duration 0 of 70-80% of the ultimate rates; however for male smokers, the rates at duration 0 are almost equal to the ultimate rates and higher than those for duration 1.

9.7. However, as demonstrated in section 8, the rates at duration 0 are particularly sensitive to the claim development distribution – varying by up to 8% under the sensitivity tests used – which is a key assumption underlying this work. Rates at other durations – and indeed the shape by age – are relatively unaffected.

9.8. In addition to these durational features, the rates exhibit shapes by age which differ significantly from currently available tables of critical illness rates. Whereas the male non-smoker rates appear to have a similar shape to mortality rates – and also to the existing tables of critical illness considered in section 6 – the rates for the other three gender/smoker categories appear to flatten at ages above about 55.

9.9. As with any CMI dataset, the experience by age and duration can be distorted by changes in the offices contributing data. The Committee considers that the 1999-2004 dataset used in this paper is also particularly vulnerable to changes in the critical illness market, as discussed in section 2. In particular the dataset varies from a very high proportion of term assurance cover at young ages and short durations to increasing proportions of endowment and whole-of-life products at older ages and high durations. This may distort the shape of the WP43 rates by both age and duration.

9.10. In addition to deriving all-causes rates for 1999-2004, we have also derived cause-specific rates for male non-smokers only for the main critical illness conditions: cancer, heart attack, death, stroke, CABG and TPD in section 5. As well as being of intrinsic interest, we consider that these rates provide important corroboration of the all-causes rates. In particular, although outside the scope of this paper, allowing for selection at a cause-specific level may lead to a better understanding of the selection pattern in the all-causes rates.

9.11. Given that we now have data for 2005 and 2006, we have compared the claims that we expect to be settled in those years, arising from diagnoses in 2004 and before – given the WP43 diagnosis rates – with the actual claims settled. The results are encouraging and indicate where we may head in terms of tracking emerging claims experience.

9.12. A substantial number of assumptions underlie these rates. It is important to recognise that there is some uncertainty associated with each of these, and hence a considerable degree of uncertainty surrounds the rates. Most of these assumptions are unchanged from those used to produce adjusted results in Working Paper 33. Indeed, no additional assumptions were required to produce the diagnosis rates in this paper however a considerable degree of judgement has been exercised, for example in deciding on the trade-off between smoothing and goodness of fit and in the weight attached to cells with relatively few claims, as discussed in section 4.

9.13. Although the Committee considers the WP43 rates to be a reasonable estimate of the true underlying rates, it is by no means the only set of rates that could have been derived and other approaches may be equally valid. Consequently the Committee is making available to member offices spreadsheets containing summarised data that will allow practitioners to experiment with alternative approaches to deriving the rates (subject to the limitation that the central claim development distribution underpins the data in the spreadsheets and cannot be varied). Member offices wishing to receive these spreadsheets should use the e-mail address at the end of this section.

9.14. The feedback received by the Committee on Working Paper 33 supported our intention to progress to deriving diagnosis rates. The Committee is very conscious that the scope of this paper is restricted; covering accelerated critical illness on a lives basis only. There are a number of extensions to this work that the Committee could consider, including:

- Derivation of diagnosis rates on an amounts basis.
- Derivation of diagnosis rates for stand-alone critical illness (albeit these may be limited to some form of adjustment to the accelerated rates, given the much lower volumes of data).
- Diagnosis rates (or adjustments to the diagnosis rates in this paper) for subsets of the data, for example by distribution channel or by office to indicate the range of variation.

9.15. However before considering any of the above, the Committee intends to derive diagnosis rates using a more recent dataset, 2003-2006. The Committee is reluctant to spend substantial further time on areas of work using the 1999-2004 dataset, as these may have limited practical benefit compared to undertaking work on the more recent dataset, given this is now available.

9.16. This decision is reinforced by the finding in section 7 that experience appears to have reduced over the period, particularly for males (albeit subject to the use of a single claim development distribution, derived from the 1999-2004 data, and a changing mix of offices over the period).

9.17. Using the 2003-2006 dataset has a number of other advantages:

- The Committee expects the 2003-2006 dataset to be more robust, in the sense that it may be less affected by changes in the critical illness market than the 1999-2004 dataset.
- The dataset covers a shorter period (4 years), compared to the 6 years of the dataset used in this paper. The analysis is therefore less vulnerable to changes in diagnosis rates and claim settlement practices during the investigation period.
- Notwithstanding the shorter period, the 2003-2006 dataset contains a similar number of settled claims in aggregate. Furthermore the percentage of claims with a date of diagnosis is significantly higher, meaning that the claim development distribution will be based on a greater number of claims than the 1999-2004 distribution used in this paper and hence should be a more accurate estimate of the underlying distribution.
- The higher number of "useable" claims may also facilitate claim development distributions to be derived with greater confidence for subsets of the data, allowing more accurate analyses.
- The dependency on off rates in estimating prior years' exposure will be greatly reduced. These were necessary for the current dataset as the CMI had no information on exposure before 1999 (or the first year for which an office submitted data, if later). For the 2003-2006 analysis, we know the in force data for most offices for the years before 2003.
- The 2003-2006 dataset is more stable in terms of contributing offices. Apart from two relatively small offices for which data is unavailable for the later years, the same offices will be included throughout the four years.
- As noted in paragraph 4.4, analysis of the experience from two periods may assist in demonstrating which features should be incorporated into formal tables of diagnosis rates. (This benefit is, of course, reduced by the overlap between the two periods but waiting for 2005-2008 data is clearly not the preferred option!)

9.18. The period 2003-2006 is also an appropriate period for further analysis as the Committee hopes that a large proportion of the data for 2007 (and subsequent years) will be on a Per Policy basis, providing additional data fields for more detailed analysis.

9.19. Whilst this paper is intended to draw the Committee's analysis of 1999-2004 experience to a conclusion, we hope that comparison of the claim development distribution and the diagnosis rates with those derived for 2003-2006, and later periods, will provide valuable insights into trends in UK critical illness experience over time.

9.20. The Committee remains conscious of the need to develop a formal statistical model to underpin our future work in analysing critical illness experience. In particular, this prevents us from providing any statistical measure of confidence around the WP43 rates. Whilst the Committee is very pleased to note the increased proportion of claims with date of diagnosis in recent data, we envisage that gaps in coverage are likely to

remain for the foreseeable future. Hence although the methodology used to derive diagnosis rates will evolve over time, it is possible that we will need to derive further sets of diagnosis rates using the current methodology.

9.21. The Committee is not undertaking a formal consultation exercise on the derivation of the WP43 diagnosis rates, which would inevitably delay the commencement of work on the 2003-2006 dataset. We will consult on the 2003-2006 rates which we hope we will then be able to recommend as formal tables for adoption by the Actuarial Profession.

9.22. Whilst we are not undertaking a formal consultation exercise, we would nevertheless be very grateful for feedback on this paper. Views on the following areas would be particularly appreciated, as these may influence the approach taken to the 2003-2006 rates:

- The prioritisation of the various 2003-2006 rates. We intend producing rates for accelerated business on a lives basis first, but views on the prioritisation of the other rates mentioned in paragraph 9.14 would be welcome.
- The need for (and prioritisation of) a full age-range table, given that the 2003-2006 dataset will still contain credible volumes for only a limited age range.
- The appropriateness of the constraints that we have applied, in particular that relating to duration discussed in paragraph 3.26.
- Other constraints that might sensibly be applied in the derivation of the rates, including between non-smoker and smoker rates.
- The choice between deriving all-causes rates directly or building these from separate sets of cause-specific rates (noting the limitations on female cancer claims referred to in paragraph 5.8).
- The reasonableness of the observed anti-selection in male smoker rates, either from analysis of other insured datasets or based on medical or other reasons.
- Similarly, the reasonableness of the observed increased selection at ages 46-55 in male non-smoker rates.
- Finally, whether our all-causes rates should include or exclude TPD.

9.23. Please e-mail any feedback by 30 April 2010, to ci@cmib.org.uk.

REFERENCES

ABI Statement of Best Practice for Critical Illness Cover (April 2006)

ABI : 2009 Review Consultation Paper (July 2009)

CMI Working Paper 14 : Methodology underlying the 1999-2002 CMI Critical Illness experience investigation (May 2005)

CMI Working Paper 18 : 1999-2002 Critical Illness experience: Feedback on Working Paper 14 and Future Work (December 2005)

CMI Working Paper 28 : Progress towards an improved methodology for analysing CMI critical illness experience (July 2007)

CMI Working Paper 33 : A new methodology for analysing CMI critical illness experience (July 2009)

Critical Illness Healthcare Study Group : "A Critical Review" presented to the Staple Inn Actuarial Society on 14 March 2000.

