Canadian Institute of Actuaries / Institut canadien des actuaires

Educational Note Supplement

Selective Lapsation for Renewable Term Insurance Products

Committee on Life Insurance Financial Reporting

February 2017

Document 217019

Ce document est disponible en français

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MEMORANDUM

To: All life insurance practitioners

From: Pierre Dionne, Chair
Practice Council

Stéphanie Fadous, Chair
Committee on Life Insurance Financial Reporting

Date: February 16, 2017

Subject: **Educational Note Supplement: Selective Lapsation for Renewable Term Insurance Products**

The Committee on Life Insurance Financial Reporting (CLIFR) has prepared this educational note supplement to review methods used to take into account the impact on mortality of selective lapsation for renewable term insurance products.

The information presented in this educational note supplement reflects CLIFR's review of the educational note Expected Mortality: Fully Underwritten Canadian Individual Life Insurance Policies (July 2002, document #202037) with respect to selective lapsation (section 620 and appendix 4). An Excel tool is also available to illustrate the different methods discussed in the paper.

CLIFR would like to acknowledge the contribution of the subcommittee that reviewed the 2002 educational note and considered alternative selective lapsation methods. Members of the subcommittee were Jean-Pierre Cormier, Emile Elefteriadis, Johnny Lam, Éric Lemay (Chair), Stephen Nighswander-Rempel, and Barry Savage.

In accordance with the Institute's Policy on Due Process for the Approval of Guidance Material other than Standards of Practice and Research Documents, this educational note supplement has been prepared by CLIFR and has received approval for distribution from the Practice Council on January 24, 2017.

If you have any questions or comments regarding this educational note supplement, please contact Stéphanie Fadous, Chair of CLIFR, at her CIA online directory address, stephanie_fadous@manulife.com.

PD, SF

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1. Summary

This educational note supplement reflects a review of the impact on mortality of selective lapsation at renewal of renewable term insurance products.

The review includes a review of the related sections of the relevant educational note, Expected Mortality: Fully Underwritten Canadian Individual Life Insurance Policies (July 2002, document #202037), then summarizes results of surveys and studies sponsored by the Society of Actuaries (SOA) regarding level premium term life insurance products.

It also presents and explains alternate methods for determining the renewal mortality assumptions, taking into account selective lapsation. The results produced by the alternate methods are compared with available experience.

Issues to consider when determining the renewal mortality assumption of the renewable term products are also discussed.

Since there is little data available, no strong conclusion can be drawn about the predictive ability of the different methods. However, a minor revision is proposed to the CIA's Valuation Technique Paper #2 (VTP2) method that better matches the limited experience observed.

2. Background

In 2002, the Committee on Life Insurance Financial Reporting (CLIFR) developed the educational note Expected Mortality: Fully Underwritten Canadian Individual Life Insurance Policies on setting expected mortality assumptions for individual life insurance policies (CIA method). The 2002 educational note exposes general principles and processes applicable to determining an expected mortality assumption. Section 620 and appendix 4 focus on selective lapsation and the mortality assumption after the renewal date of renewable term insurance products to reflect the deterioration in mortality resulting from the higher lapsation rate of healthy lives versus that of unhealthy lives.

Since 2002, experience for lapse and mortality assumptions at renewal of renewable term insurance products has become available. Many studies have been presented over the last decade. The following are studies that have been sponsored by the SOA:

- Report on the Survey of Post-Level Premium Period Lapse and Mortality Assumptions for Level Premium Term Plans (2013) (September 2013); and
- Report on the Lapse and Mortality Experience of Post-Level Premium Period Term Plans (2014) (May 2014).

Considering the time elapsed since the publication of the aforementioned educational note, the evolution of premium design (higher premium jumps), and the increased number of discussions in the industry resulting from the publication of studies on the subject, CLIFR decided to investigate the topic. This educational note supplement summarizes the findings.

3. Objectives

The objectives of this educational note supplement are to

- Review the relevant topics in the 2002 educational note to support a narrow range of practice;
- Summarize the findings of recent SOA publications;
- Analyze the experience available in Canada;
- Identify different methods to estimate deteriorated mortality;
- Assess the appropriateness of those methods considering the evolution of product design; and
- Clarify the implementation of the methods to ensure they are appropriately applied.

4. The 2002 Educational Note

This section summarizes the key provisions of the 2002 educational note related to selective lapsation (section 620 and appendix 4). The summary is not exhaustive and the actuary is encouraged to read the 2002 educational note for a thorough understanding.