Critical Illness Trends Research Group : "Exploring the Critical Path" presented to the Staple Inn Actuarial Society on 6 December 2006.

Gen Re : "A Critical Table" (2007). Available from: http://www.genre.com/page/0,1019,ref%253DLifeHealthUKCriticalIllness-en,00.html

Society of Actuaries in Ireland Working Party ; Reserving for Critical Illness guarantees; presented to the Society on 30 November 1994

Swiss Re Health Watch 5 (2002)

Swiss Re Term & Health Watch 2003

Swiss Re Term & Health Watch 2004

Swiss Re Term & Health Watch 2005

Appendix A: Impact of revised assumptions on 'adjusted' results for 1999-2002

A1. In this appendix we show summary results for 1999-2002. These are included to illustrate the effect of the changes on the results contained in Appendix C of Working Paper 33 as a result of revised assumptions described in paragraphs 3.8 to 3.14 of this paper. These results are for male non-smokers only – other gender/smoker datasets show differences of similar magnitude.

A2. These results are for accelerated business on a lives basis, covering all causes of claim (including mortality).

A3. Table A1 is an updated version of Table C1 in Working Paper 33, reflecting the updated methodology but based on the same underlying data. The derivation of the values contained in the eight columns is explained in Appendix C of Working Paper 33. In all cases, claims are aggregated by age (nearest birthday) and (curtate) duration.

A4. Table A2 shows the effect of the changes by comparing the two columns in the results that are affected by the changes: the expected diagnosed claims based on the exposure estimated in Working Paper 33 (EDC') and the expected settled claims during 1999-2002 (ESC).

A5. Note that, as discussed in section 3, CIBT93 was used as the table for producing the expected claims in this Appendix, whereas CIBT02 (Extended Cover) has been used in the remainder of this paper.

Table A1: Full Acceleration business; Lives basis; All Causes (incl. mortality); 1999–2002; Male Non-Smokers

Age Band	Based on age and duration at date of diagnosis				Based on age and duration at date of settlement			Ratio of ASCs/ESC to ASCd/EDC
	Actual Settled Claims (ASCd)	Expected Diagnosed Claims (EDC)	100 ASCd/ EDC	Expected Diagnosed Claims (EDC')	Actual Settled Claims (ASCs)	Expected Settled Claims (ESC)	100 ASCs/ ESC	
	Diagnosed at duration 0				**Settled at duration 0**			
< 30	133	320.9	41%	315.3	96	175.0	55%	132%
31-40	255	720.4	35%	714.7	171	398.7	43%	121%
41-50	209	785.7	27%	777.7	132	434.5	30%	114%
51-60	138	569.4	24%	561.4	96	319.0	30%	124%
61+	25	58.4	43%	57.5	18	34.2	53%	123%
All	**760**	**2,454.7**	**31%**	**2,426.5**	**513**	**1,361.3**	**38%**	**122%**
	Diagnosed at duration 1				**Settled at duration 1**			
< 30	115	218.1	53%	215.5	109	203.6	54%	102%
31-40	226	559.3	40%	553.0	228	512.5	44%	110%
41-50	184	615.1	30%	603.2	203	558.6	36%	121%
51-60	183	487.0	38%	477.2	164	443.7	37%	98%
61+	17	62.2	27%	61.2	20	57.8	35%	127%
All	**725**	**1,941.7**	**37%**	**1,910.2**	**724**	**1,776.3**	**41%**	**109%**
	Diagnosed at duration 2				**Settled at duration 2**			
< 30	85	149.0	57%	149.7	65	150.9	43%	76%
31-40	193	448.2	43%	450.0	195	441.3	44%	103%
41-50	202	491.2	41%	491.2	179	481.8	37%	90%
51-60	153	394.7	39%	392.6	163	388.9	42%	108%
61+	25	60.5	41%	59.4	21	59.8	35%	85%
All	**628**	**1,543.7**	**41%**	**1,542.8**	**623**	**1,522.6**	**41%**	**101%**
	Diagnosed at duration 3				**Settled at duration 3**			
< 30	66	99.4	66%	98.9	68	101.8	67%	101%
31-40	137	370.4	37%	368.8	143	366.9	39%	105%
41-50	173	415.2	42%	415.0	182	412.2	44%	106%
51-60	127	332.5	38%	331.4	146	333.0	44%	115%
61+	23	52.4	44%	53.0	25	55.0	45%	104%
All	**526**	**1,269.8**	**41%**	**1,267.2**	**564**	**1,268.8**	**44%**	**107%**
	Diagnosed at duration 4				**Settled at duration 4**			
< 30	27	62.6	43%	63.0	39	65.1	60%	139%
31-40	115	301.3	38%	300.1	137	298.8	46%	120%
41-50	119	359.6	33%	356.4	122	353.5	35%	104%
51-60	122	290.7	42%	284.8	125	286.1	44%	104%
61+	11	43.9	25%	42.9	17	45.0	38%	151%
All	**394**	**1,058.2**	**37%**	**1,047.1**	**440**	**1,048.6**	**42%**	**113%**
	Diagnosed at duration 5+				**Settled at duration 5+**			
< 30	34	65.9	52%	66.2	39	69.6	56%	109%
31-40	271	625.2	43%	622.9	305	624.9	49%	113%
41-50	432	1,040.6	42%	1,033.1	488	1,027.4	48%	114%
51-60	374	1,019.7	37%	1,008.5	456	1,010.7	45%	123%
61+	87	205.7	42%	200.6	109	208.3	52%	124%
All	**1,198**	**2,957.2**	**41%**	**2,931.4**	**1,397**	**2,940.9**	**48%**	**117%**
	Diagnosed at all durations				**Settled at all durations**			
< 30	460	915.9	50%	908.5	416	765.95	54%	108%
31-40	1,197	3,024.8	44%	3,009.5	1,179	2642.98	45%	103%
41-50	1,319	3,707.5	36%	3,676.6	1,306	3268.02	40%	112%
51-60	1,097	3,094.0	35%	3,055.8	1,150	2781.38	41%	117%
61+	188	483.1	39%	474.6	210	460.05	46%	117%
All	**4,261**	**11,225.3**	**38%**	**11,125.2**	**4,261**	**9918.4**	**43%**	**113%**

Table A2: Impact of changes in assumptions.