- Selective lapses are lapses whose mortality experience would be identical to that of newly selected lives.
- Lapse rates on renewable term insurance products can be expected to show a temporary increase when premium rates rise at a renewal date.
- In general, healthy lives are more likely to lapse their policies at renewal than unhealthy lives, the net effect being a deterioration in mortality for the remaining lives.
- The actuary would consider the effects of selective lapsation on mortality. The following factors would be considered when determining the selective lapse rate assumption:
    - Size of premium rate increase;
    - Period between premium increases;
    - Duration;
    - Policy size;
    - Distribution system used;
    - Heaped renewal commissions;
    - External market conditions;
    - Proportion of healthy lives remaining; and
    - Conversion activity.

- Selective lapses may occur at times other than at renewal.
- Some of the effects of selective lapsation may already be included in the mortality experience data used to determine the mortality assumption before or after the renewal date.
- The formulas described in appendix 4 of the 2002 educational note assume that no effect of selective lapsation is in the underlying mortality assumption, i.e., underlying lapses are comparable to those that were experienced in the exposure underlying the construction of the select mortality table.
- If the mortality experience data fully reflects the effects of selective lapsation, the actuary can use this data as the base for the expected mortality assumption without adjustment for selective lapsation, to the extent that the same level of selective lapses will be experienced in the future.

5. Summary of SOA Publications and Key Findings

Note that SOA publications are based on U.S.-design term products which are different than Canadian term products. In Canada, a new level premium period after the renewal date is common practice. In the U.S., the common design is annually increasing guaranteed premium rates which are usually set based on conservative mortality rates (high multiple of experience).

5.1 Report on the Survey of Post-Level Premium Period Lapse and Mortality Assumptions for Level Premium Term Plans (2013)

This survey covered the mortality and lapse assumptions used by actuaries for pricing and modeling level premium term products at the end of 2012. In total, the survey received 41 responses. Though the findings are related to pricing assumptions the following observations are relevant to this review:

- 29 of the 41 respondents (71%) assumed a lapse assumption of less than 100% at the end of the level premium period for at least one of their level term products; and
- A 100% lapse assumption was more frequent for the 20- and 30-year term (vs. 10- and 15-year term).

Among those who did not use a 100% lapse assumption

- The median lapse rate assumed at the end of the level premium period increased with the term length (80% for term 10 and 95% for term 30). Including the year following the renewal date, the cumulative lapse rate was 88% for term 10 and 96% for term 30;
- The median mortality deterioration assumed for the year after the renewal date was between 232% and 300% (100% reflects no deterioration);

- The mortality deterioration assumptions generally begin grading down in the third year after the renewal date;
- A variety of methods were used for determining the mortality deterioration assumptions: Dukes-MacDonald or derivatives of Dukes-MacDonald, CIA method, flat multiple, and other methods based on actuarial judgment;
- There was a fairly strong correlation between the level of the lapse assumption at the end of the level premium period and the mortality deterioration assumed in the year after the renewal date; and
- The median premium jump multiple at renewal was between 3.2 and 25.5, depending on issue age, gender, term period, and risk class. As a comparison, the median premium jump multiple for a policyholder who would lapse and buy another policy with the same term period was between 1.9 and 6.0.

5.2 Report on the Lapse and Mortality Experience of Post-Level Premium Period Term Plans (2014)

This study considers both mortality and lapse experience.

Some adjustments were made to the data gathered. The most significant adjustment was to set the lapse date at the beginning of the grace period to replicate the true effective date of termination. The grace period was between 30 and 100 days.

The following highlights key findings of the study which are most relevant for the Canadian business.

Key Findings: Lapse Experience

<u>Premium Jump Ratio</u>

- Policies with higher premium jumps also have higher lapses at renewal.
- The pattern of term 15 experience is very similar to that of term 10, although the lapses appear to be slightly lower at the higher premium jumps.

<u>Premium Jump Ratio and Post-Level Period Premium Structure</u>

- The study categorizes the post-level premium structures:
  - **Premium jump to Annual Renewal Term (ART)** – Premium annually increasing. Usually at a fixed percentage of the ultimate period rates of an industry mortality table.
  - **Premium grade to ART** – Premium gradually increasing from level premium to ART level.
  - **Premium jump to new level period** – A new level premium.
  - **Premium jump to other** – Combination of the “Premium grade to ART” and “Premium jump to new level period” structures.

- Two categories were analyzed for the purpose of the report: “Premium jump to ART” and “Premium jump to other”.
- “Premium jump to other” products experienced lower lapse rates at renewal than “Premium jump to ART” products below a six-time jump (results are relatively thin above a six time jump for “jump to other” products).
- Pattern observed for term 15 is very similar to that observed for term 10.

Premium Jump Ratio by Company

- While there are differences by company, the general trend holds for all companies: lapse rates increase very quickly at the lowest premium jumps, begin to level off as jumps begin to increase, and then level off at the highest premium jump levels.

Issue Age and Premium Jump Ratio

- Lapse rates increase by issue age even within a premium jump band.

Face Amount and Premium Jump

- Lapse rates increase with face amount. Lapse rates also increase with face amounts within a given premium jump band.

Lapse Skewness

- Lapses in the year just before the renewal date are heavily skewed towards the end of the policy year.
- Lapses in the first year following the renewal date are heavily skewed towards the beginning of the policy year.

Key Findings: Mortality Deterioration

Premium Jump Ratio

- Mortality rates increase significantly as the premium jump ratio increases.

Grace Period

- The grace period is the time after the missed insurance premium is due, where a life insurance policy is still in force even though the payment is past due. The grace period can cause excess mortality by providing “free” life insurance to all policies, specifically to those that would have planned to lapse.
- Excess mortality during the grace period is more evident when lapse rates are elevated.

Lapse Rate vs. Mortality Deterioration

- While there are a wide range of results, it is clear that the mortality rates are increasing more quickly at the highest lapse rates.

6. Canadian Experience

Canadian experience measuring both mortality and lapse experiences on renewable term insurance products is not publicly available. The CIA Lapse Experience Study for 10-Year Term Insurance (January 2014, document #214011) provides no information on mortality, and the CIA Canadian Standard Ordinary Life Experience 2012–2013 Using 97-04 Tables (July 2015, document #215062) and Canadian Standard Ordinary Life Experience 2012–2013 Using 86-92 Tables (July 2015, document #215061) provide no information on the lapse rates associated with the mortality experience.

Table 1 below illustrates the Canadian mortality experience covering policy anniversaries 2011–12 and 2012–13 for renewable term 10 policies (excluding riders), by policy year, for issue ages 30–59 and face amounts of $100,000 and greater. The experience is normalized to experience over policy years 6–10, similar to what was completed for the investigation of the SOA experience.

It is important to note, for credibility considerations, that there are only 502 claims for policy years 11 to 15.

Table 1: Canadian mortality experience for renewable term 10 products, 2011–12 and 2012–13

Policy year	Exposure		Claims		A/E(*) (97-04)	
	#	$	#	$	#	$
6	114,943	48,516,346,145	128	43,619,000	103%	98%
7	109,241	43,979,247,145	131	42,606,193	97%	92%
8	105,507	39,158,875,648	142	41,152,000	97%	89%
9	111,699	37,954,608,459	162	58,359,114	95%	114%
10	109,799	34,345,374,743	205	56,886,152	107%	105%
11	41,526	11,651,065,604	142	39,570,709	216%	236%
12	31,433	8,021,778,370	107	27,001,919	199%	221%
13	31,441	7,321,520,562	85	22,810,066	145%	184%
14	31,195	6,751,135,239	90	19,926,575	143%	160%
15	27,768	5,747,267,596	78	16,498,650	130%	146%
	714,552	243,447,219,511	1,270	368,430,378		

(*) Normalized to experience over policy years 6–10

Note that the mortality experience following the renewal date is worse when using the face amount basis rather than the number of claims basis. This may indicate that selective lapse rates are higher for higher face amounts.

7. Methods to Reflect Deteriorated Mortality

The following three commonly used methods were explored. Other approaches could be considered.

- Dukes-MacDonald, as published in 1980;
- Becker-Kitsos, published in 1984; and
- CIA's Valuation Technique Paper #2 The Valuation of Individual Renewable Term Insurance (VTP2), published in 1986 (reproduced in the 2002 educational note, appendix 4).

In 1980, Jeffery Dukes and Andrew M. MacDonald published the paper Pricing a Select and Ultimate Annual Renewable Term Product (Transactions of Society of Actuaries, 32 (1980) 547–584). Among other things, a general equation for computing the extra mortality under various lapse assumptions was presented. This is now called the "Dukes-MacDonald selective lapsation model".