Age Band	WP33	Refined	Ratio of Refined 100A/E to WP33 100A/E	WP33		Refined		Ratio of Refined 100A/E to WP33 100A/E
	Expected Diagnosed Claims (EDC')	Expected Diagnosed Claims (EDC')		Expected Settled Claims (ESC)	100 ASCs / ESC	Expected Settled Claims (ESC)	100 ASCs / ESC	
	Diagnosed at duration 0			**Settled at duration 0**				
< 30	314.5	315.3	100%	179.0	54%	175.0	55%	102%
31-40	713.0	714.7	100%	398.4	43%	398.7	43%	100%
41-50	775.7	777.7	100%	431.3	31%	434.5	30%	99%
51-60	560.0	561.4	100%	312.4	31%	319.0	30%	98%
61+	57.3	57.5	100%	32.0	56%	34.2	53%	94%
All	**2,420.6**	**2,426.5**	**100%**	**1,353.1**	**38%**	**1,361.3**	**38%**	**99%**
	Diagnosed at duration 1			**Settled at duration 1**				
< 30	215.7	215.5	100%	208.8	52%	203.6	54%	103%
31-40	553.5	553.0	100%	514.5	44%	512.5	44%	100%
41-50	603.5	603.2	100%	558.3	36%	558.6	36%	100%
51-60	477.6	477.2	100%	438.7	37%	443.7	37%	99%
61+	61.2	61.2	100%	55.8	36%	57.8	35%	97%
All	**1,911.5**	**1,910.2**	**100%**	**1,776.1**	**41%**	**1,776.3**	**41%**	**100%**
	Diagnosed at duration 2			**Settled at duration 2**				
< 30	149.8	149.7	100%	155.1	42%	150.9	43%	103%
31-40	450.3	450.0	100%	442.9	44%	441.3	44%	100%
41-50	491.4	491.2	100%	481.4	37%	481.8	37%	100%
51-60	392.8	392.6	100%	385.0	42%	388.9	42%	99%
61+	59.4	59.4	100%	58.1	36%	59.8	35%	97%
All	**1,543.6**	**1,542.8**	**100%**	**1,522.4**	**41%**	**1,522.6**	**41%**	**100%**
	Diagnosed at duration 3			**Settled at duration 3**				
< 30	99.0	98.9	100%	105.2	65%	101.8	67%	103%
31-40	369.1	368.8	100%	368.8	39%	366.9	39%	101%
41-50	415.2	415.0	100%	412.3	44%	412.2	44%	100%
51-60	331.6	331.4	100%	330.0	44%	333.0	44%	99%
61+	53.1	53.0	100%	53.6	47%	55.0	45%	97%
All	**1,267.9**	**1,267.2**	**100%**	**1,269.8**	**44%**	**1,268.8**	**44%**	**100%**
	Diagnosed at duration 4			**Settled at duration 4**				
< 30	63.0	63.0	100%	68.1	57%	65.1	60%	104%
31-40	300.3	300.1	100%	301.7	45%	298.8	46%	101%
41-50	356.5	356.4	100%	354.6	34%	353.5	35%	100%
51-60	285.0	284.8	100%	284.3	44%	286.1	44%	99%
61+	42.9	42.9	100%	44.1	39%	45.0	38%	98%
All	**1,047.7**	**1,047.1**	**100%**	**1,052.6**	**42%**	**1,048.6**	**42%**	**100%**
	Diagnosed at duration 5+			**Settled at duration 5+**				
< 30	66.3	66.2	100%	73.6	53%	69.6	56%	106%
31-40	623.7	622.9	100%	633.9	48%	624.9	49%	101%
41-50	1,033.9	1,033.1	100%	1,032.1	47%	1,027.4	48%	100%
51-60	1,009.3	1,008.5	100%	1,006.4	45%	1,010.7	45%	100%
61+	200.7	200.6	100%	203.1	54%	208.3	52%	97%
All	**2,933.9**	**2,931.4**	**100%**	**2,949.1**	**47%**	**2,940.9**	**48%**	**100%**
	Diagnosed at all durations			**Settled at all durations**				
< 30	908.3	908.5	100%	789.8	53%	766.0	54%	103%
31-40	3,009.9	3,009.5	100%	2,660.1	44%	2,643.0	45%	101%
41-50	3,676.2	3,676.6	100%	3,270.0	40%	3,268.0	40%	100%
51-60	3,056.3	3,055.8	100%	2,756.7	42%	2,781.4	41%	99%
61+	474.6	474.6	100%	446.6	47%	460.0	46%	97%
All	**11,125.2**	**11,125.2**	**100%**	**9,923.2**	**43%**	**9,918.4**	**43%**	**100%**

Appendix B: Discussion on methodologies for deriving diagnosis rates

B1. In section 3, we described the approach that the Committee followed to derive the diagnosis rates set out in this paper. As we noted the Committee experimented with a number of approaches and in this Appendix we provide an overview of the other approaches, the rationale for the use of the approach adopted and compare the approach with more conventional graduation methodologies.

B2. The approach outlined in section 3 involved setting diagnosis rates that produce expected settled claims that are close to the actual settled claims, by both age and duration. The approach was intuitive seeking to gradually improve the goodness of fit at successive steps, by eliminating areas of poor fit.

B3. The Committee explored other approaches of obtaining rates from matching expected settled claims to actual settled claims, by both age and duration; including a parametric approach, imposing a model on the rates at successive durations and solving for the variables within the model, optimising the parameter values to minimise the difference between actual and expected settled claims. Applied to the four different gender/ smoker datasets, these approaches yielded useful insights that could be incorporated into the intuitive approach that we followed. None of these alternative approaches yielded a set of rates that was demonstrably better than those derived intuitively, in terms of goodness of fit and smoothness.

B4. A different approach altogether was to attempt to "solve" for the diagnosis rates. The diagnosis rate for an arbitrary young age (say age 20) and duration 0 can be set. This then fixes the contribution to expected settled claims at all older ages and higher durations at settlement from this age and duration at diagnosis, allowing us to solve for the duration 0 diagnosis rates for successive ages. Once the duration 0 rates have been derived for all ages, we can then solve for the rates at duration 1, again starting at the youngest age (20), as all claims settled at age 20, duration 1 are assumed to have come from either age 20, duration 1 itself or from age 20, duration 0. This iterative process produces very erratic rates (indeed these crude rates can be negative in some cases) that then need considerable smoothing before they can be used in practice. At ages where there are credible volumes of data, these smoothed rates were comparable to the rates derived by our intuitive approach; however the Committee considered that the wide variety of rates at older and younger ages produced by different smoothing techniques meant that this approach was less robust than the intuitive approach.

B5. It should be noted that the conventional approach within CMI mortality graduations of graduating the ultimate experience first was inappropriate here. First, there is a methodological issue, as the ultimate experience, which is based on settled claims, depends on the assumed diagnosis rates at the select durations; hence the ultimate rates would need to be re-visited once the select rates had been derived. There is also the practical issue that a large proportion of the 1999-2004 experience exists at the shorter durations; for example, Table 3.2 shows that only around a third of the settled claims for male non-smokers in 1999-2004 were at durations 5 and over.

B6. The approaches adopted in this work and described above may appear unconventional when compared to other CMI graduations. This has been driven by the lack of independence within the diagnosis rates; as they are derived (in some way) by equating expected settled claims to actual settled claims, the value ascribed to the diagnosis rate at any given age and duration impacts on other diagnosis rates. An alternative

approach, which avoids this interdependency, would be to derive rates of claim that reflect both the probability of diagnosis (at a given age and duration) *and* the probability of settlement (at a given age and duration), whereas we have separated the diagnosis rates from the claim development distribution in our recent work. Diagnosis rates are then the combination of all these rates of claim that arise from a common age and duration at diagnosis. Work on such an approach by a PhD student at Heriot-Watt University is underway and the Committee will be very interested to see the results.

B7. As noted above, conventional graduation techniques were not available to us, as they depend on independence. It is though worth noting that many facets of conventional graduations require subjective decisions, similar to those we have made, for example in deciding which durations to graduate separately and which to combine, and what constraints to apply (if any) to achieve a plausible relationship between smoker and non-smoker rates. However, in those situations, the judgements required can be guided by formal statistical tests which were not available to us.

B8. In conclusion, although the approach adopted by the Committee may appear unusual, we consider that it provides a pragmatic solution to deriving diagnosis rates given the data available.

Appendix C: Derivation of cause-specific rates for male non-smokers

C1. This appendix contains tables and notes illustrating the derivation of cause-specific diagnosis rates for male non-smokers, as discussed in section 5 of this paper.

C2. Paragraphs C3 to C7 describe the structure of the remainder of this appendix for each cause of claim.

C3. The first table (e.g. Table C1 for cancer) shows the Actual Settled Claims for that cause. This table corresponds to Table 3.2 for all-causes combined. Note that this table covers the same age range (20 to 70) as the earlier tables; however because of the low numbers of claims at either end of this age range, the other tables (described in paragraphs C6 and C7, respectively) cover ages 30 to 60 only.

C4. For each cause we have then included brief notes that may aid understanding of the derivation. In each case, the notes relate to the three stages of adjustment (corresponding to those used for the all-causes rates, set out in paragraph 3.23), i.e.:

i. An all-ages, all-durations adjustment is used to achieve an overall 100 A/E of 100. Note that here the cause-specific CIBT02 table is used to calculate the expected settled claims.
ii. A brief description of the shape of the age adjustments that are then applied to achieve all-durations 100 A/Es of close to 100 for each age band.
iii. The re-shaping by duration that is then applied to achieve all-ages 100 A/Es of close to 100 for each duration. As noted in section 5, the Committee used the same adjustments at durations 1 to 4, irrespective of whether this particular approach appeared to be implied by the data for that cause.

C5. Note that, as in section 3, the CIBT02 rates have been applied to age nearest data without adjustment. This affects the adjustments but not the final rates.

C6. The second table (e.g. Table C2 for cancer) shows the adjustments to the cause-specific rates from the CIBT02 table by age and duration after steps i to iii. This table corresponds to Table 3.8 for all-causes combined. Note that, as with Table 3.8, this table only shows the adjustments to the nearest integer for quinquennial ages.

C7. The third table (e.g. Table C3 for cancer) shows the values of 100 x Actual Settled Claims / Expected Settled Claims using the adjusted rates and hence illustrates the fit of the cause-specific rates to the data. This table corresponds to Table 3.7 for the all-causes rates. Note that in this table "ALL" means ages 30-60 only.

Cancer

Table C1: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	19	15	15	3	1	0	**53**
26-30	36	64	44	33	21	16	**214**
31-35	64	85	61	44	37	66	**357**
36-40	50	99	72	55	39	135	**450**
41-45	46	89	84	49	33	151	**452**
46-50	21	53	61	53	23	158	**369**
51-55	42	49	66	60	38	157	**412**
56-60	28	56	56	43	35	148	**366**
61-65	5	9	11	7	14	62	**108**
66-70	1	3	3	1	1	22	**31**
ALL	**312**	**522**	**473**	**348**	**242**	**915**	**2,812**

Steps in deriving rates:

i. The overall 100 A/E was 59% of CIBT02 (cancer).

ii. The shaping by age increased the adjustments at ages up to 43 and reduced the adjustments at ages 45 and over.

iii. The re-shaping by duration reduced the adjustments at duration 0 by 17% and increased the adjustments at durations 5+ by 13%.

Table C2: Adjustments to CIBT02 (cancer only) by age and duration

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
30	57%	69%	69%	69%	69%	78%
35	55%	67%	67%	67%	67%	75%
40	55%	67%	67%	67%	67%	75%
45	47%	57%	57%	57%	57%	64%
50	38%	46%	46%	46%	46%	52%
55	47%	56%	56%	56%	56%	63%
60	46%	56%	56%	56%	56%	63%

Table C3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C2

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	130	108	91	93	106	83	**100**	99
36-40	92	111	93	99	93	105	**101**	100
41-45	92	106	113	92	81	102	**100**	101
46-50	56	82	105	124	69	117	**99**	96
51-55	116	77	109	128	102	98	**102**	102
56-60	107	113	112	104	104	90	**100**	109
ALL	**99**	**100**	**103**	**106**	**92**	**100**	**100**	**101**

Heart Attack

Table C4: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	0	1	0	0	0	0	**1**
26-30	0	3	2	0	2	2	**9**
31-35	12	7	8	2	3	4	**36**
36-40	13	27	10	11	6	27	**94**
41-45	16	26	20	17	17	53	**149**
46-50	20	41	30	24	20	84	**219**
51-55	20	42	45	32	20	123	**282**
56-60	20	24	26	9	17	67	**163**
61-65	6	8	7	12	6	31	**70**
66-70	0	0	0	1	3	4	**8**
ALL	**107**	**179**	**148**	**108**	**94**	**395**	**1,031**

Steps in deriving rates:

i. The overall 100 A/E was 23% of CIBT02 (heart attack).

ii. The shaping by age reduced the adjustments up to age 49 and increased the adjustments at ages 50 and over.

iii. The re-shaping by duration reduced the adjustments at duration 0 by 4% and increased the adjustments at durations 5+ by 22%.

Table C5: Adjustments to CIBT02 (heart attack only) by age and duration

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
30	16%	17%	17%	17%	17%	20%
35	14%	15%	15%	15%	15%	18%
40	15%	15%	15%	15%	15%	19%
45	16%	17%	17%	17%	17%	21%
50	23%	24%	24%	24%	24%	29%
55	29%	30%	30%	30%	30%	37%
60	24%	25%	25%	25%	25%	30%

Table C6: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C2

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	222	89	125	45	91	50	**101**	91
36-40	104	144	65	101	73	101	**102**	102
41-45	88	93	85	102	133	107	**100**	99
46-50	81	106	90	99	106	103	**99**	100
51-55	73	93	110	102	80	108	**99**	98
56-60	151	103	115	49	112	85	**95**	95
ALL	**99**	**103**	**98**	**90**	**100**	**100**	**99**	**98**

Deaths

Table C7: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	20	22	15	4	3	1	**65**
26-30	40	57	24	32	16	30	**199**
31-35	51	64	56	48	32	63	**314**
36-40	45	69	45	36	26	89	**310**
41-45	30	59	38	42	28	103	**300**
46-50	32	54	24	34	16	105	**265**
51-55	16	30	30	18	24	89	**207**
56-60	15	17	16	21	12	63	**144**
61-65	5	5	11	7	4	36	**68**
66-70	0	1	2	1	1	14	**19**
ALL	**254**	**378**	**261**	**243**	**162**	**593**	**1,891**

Steps in deriving rates:

i. The overall 100 A/E was 33% of CIBT02 (deaths).
ii. The shaping by age reduced the adjustments at ages up to 54 and increased the adjustments at ages 56 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 17% and increased the adjustments at durations 5+ by 23%.

Table C8: Adjustments to CIBT02 (death only) by age and duration

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
30	28%	34%	34%	34%	34%	42%
35	26%	32%	32%	32%	32%	39%
40	22%	26%	26%	26%	26%	33%
45	26%	32%	32%	32%	32%	39%
50	26%	32%	32%	32%	32%	39%
55	27%	33%	33%	33%	33%	41%
60	36%	44%	44%	44%	44%	54%

Table C9: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C2

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	105	93	98	119	108	87	**99**	102
36-40	106	111	86	96	91	95	**98**	97
41-45	81	107	80	124	108	101	**100**	103
46-50	109	121	62	120	72	107	**101**	95
51-55	80	94	102	79	133	106	**100**	100
56-60	132	88	85	136	95	93	**99**	100
ALL	**100**	**104**	**86**	**112**	**101**	**99**	**99**	**100**

Stroke

Table C10: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	0	2	0	0	0	0	**2**
26-30	3	2	1	1	1	1	**9**
31-35	4	6	9	3	1	8	**31**
36-40	6	9	10	7	8	16	**56**
41-45	7	7	16	15	8	26	**79**
46-50	12	7	11	6	7	29	**72**
51-55	2	11	9	10	7	23	**62**
56-60	2	6	15	13	6	19	**61**
61-65	2	5	4	3	3	16	**33**
66-70	0	0	0	0	1	5	**6**
ALL	**38**	**55**	**75**	**58**	**42**	**143**	**411**

Steps in deriving rates:

i. The overall 100 A/E was 30% of CIBT02 (stroke).
ii. The shaping by age reduced the adjustments at ages up to 38 and over 46 and increased the adjustments for ages 39 to 46.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 17% and left the adjustments at durations 5+ unchanged.

Table C11: Adjustments to CIBT02 (stroke only) by age and duration

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
30	15%	18%	18%	18%	18%	18%
35	24%	29%	29%	29%	29%	29%
40	28%	33%	33%	33%	33%	33%
45	30%	36%	36%	36%	36%	36%
50	26%	31%	31%	31%	31%	31%
55	21%	25%	25%	25%	25%	25%
60	53%	64%	64%	64%	64%	64%

Table C12: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C11

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	106	90	155	73	33	127	**104**	97
36-40	92	76	94	92	139	101	**96**	95
41-45	88	47	118	153	106	107	**101**	100
46-50	179	55	92	68	102	115	**100**	77
51-55	39	108	90	129	113	97	**98**	109
56-60	51	73	176	185	104	74	**103**	136
ALL	**97**	**71**	**116**	**120**	**105**	**100**	**100**	**101**

CABG

Table C13: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	0	0	0	0	0	0	**0**
26-30	0	0	0	0	0	0	**0**
31-35	1	2	1	0	2	2	**8**
36-40	1	2	2	3	0	5	**13**
41-45	1	9	3	4	0	14	**31**
46-50	4	7	10	6	4	18	**49**
51-55	4	13	4	8	13	43	**85**
56-60	2	7	7	2	5	36	**59**
61-65	1	3	2	2	0	14	**22**
66-70	0	0	0	2	1	2	**5**
ALL	**14**	**43**	**29**	**27**	**25**	**134**	**272**

Steps in deriving rates:

i. The overall 100 A/E was 35% of CIBT02 (CABG).
ii. The shaping by age increased the adjustments at ages up to 35 and for ages 53 to 57 and reduced the adjustments for ages 36 to 52 and over 57.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 50% and increased the adjustments at durations 5+ by 55%.