Since 1980, different versions of that model have been developed. All the methods use a similar approach but they use different mechanics and produce different results. The methods

- Are based on underlying base mortality tables that do not contain experience from products exhibiting high lapses (and associated mortality) resulting from an increase in premium;
- Are based on knowing the underlying lapse rates (i.e., lapses consistent with the base mortality table);
- Keep track of notional cohorts that lapse and persist;
- Further segment the cohorts that lapse into those with select mortality or average (i.e., attained age) mortality;
- Decrement the cohorts at their respective mortality rates and at the underlying lapse rates;
- Assume that all lapses other than the underlying lapses occur just prior to the end of the policy year;
- Apply the principle of conservation of deaths to the cohorts to solve for the mortality of the residual persisting (persisters) cohort;
- Result in excess mortality that grades off to nil after the select period of the base table; and
- Assume no grace period.

The three methods are summarized:

1. Dukes-MacDonald Method (DM)

This method, as presented in the 1980 original paper, assumes that 100% of the lapses other than the underlying lapses are selective, i.e., their mortality follows the select mortality of a newly underwritten group.

Subsequent variations of DM use the concept of effectiveness where some of the additional lapses are not select. This educational note supplement discusses two variations of DM: DM1 and DM2 (see table 2).

2. Becker-Kitsos Method (BK)

This method starts with the Dukes-MacDonald method and refines it by adding an effectiveness factor. Additional lapses are assumed to have mortality equal to fully select, plus an extra mortality equal to a portion of the initial difference between the select and the persisting groups. This extra mortality is graded off over the select period.

3. VTP2

VTP2 uses similar concepts and parameters as DM1. The most important difference between VTP2 and DM1 resides in the occurrence of the underlying lapses.

As explained in appendix 4 of the 2002 educational note, VTP2 formulas assume that

- The average and selective lapse rates are applied to the population persisting just prior to the anniversary and acted on instantaneously at the anniversary; and
- The underlying lapse rate, like the mortality rate, is assumed to apply continuously.

Unlike VTP2, DM1 assumes that the underlying lapses occur immediately prior to the selective lapses.

<u>Differences between the Methods</u>

A subtle but important difference between the methods is the definition of residual mortality and simultaneously, the size of the cohort of persisters.

Table 2 below summarizes the differences in the size of the cohort of persisters in the policy year following a renewal date using similar terminology as VTP2.

The total cohort (T), exhibiting average mortality, is divided into four groups:

- Those among the additional lapses who lapse with select mortality (S);
- Those among the additional lapses who lapse with average mortality (A);
- Those who lapse with underlying mortality (U), i.e., those lapses already accounted for in the construction of the base mortality table; and

- Those who don't lapse, i.e., the persisters (P).

The goal of the methods is to determine the mortality of the persisters.

Table 2: Comparison of methods

	Cohort				
Method	**T = 100%**	**S**	**A**	**U**	**P = 1 – S – A – U**
BK*	$q'_{[x]+t}$	$q_{[x+t]}*[1 + R*G(t)]*(q_{[x]+t} - q_{[x+t]})/q_{[x]+t}$	Ignored	$q'_{[x]+t}$	$q''_{[x]+t}$
DM1	$q'_{[x]+t}$	$q_{[x+t]}$	$q_{[x]+t}$	$q'_{[x]+t}$	$q''_{[x]+t}$
DM2	$q'_{[x]+t}$	$q_{[x+t]}$	Ignored	$q'_{[x]+t}$	$q''_{[x]+t}$
VTP2	$q'_{[x]+t}$	$q_{[x+t]}$	$q'_{[x]+t}$	Ignored	$q''_{[x]+t}$

* G() represents the grading-off function over the select period
R is a parameter that controls the level of mortality (smaller values of R translate into higher levels of persister's mortality)
B-K recommend 0.2 ≤ R ≤ 0.4 and G(1) = 1, linearly grading to 0 after the select period

The methods apply the conservation of deaths principle to solve for the residual mortality of the cohort of persisters.

For example, under VTP2:

$q'_{[x]+t} = S*q_{[x+t]} + A*q'_{[x]+t} + (1 - S - A)*q''_{[x]+t}$, or

$q''_{[x]+t} = [(1 - A)*q'_{[x]+t} - S*q_{[x+t]}]/(1 - S - A)$, in the first year following the renewal date.