Table C14: Adjustments to CIBT02 (CABG only) by age and duration

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
30	0%	0%	0%	0%	0%	0%
35	25%	50%	50%	50%	50%	78%
40	13%	25%	25%	25%	25%	39%
45	13%	26%	26%	26%	26%	40%
50	14%	29%	29%	29%	29%	44%
55	18%	36%	36%	36%	36%	56%
60	17%	34%	34%	34%	34%	52%

Table C15: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C14

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	119	105	54	0	211	71	**83**	83
36-40	108	91	93	194	0	105	**102**	99
41-45	50	186	62	115	0	109	**101**	101
46-50	144	103	145	118	100	84	**104**	119
51-55	104	131	38	96	198	114	**111**	107
56-60	82	104	91	31	96	106	**94**	81
ALL	**101**	**124**	**79**	**88**	**117**	**104**	**102**	**101**

TPD

Table C16: Actual Settled Claims in 1999-2004, male non-smokers, by age band and duration

Age nearest at settlement	**Curtate duration at settlement**						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	0	0	1	0	0	0	**1**
26-30	0	4	3	0	1	7	**15**
31-35	0	2	5	4	9	16	**36**
36-40	1	5	9	4	4	19	**42**
41-45	0	5	3	6	3	22	**39**
46-50	1	1	5	7	3	17	**34**
51-55	1	3	4	4	6	26	**44**
56-60	1	1	4	4	6	20	**36**
61-65	0	0	0	1	1	7	**9**
66-70	0	0	0	0	0	0	**0**
ALL	**4**	**21**	**34**	**30**	**33**	**134**	**256**

Steps in deriving rates:

i. The overall 100 A/E was 17% of CIBT02 (TPD).
ii. The shaping by age increased the adjustments at ages up to 40 and reduced the adjustments at ages 41 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 83% and increased the adjustments at durations 5+ by 70%.

Table C17: Adjustments to CIBT02 (TPD only) by age and duration

Age nearest at diagnosis	**Curtate duration at diagnosis**					
	0	**1**	**2**	**3**	**4**	**5+**
30	6%	36%	36%	36%	36%	62%
35	4%	26%	26%	26%	26%	45%
40	3%	18%	18%	18%	18%	30%
45	2%	13%	13%	13%	13%	23%
50	2%	12%	12%	12%	12%	21%
55	3%	17%	17%	17%	17%	28%
60	3%	16%	16%	16%	16%	28%

Table C18: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C17

Age nearest at settlement	**Curtate duration at settlement**							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	0	41	75	74	215	120	**102**	95
36-40	133	106	136	73	90	98	**101**	104
41-45	0	127	54	130	80	111	**102**	95
46-50	200	31	108	179	93	88	**98**	107
51-55	182	80	72	82	149	103	**100**	94
56-60	293	40	99	105	183	85	**96**	110
ALL	**113**	**74**	**91**	**103**	**135**	**99**	**100**	**100**

Appendix D: Diagnosis rates, 1999-2004

D1. This appendix contains all-causes diagnosis rates for 1999-2004 for accelerated business, derived in this paper, and referred to as WP43 rates.

Table D1: Male Non-Smoker rates

Age	Curtate duration						Age
Exact	0	1	2	3	4	5+	Exact
25	**0.00058**	**0.00071**	**0.00071**	**0.00071**	**0.00071**	**0.00082**	**25**
26	0.00059	0.00072	0.00072	0.00072	0.00072	0.00084	26
27	0.00061	0.00073	0.00073	0.00073	0.00073	0.00086	27
28	0.00063	0.00076	0.00076	0.00076	0.00076	0.00088	28
29	0.00064	0.00078	0.00078	0.00078	0.00078	0.00090	29
30	**0.00065**	**0.00080**	**0.00080**	**0.00080**	**0.00080**	**0.00092**	**30**
31	0.00068	0.00083	0.00083	0.00083	0.00083	0.00096	31
32	0.00071	0.00086	0.00086	0.00086	0.00086	0.00100	32
33	0.00074	0.00090	0.00090	0.00090	0.00090	0.00105	33
34	0.00077	0.00095	0.00095	0.00095	0.00095	0.00111	34
35	**0.00082**	**0.00102**	**0.00102**	**0.00102**	**0.00102**	**0.00118**	**35**
36	0.00087	0.00110	0.00110	0.00110	0.00110	0.00126	36
37	0.00094	0.00117	0.00117	0.00117	0.00117	0.00135	37
38	0.00101	0.00124	0.00124	0.00124	0.00124	0.00144	38
39	0.00110	0.00133	0.00133	0.00133	0.00133	0.00154	39
40	**0.00119**	**0.00144**	**0.00144**	**0.00144**	**0.00144**	**0.00168**	**40**
41	0.00131	0.00160	0.00160	0.00160	0.00160	0.00186	41
42	0.00146	0.00179	0.00179	0.00179	0.00179	0.00207	42
43	0.00163	0.00198	0.00198	0.00198	0.00198	0.00230	43
44	0.00179	0.00218	0.00218	0.00218	0.00218	0.00253	44
45	**0.00196**	**0.00239**	**0.00239**	**0.00239**	**0.00239**	**0.00276**	**45**
46	0.00213	0.00260	0.00259	0.00259	0.00259	0.00300	46
47	0.00232	0.00284	0.00283	0.00283	0.00283	0.00328	47
48	0.00257	0.00314	0.00314	0.00314	0.00314	0.00364	48
49	0.00289	0.00353	0.00353	0.00353	0.00353	0.00408	49
50	**0.00325**	**0.00397**	**0.00397**	**0.00397**	**0.00397**	**0.00460**	**50**
51	0.00364	0.00444	0.00444	0.00444	0.00444	0.00515	51
52	0.00407	0.00497	0.00497	0.00497	0.00497	0.00576	52
53	0.00458	0.00558	0.00558	0.00558	0.00558	0.00647	53
54	0.00511	0.00624	0.00624	0.00624	0.00624	0.00723	54
55	**0.00567**	**0.00692**	**0.00692**	**0.00692**	**0.00692**	**0.00802**	**55**
56	0.00627	0.00764	0.00764	0.00764	0.00764	0.00886	56
57	0.00693	0.00844	0.00844	0.00844	0.00844	0.00979	57
58	0.00767	0.00933	0.00933	0.00933	0.00933	0.01083	58
59	0.00850	0.01033	0.01033	0.01033	0.01033	0.01200	59
60	**0.00939**	**0.01140**	**0.01140**	**0.01140**	**0.01140**	**0.01326**	**60**
61	0.01030	0.01250	0.01250	0.01250	0.01250	0.01454	61
62	0.01123	0.01362	0.01362	0.01362	0.01362	0.01586	62
63	0.01223	0.01487	0.01487	0.01487	0.01487	0.01728	63
64	0.01346	0.01642	0.01642	0.01642	0.01642	0.01905	64
65	**0.01472**	**0.01795**	**0.01795**	**0.01795**	**0.01795**	**0.02083**	**65**

Table D2: Male Smoker rates

Age	Curtate duration						Age
Exact	0	1	2	3	4	5+	Exact
25	**0.00072**	**0.00064**	**0.00073**	**0.00073**	**0.00073**	**0.00073**	**25**
26	0.00073	0.00065	0.00075	0.00075	0.00075	0.00075	26
27	0.00077	0.00068	0.00079	0.00079	0.00079	0.00079	27
28	0.00082	0.00073	0.00084	0.00084	0.00084	0.00084	28
29	0.00088	0.00079	0.00090	0.00090	0.00090	0.00090	29
30	**0.00096**	**0.00085**	**0.00098**	**0.00098**	**0.00098**	**0.00098**	**30**
31	0.00105	0.00093	0.00107	0.00107	0.00107	0.00107	31
32	0.00115	0.00102	0.00117	0.00117	0.00117	0.00117	32
33	0.00127	0.00113	0.00130	0.00130	0.00130	0.00130	33
34	0.00141	0.00125	0.00144	0.00144	0.00144	0.00144	34
35	**0.00156**	**0.00138**	**0.00159**	**0.00159**	**0.00159**	**0.00159**	**35**
36	0.00173	0.00153	0.00176	0.00176	0.00176	0.00176	36
37	0.00191	0.00170	0.00195	0.00195	0.00195	0.00195	37
38	0.00212	0.00188	0.00217	0.00217	0.00217	0.00217	38
39	0.00236	0.00209	0.00241	0.00241	0.00241	0.00241	39
40	**0.00262**	**0.00232**	**0.00267**	**0.00267**	**0.00267**	**0.00267**	**40**
41	0.00291	0.00258	0.00297	0.00297	0.00297	0.00297	41
42	0.00328	0.00291	0.00335	0.00335	0.00335	0.00335	42
43	0.00377	0.00335	0.00385	0.00385	0.00385	0.00385	43
44	0.00436	0.00387	0.00445	0.00445	0.00445	0.00445	44
45	**0.00508**	**0.00451**	**0.00519**	**0.00519**	**0.00519**	**0.00519**	**45**
46	0.00589	0.00523	0.00601	0.00601	0.00601	0.00601	46
47	0.00675	0.00599	0.00689	0.00689	0.00689	0.00689	47
48	0.00767	0.00681	0.00783	0.00783	0.00783	0.00783	48
49	0.00861	0.00765	0.00879	0.00879	0.00879	0.00879	49
50	**0.00957**	**0.00850**	**0.00977**	**0.00977**	**0.00977**	**0.00977**	**50**
51	0.01055	0.00937	0.01077	0.01077	0.01077	0.01077	51
52	0.01157	0.01027	0.01181	0.01181	0.01181	0.01181	52
53	0.01261	0.01120	0.01287	0.01287	0.01287	0.01287	53
54	0.01369	0.01215	0.01397	0.01397	0.01397	0.01397	54
55	**0.01480**	**0.01313**	**0.01510**	**0.01510**	**0.01510**	**0.01510**	**55**
56	0.01593	0.01414	0.01626	0.01626	0.01626	0.01626	56
57	0.01710	0.01518	0.01745	0.01745	0.01745	0.01745	57
58	0.01830	0.01624	0.01867	0.01867	0.01867	0.01867	58
59	0.01953	0.01734	0.01993	0.01993	0.01993	0.01993	59
60	**0.02074**	**0.01841**	**0.02116**	**0.02116**	**0.02116**	**0.02116**	**60**
61	0.02191	0.01945	0.02236	0.02236	0.02236	0.02236	61
62	0.02311	0.02052	0.02358	0.02358	0.02358	0.02358	62
63	0.02432	0.02159	0.02482	0.02482	0.02482	0.02482	63
64	0.02555	0.02268	0.02607	0.02607	0.02607	0.02607	64
65	**0.02617**	**0.02323**	**0.02670**	**0.02670**	**0.02670**	**0.02670**	**65**

Table D3: Female Non-Smoker rates

Age	Curtate duration						Age
Exact	**0**	**1**	**2**	**3**	**4**	**5+**	**Exact**
25	**0.00037**	**0.00044**	**0.00046**	**0.00046**	**0.00046**	**0.00046**	**25**
26	0.00042	0.00050	0.00053	0.00053	0.00053	0.00053	26
27	0.00046	0.00056	0.00059	0.00059	0.00059	0.00059	27
28	0.00051	0.00061	0.00064	0.00064	0.00064	0.00064	28
29	0.00056	0.00068	0.00071	0.00071	0.00071	0.00071	29
30	**0.00062**	**0.00075**	**0.00079**	**0.00079**	**0.00079**	**0.00079**	**30**
31	0.00068	0.00082	0.00086	0.00086	0.00086	0.00086	31
32	0.00075	0.00091	0.00095	0.00095	0.00095	0.00095	32
33	0.00083	0.00100	0.00105	0.00105	0.00105	0.00105	33
34	0.00091	0.00109	0.00115	0.00115	0.00115	0.00115	34
35	**0.00097**	**0.00117**	**0.00123**	**0.00123**	**0.00123**	**0.00123**	**35**
36	0.00104	0.00125	0.00131	0.00131	0.00131	0.00131	36
37	0.00111	0.00134	0.00140	0.00140	0.00140	0.00140	37
38	0.00119	0.00143	0.00150	0.00150	0.00150	0.00150	38
39	0.00127	0.00153	0.00160	0.00160	0.00160	0.00160	39
40	**0.00136**	**0.00164**	**0.00172**	**0.00172**	**0.00172**	**0.00172**	**40**
41	0.00146	0.00176	0.00184	0.00184	0.00184	0.00184	41
42	0.00158	0.00190	0.00200	0.00200	0.00200	0.00200	42
43	0.00171	0.00207	0.00217	0.00217	0.00217	0.00217	43
44	0.00186	0.00225	0.00236	0.00236	0.00236	0.00236	44
45	**0.00204**	**0.00246**	**0.00258**	**0.00258**	**0.00258**	**0.00258**	**45**
46	0.00224	0.00270	0.00284	0.00284	0.00284	0.00284	46
47	0.00248	0.00298	0.00313	0.00313	0.00313	0.00313	47
48	0.00275	0.00331	0.00348	0.00348	0.00348	0.00348	48
49	0.00306	0.00368	0.00386	0.00386	0.00386	0.00386	49
50	**0.00336**	**0.00405**	**0.00425**	**0.00425**	**0.00425**	**0.00425**	**50**
51	0.00365	0.00439	0.00461	0.00461	0.00461	0.00461	51
52	0.00391	0.00470	0.00494	0.00494	0.00494	0.00494	52
53	0.00415	0.00499	0.00524	0.00524	0.00524	0.00524	53
54	0.00437	0.00526	0.00553	0.00553	0.00553	0.00553	54
55	**0.00459**	**0.00553**	**0.00581**	**0.00581**	**0.00581**	**0.00581**	**55**
56	0.00484	0.00582	0.00611	0.00611	0.00611	0.00611	56
57	0.00509	0.00613	0.00644	0.00644	0.00644	0.00644	57
58	0.00535	0.00644	0.00676	0.00676	0.00676	0.00676	58
59	0.00559	0.00673	0.00707	0.00707	0.00707	0.00707	59
60	**0.00582**	**0.00701**	**0.00736**	**0.00736**	**0.00736**	**0.00736**	**60**
61	0.00605	0.00729	0.00766	0.00766	0.00766	0.00766	61
62	0.00629	0.00757	0.00795	0.00795	0.00795	0.00795	62
63	0.00652	0.00785	0.00825	0.00825	0.00825	0.00825	63
64	0.00675	0.00813	0.00854	0.00854	0.00854	0.00854	64
65	**0.00718**	**0.00865**	**0.00908**	**0.00908**	**0.00908**	**0.00908**	**65**

Table D4: Female Smoker rates

Age	Curtate duration						Age
Exact	0	1	2	3	4	5+	Exact
25	**0.00049**	**0.00052**	**0.00055**	**0.00055**	**0.00055**	**0.00062**	**25**
26	0.00054	0.00057	0.00060	0.00060	0.00060	0.00068	26
27	0.00059	0.00063	0.00066	0.00066	0.00066	0.00074	27
28	0.00063	0.00067	0.00071	0.00071	0.00071	0.00079	28
29	0.00068	0.00072	0.00076	0.00076	0.00076	0.00085	29
30	**0.00074**	**0.00079**	**0.00083**	**0.00083**	**0.00083**	**0.00092**	**30**
31	0.00080	0.00085	0.00090	0.00090	0.00090	0.00100	31
32	0.00086	0.00092	0.00097	0.00097	0.00097	0.00108	32
33	0.00093	0.00100	0.00105	0.00105	0.00105	0.00117	33
34	0.00102	0.00109	0.00114	0.00114	0.00114	0.00128	34
35	**0.00111**	**0.00119**	**0.00125**	**0.00125**	**0.00125**	**0.00140**	**35**
36	0.00121	0.00130	0.00136	0.00136	0.00136	0.00153	36
37	0.00132	0.00141	0.00148	0.00148	0.00148	0.00166	37
38	0.00143	0.00153	0.00161	0.00161	0.00161	0.00180	38
39	0.00156	0.00167	0.00175	0.00175	0.00175	0.00196	39
40	**0.00171**	**0.00183**	**0.00192**	**0.00192**	**0.00192**	**0.00215**	**40**
41	0.00190	0.00203	0.00213	0.00213	0.00213	0.00239	41
42	0.00212	0.00227	0.00239	0.00239	0.00239	0.00267	42
43	0.00237	0.00253	0.00267	0.00267	0.00267	0.00299	43
44	0.00265	0.00283	0.00298	0.00298	0.00298	0.00334	44
45	**0.00299**	**0.00319**	**0.00336**	**0.00336**	**0.00336**	**0.00377**	**45**
46	0.00340	0.00363	0.00382	0.00382	0.00382	0.00428	46
47	0.00388	0.00414	0.00436	0.00436	0.00436	0.00488	47
48	0.00441	0.00471	0.00496	0.00496	0.00496	0.00555	48
49	0.00499	0.00532	0.00560	0.00560	0.00560	0.00627	49
50	**0.00556**	**0.00593**	**0.00625**	**0.00625**	**0.00625**	**0.00700**	**50**
51	0.00611	0.00652	0.00687	0.00687	0.00687	0.00769	51
52	0.00665	0.00709	0.00747	0.00747	0.00747	0.00836	52
53	0.00717	0.00765	0.00805	0.00805	0.00805	0.00902	53
54	0.00768	0.00819	0.00863	0.00863	0.00863	0.00966	54
55	**0.00819**	**0.00874**	**0.00920**	**0.00920**	**0.00920**	**0.01030**	**55**
56	0.00869	0.00927	0.00976	0.00976	0.00976	0.01093	56
57	0.00917	0.00979	0.01030	0.01030	0.01030	0.01154	57
58	0.00965	0.01030	0.01084	0.01084	0.01084	0.01214	58
59	0.01012	0.01080	0.01137	0.01137	0.01137	0.01273	59
60	**0.01059**	**0.01130**	**0.01190**	**0.01190**	**0.01190**	**0.01333**	**60**
61	0.01106	0.01181	0.01243	0.01243	0.01243	0.01392	61
62	0.01153	0.01231	0.01296	0.01296	0.01296	0.01451	62
63	0.01201	0.01281	0.01349	0.01349	0.01349	0.01511	63
64	0.01248	0.01332	0.01402	0.01402	0.01402	0.01570	64
65	**0.01271**	**0.01357**	**0.01428**	**0.01428**	**0.01428**	**0.01599**	**65**