With algebra, this may be re-expressed into the more intuitive form that adds to the base mortality rate q'[x]+t, the foregone mortality from selective lapses allocated to the cohort of persisters:

$q''_{[x]+t} = q'_{[x]+t} + S*(q'_{[x]+t} - q_{[x+t]})/(1 - S - A)$

Note that using the same parameters, since the parameter A or U is ignored, all the methods other than DM1 outlined in table 2, have cohorts of persisters that are factually larger than the true cohort of persisters. This results in persisters' mortality that is lower than under DM1.

<u>Common Problems or Issues</u>

a) Skewness of lapses

All the methods have a few shortcomings, the most significant being that they assume the excess lapses occur at the end of the policy year. In reality, there is skewness in lapses throughout a policy year, in particular in the year following a renewal date, where lapses are concentrated at the beginning of the next policy year. The consequence is that projected mortality is underestimated in the year following the renewal date. For example, if lapse rates were 40% in year 10 and 60% in year 11, the reality is that 90% of the 60% lapses occur within the first few policy months in policy year 11. Applying these methods without being cognizant of this results in a calculation of mortality as if the 60% lapse rate occurred at the end of policy year 11, therefore underestimating mortality in year 11 and in subsequent years as well.

b) Shape of the underlying mortality table

A consequence of all the methods is that the level and run-off pattern of the excess mortality is highly dependent on the shape of the underlying mortality table. An unusual run-off pattern may be observed where there are discontinuities in the shape of the table. For example, if the base table is defined as the CIA 97-04 after applying the calibration percentages shown in table 3 below and then apply VTP2 using a 70% total lapse rate in policy year 10, a 5% underlying lapse rate, and a selective proportion of 90%, then the excess mortality (excess over attained age mortality) wears off as shown in table 4 below. In the first case, the runoff pattern to attained age mortality steadily approaches zero at high policy years, whereas in the second case it drops below attained age mortality before increasing again. This illustrates the importance of ensuring that the base mortality table is appropriately selected.

Table 3: Illustrative calibration percentages

Policy year	Calibration A Recent experience excluding term business	Calibration B: Alternative (hypothetical for illustration purpose)
1–5	67%	67%
6–10	67%	67%
11–15	72%	72%
16+	78%	65%

Table 4: Resulting run-off pattern of excess mortality relative to attained age mortality

Policy year	Calibration A	Calibration B
11	101%	101%
12	83%	83%
13	75%	75%
14	69%	69%
15	65%	65%
16	70%	51%
17	65%	44%
18	60%	38%
19	55%	32%
20	50%	26%
21	37%	10%
22	32%	4%
23	27%	-2%
24	23%	-7%
25	18%	-13%
26+	0%	0%

c) Grace Period

Although this is not a flaw of any of the methods but rather an insurance cash flow modelling item, it can be noted that deaths during the grace period following a renewal date will be supported by a much smaller persisting group.

If lapse rates are low, modelling deaths during the grace period is insignificant. This is not the case when excess lapses are very high. For example, if T = S + A + U is the total lapse rate occurring at the renewal date, then the formula

$$[S*q_{[x+t]} + (A + U)*q'_{[x]+t}]*\text{Grace period}/365/(1 - T)$$

approximately represents the DM1 mortality rate for those dying during the grace period, allocated to the cohort of persisters. This quantity would be added to the persisters' mortality in the year following the renewal date. Note that the "U" term would be ignored under VTP2 since the underlying deaths are assumed to occur prior to the renewal date.

8. Appropriateness of the Methods

As noted earlier, all the methods are based on knowing the underlying lapse rates.

A public source of information is the SOA May 2014 study, although the data covers U.S. experience based on U.S.-styled term products.

U.S. Experience

This section investigates how well the mortality deterioration models predict mortality compared to actual experience but only for policy year 11, since U.S. term 10 products have a very different premium pattern than Canadian term 10 products after the 11th policy year.

It could be argued that lapses in excess of underlying lapses (excess lapses) and the relative extra mortality rates between the U.S. and Canada would not vary significantly in the year following a renewal date, for a given premium jump between year 10 and year 11 for a renewable term 10 product. No investigation was performed to analyse whether Canadian and U.S. policyholders would behave any differently at the end of policy year 10 and the first few months of policy year 11 when faced with a large increase in their premiums.