Appendix E: Comparison of WP43 rates with other tables

CIBT93

E1. CIBT93 was largely developed from English population data in respect of 1993 and is not adjusted for insured experience (except that the TPD element was derived from insured income protection experience). A detailed description of the derivation can be found in "A Critical Review" (2000).

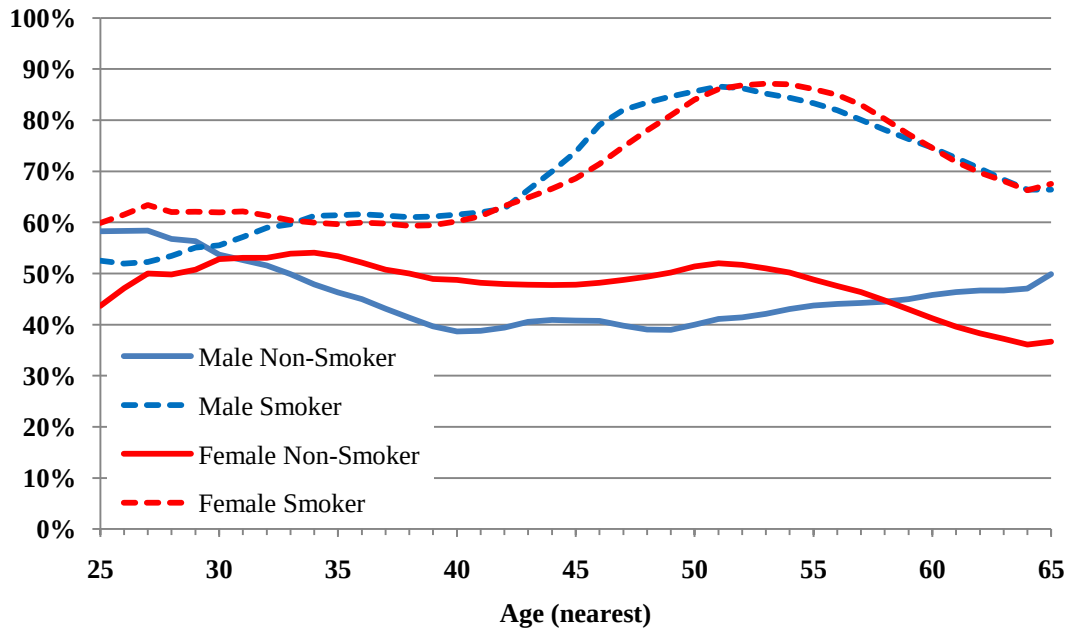
E2. Separate rates are provided for males and females, but they are aggregate rates, i.e. they are not adjusted for smoking status.

E3. The tables only allow for certain critical illnesses (cancer, heart attack, stroke, coronary artery bypass surgery, multiple sclerosis, kidney failure, major organ transplant, TPD and – for accelerated cover – death).

E4. Although the paper stated that the age definition of the CIBT93 table was age exact, this appears to be contradicted by the details of an experience investigation in section 4. Using a census method to calculate exposure, there are two distinct groups of lives, one aged x nearest at the start of the year and one aged x nearest at the end of the year. Hence lives are aged x nearest, on average, throughout the year and $q_{x-½}$ (rather than q_x) is required, assuming an age exact table. However the paper states that no adjustment has been made to CIBT93 where it is applied to (in force) data with an age definition of age nearest at 31 December. Consultation with the authors has also confirmed that this is what was actually done.

E5. CIBT93 has been used as the main comparison for CMI critical illness results prior to this paper and the CMI has always used the latter approach to CIBT93, i.e. CMI results are consistent with the results in "A Critical Review", rather than with CIBT93 being an age exact table for the integral ages shown. This is therefore consistent with the basis on which the rates have been derived in this paper (before the interpolation referred to in paragraph 6.10) and the comparison in Figure E1 is on this basis.

Figure E1: Ultimate WP43 diagnosis rates as a percentage of CIBT93



E6. It will be noted that the WP43 rates for non-smokers are a relatively flat percentage of the population-based table, at around 40% for males and around 50% for females, at the ages where we have most data. In contrast the smoker rates show a distinct "hump", peaking at around 85% of CIBT93 at just over age 50 for both males and females.

CIBT02

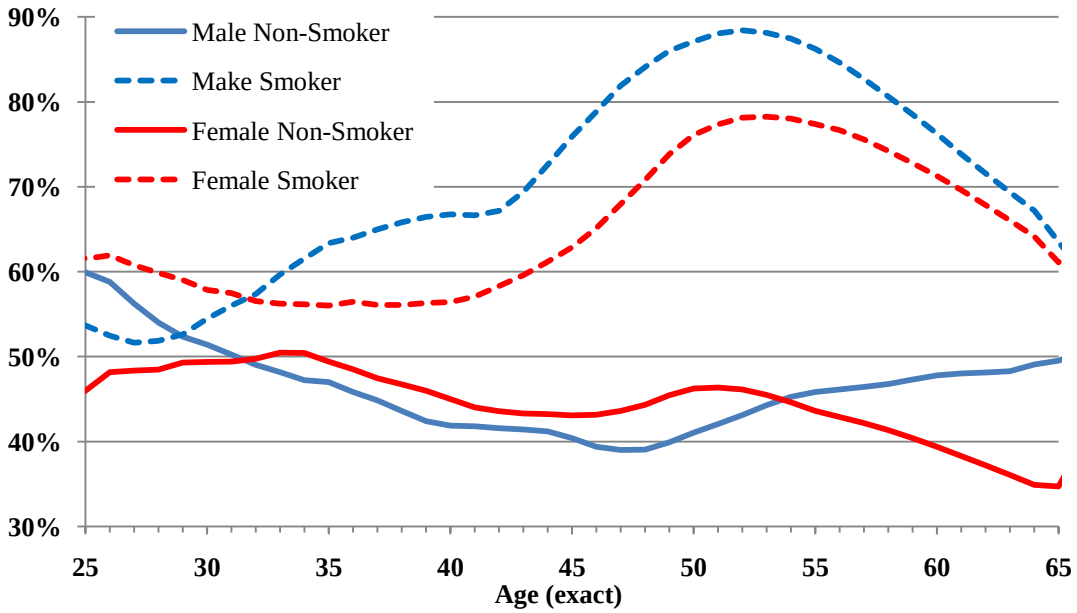
E7. CIBT02 is effectively an updated version of CIBT93, based on more recent population data, applicable to 2002. As with CIBT93, it is not adjusted for insured experience, except that the TPD element was derived from insured income protection experience. A detailed description of the derivation can be found in "Exploring the Critical Path" (2006).

E8. Separate rates are provided for males and females, but they are aggregate rates, i.e. they are not adjusted for smoking status.

E9. There are two tables: 'Core Cover' and 'Extended Cover'. The former covers the same conditions as CIBT93, whereas the latter also covers a further 17 conditions that have been included in some more recent critical illness products.