The following data segments of the SOA study were analysed:

- Risk class — All defined non-smoker and smoker classes
- Issue ages — Ages 30 to 59
- Calendar years — 2005 to 2012
- Issue years — 1994 to 2002
- Gender — Males and females
- Term period — Term 10
- Face amount — From $100,000 to $999,999
- Premium frequency — Annual for lapses
annual, semi-annual, quarterly, and monthly for mortality
- Premium jump ratio — From 5.01 to 7.00
- Post-level premium jump structure — Premium jump to ART

Table 5 below summarizes the lapse rates at durations 6 to 11 for the above-mentioned cohort while table 6 below summarizes the mortality rates at the same durations.

Table 5: Lapse rates at durations 6–9, 10 and 11

Premium jump ratio	Duration	Number of lapses	Lapse rate	
			Based on amount	Based on number
5.01–7.00	6–9	1,804	5.7%	5.6%
	10	8,727	86.0%	86.3%
	11	531	45.0%	43.1%

Table 6: Actual-to-expected ratios at durations 6–10 and 11

Duration	Number of deaths	Actual to expected ratio (based on the 2008 VBT)	
		Based on face amount	Based on number of deaths
6–10	464	79.9%	85.4%
11	54	319.4%	336.3%
Relative mortality 11/(6–10)		399.6%	393.9%

Lapse rates for this group of policies were 86.0% in year 10. According to the SOA May 2014 study, approximately 23% of lapses occur during the first three months in policy year 11 for annual premium payment mode. Assuming those lapses (23% of 45.0%) would be attributed to the total excess lapse rate, the total lapse rate for policy year 10 is 100% – (1 – 86.0%)*(1 – 23%*45.0%) ≈ 87.5%.

The relative mortality experience in policy year 11 was approximately 400% of attained age mortality, assuming that attained age mortality is represented by the duration 6–10 mortality experience expressed as a uniform percentage of the base mortality level.

In the first year following a renewal date, the persisters' mortality can be calculated using DM1, DM2, and VTP2.

An underlying table based on the 2008 Valuation Basic Table (VBT) was assumed but calibrated to experience that is based on level premium products in order to remove distortions from additional lapses. Select and attained age 50-year-old mortality was assumed to correspond to a 40-year-old issue age, which roughly corresponds to the experience shown.

Based on the experience above, projected relative mortality will be calculated using a total lapse rate of 87.5% applied at the end of policy year 10, and the underlying lapse rate is assumed to be 5.5%. The only unobservable parameter is the selective proportion parameter. This parameter must be estimated in order to fit the mortality deterioration models based on observed mortality and lapse experience.

Table 7 below shows the resulting selective lapse and average lapse rates assuming three selective proportion scenarios (75%, 85%, and 95%).

Table 7: Lapse rates under several selective proportion assumptions

Lapse rate	Selective proportion		
	75%	85%	95%
Total (T)	87.5%	87.5%	87.5%
Underlying (U)	5.5%	5.5%	5.5%
Excess	82.0%	82.0%	82.0%
Selective (S)	61.5%	69.7%	77.9%
Average (A)	20.5%	12.3%	4.1%

Table 8 below shows the results of the mortality deterioration calculated using DM1, DM2 and VTP2 and the parameters shown in table 7.

Table 8: Relative mortality ratio (without grace period effect)

Method	Selective proportion		
	75%	85%	95%
DM1	428.3%	472.1%	515.9%
DM2	224.4%	287.5%	413.2%
VTP2	328.0%	358.4%	388.8%

Even using a selective proportion of 95%, VTP2 doesn't produce the observed mortality of 400%.

However, those models do not account for deaths during the grace period. Using a 30-day grace period, the extra projected mortality on account of deaths over the grace period would result in mortality that is approximately 6.4%, 5.0%, and 5.1% higher for DM1, DM2, and VTP2 respectively at the 85% selective proportion. The grace period deaths decrease as the selective proportion increases since a higher proportion of lapses are assumed to be select and hence have lower mortality.

Table 9 below shows the results when taking into account a 30-day grace period effect.

Table 9: Relative mortality ratio (with grace period effect)

Method	Selective proportion		
	75%	**85%**	**95%**
DM1	458.6%	502.2%	545.1%
DM2	235.9%	301.8%	432.4%
VTP2	346.5%	376.5%	406.1%

While the credibility of the mortality and lapse experiences shown above is very limited (only 54 claims), it does suggest that VTP2, without modification, may not be able to reproduce the very high level of policy year 11 mortality observed in the SOA study at high excess lapse rates. In this particular instance, if one also added deaths during the grace period, as described earlier, that would close the gap. Alternatively, DM1 would result in higher mortality even when not taking into account the impact of the grace period.