E10. The authors of "Exploring the Critical Path" intended CIBT02 to be used with an age definition of age exact; a comparison of the WP43 rates with the CIBT02 (Extended Cover) rates using this age definition is illustrated in Figure E2. (Note that the percentages in Figure E2 do not correspond to the adjustments in section 3, where we applied CIBT02 to age nearest data.)

Figure E2: Ultimate WP43 diagnosis rates as a percentage of CIBT02 (Extended Cover)



E11. At these ages, as noted earlier, CIBT02 is generally higher than CIBT93 hence the absolute values of the WP43 rates compared to CIBT02 are lower than the comparison with CIBT93, however the shape of the two comparisons are similar.

IC94

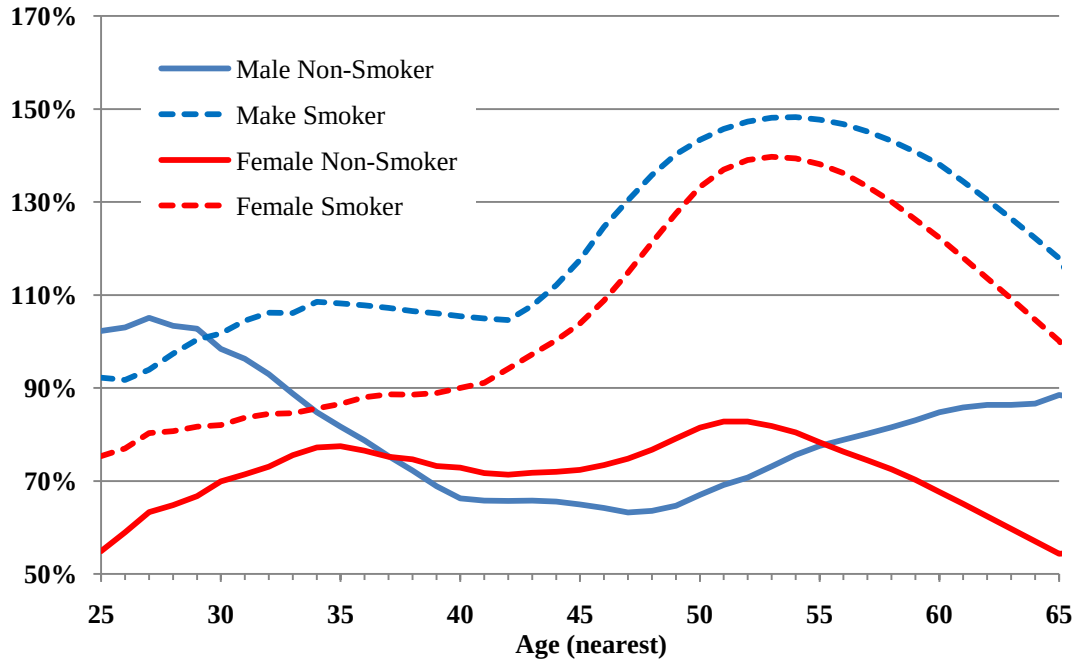
E12. IC94 was largely derived from UK population data but adjusted for Irish experience. Further adjustments were then made to attempt to move from population experience to insured experience. There are separate tables for males and females, on an aggregate

basis (i.e. with no adjustment for smoker/non-smoker). A detailed description of the derivation can be found in the paper "Reserving for Critical Illness Guarantees" presented to the Society of Actuaries in Ireland in November 1994.

E13. No age definition is stated within the paper; we have treated IC94 as age nearest in the comparison below.

E14. Figure E3 compares the ultimate rates derived in this paper (before the interpolation referred to in paragraph 6.10) with IC94. The absolute values are substantially higher than those in Figures E1 and E2 for CIBT93 and CIBT02, respectively, presumably reflecting the adjustment applied to make IC94 appropriate to insured lives. The shape of the comparison, though, is broadly similar to those seen earlier.

Figure E3: Ultimate WP43 diagnosis rates as a percentage of IC94



CIIT00

E15. CIIT00 is based on the population table CIBT02, but reshaped to reflect the 1999-2002 experience data made available by the CMI. A detailed description of the derivation can be found in "A Critical Table" (2007).

E16. Separate rates are provided for males and females, and also for non-smokers and smokers.

E17. The tables cover 22 critical illness conditions (and death, in the accelerated rates); i.e. most of those included in the CIBT02 (Extended Cover) table. The authors attempted to adjust the CMI experience for the shortfall in exposure arising where offices do not cover the "full" range of critical illnesses. (NB The authors used the list of data contributors released by the CMI, but did not have access to information on which offices contributed data in which years, nor the volumes of data.)

E18. The rates are stated to be "age exact"; consequently the comparison of the rates derived in this paper with CIIT00 in Figure 6.7 uses the rates as set out in Appendix D.

E19. The rates allow for a select period of three years. This was done by combining causes of claim into one of eight cause-groups and assessing the appropriate "selection discount" from the ultimate rates for that group. The discounts were gender/smoker-specific for cancer and death, but uniform for the other cause groups. The all-causes rates were then calculated as the sum of the cause-specific rates, i.e. allowing for different selection discounts by cause group.

E20. Note that a comparison of WP43 rates against CIIT00 is contained in section 6 and is not repeated here.

E21. As noted in section 6, the WP43 rates and CIIT00 rates use CMI data from different time-periods in their construction (1999-2004 data for WP43, 1999-2002 data for CIIT00). In addition there are numerous other differences in the construction of the two tables; in the Committee's view, the most significant of these are:

i. The derivation of CIIT00 assumed that a 15% grossing-up factor (an adjustment indicated by the Committee in CMI Working Paper 14) was applied across-the-board. In deriving the WP43 rates, the Committee has estimated growth patterns more accurately via the back-projection of in force data.

ii. The construction of CIIT00 was undertaken at a cause-specific level, then aggregated to all-causes. (Some less frequent causes were amalgamated with other "similar" causes).

iii. Both the WP43 rates and the CIIT00 rates were constructed by adjusting CIBT02 by factors derived from the CMI dataset. Whilst the Committee recognises that in many instances the credibility of its adjustments by age may be limited (due to low data volumes), it has sought to apply such adjustments in all cases. In contrast, the adjustments for CIIT00 were only undertaken where there were at least 100 settled claims for a particular cause-group, gender and smoker status. Whilst this approach led to adjustments being applied for the most significant causes of claim at the key ages, the Committee understands that the adjustments were applied by age in CIIT00 in a cruder manner. In addition, for causes of claim other than cancer, cardiovascular and death, a single adjustment was applied at all ages for CIIT00.

iv. Both sets of rates allow for selection at an all-ages level only; however the Committee derived selection patterns for each gender/smoker dataset separately whereas this was only done for cancer and death in constructing CIIT00. The authors considered that the "composition" of these claim groups would differ by age and gender whereas for other causes – such as heart attack, it would not. Hence for causes other than cancer and death, the select pattern in CIIT00 was derived for all four gender/smoker datasets combined. As discussed in section 4, the Committee's initial analysis of male smoker experience by cause indicates that heart attack is one cause that gives rise to the apparent lack of selection at duration 0.

E22. In addition, there are many differences that the Committee considers likely to be less material, including:

- CIIT00 used combined accelerated and stand-alone data, whereas the WP43 rates use accelerated business only.
- The construction of CIIT00 assumed a single adjustment from the date of diagnosis to the date of settlement for each cause; in contrast, the Committee has not differentiated by cause (in deriving all-causes rates) but has allowed for a distribution of these time-intervals, rather than a single value.

- The construction of CIIT00 considered the critical illness conditions covered by each company and sought to adjust the exposure accordingly. As noted in paragraph 6.9, the Committee has not followed this approach in constructing the WP43 rates.
- The CIIT00 rates were constrained so that the smoker rates always exceed the non-smoker rates. As noted in section 4, the Committee has not applied such a constraint in the WP43 rates (although it expects to for the 2003-2006 rates, should this prove necessary).

E23. The Committee believes that overall its approach offers a clear improvement on the approach used to construct CIIT00, notably in the increased accuracy of the calculation of growth in exposure. The WP43 rates also benefit from the much greater credibility in the 1999-2004 dataset, compared with that covering only 1999-2002. However the Committee also acknowledges that the authors of CIIT00 produced their rates much earlier than the Committee was able to achieve.