Canadian Experience

Consider the Canadian mortality experience covering policy anniversaries in 2011–12 and 2012–13. Since the CIA mortality studies do not provide the corresponding lapse experience, an assumption for the total effective lapse rate for policy year 10 has to be determined.

For the purpose of this educational note supplement, the assumption is a 70% total effective lapse rate at the end of policy year 10 for policies issued from 2001 to 2003 (10 years earlier than the mortality experience). However, such an assumption would not be appropriate for policies whose mortality experience is measured at later durations since the premium jumps were smaller, as an example, for policies issued in 1996-1998 than for those issued in 2001-2003. For the purpose of this educational note supplement, the assumption is a 65% total lapse rate for the mortality experience in policy year 15 (which is consistent with the lapse rates published in the CIA's 2014 study on lapse experience for term 10 policies from a similar generational cohort) and a 67.5% total lapse rate for the mortality experience in policy year 13.

This illustrates one challenge of trying to fit mortality deterioration model parameters to mortality experience that is not tracked by cohort and provides no information about the lapse rates experienced.

This educational note supplement therefore considers a simple, high-level analysis using broad assumptions and disparate sources of mortality and lapse information, since there is no alternative.

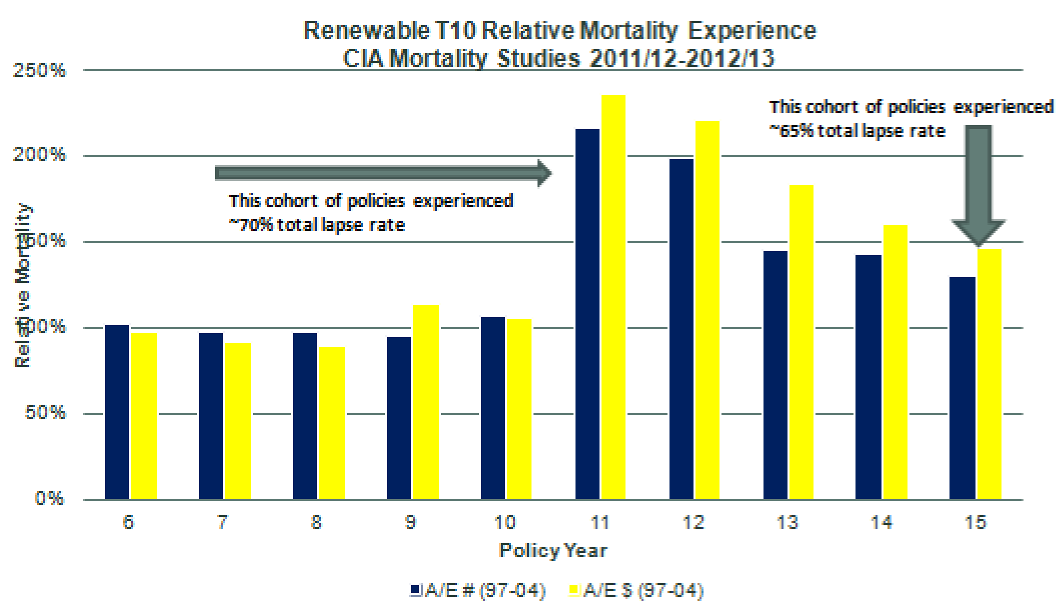
In the high-level analysis below, the actual versus predicted relationship is compared between the deteriorated and not-deteriorated mortality in policy years 11–15 under two models: DM1 and VTP2.

The same calibration percentages applied to the CIA 97–04 that were defined in table 3 (calibration A, permanent products) are assumed. This suggests an underlying lapse rate assumption of approximately 5%, which is believed to be consistent with lapse rates experienced by the permanent policies underlying that calibration.

Select and attained age 50-year-old mortality is assumed to correspond to an issue age of 40, which roughly corresponds to the average issue age underlying the renewable term 10 mortality experience being investigated.

The following graph illustrates CIA mortality experience over 2011–12 and 2012–13 on renewable term 10 policies (excluding riders) by policy year for issue ages 30–59 and face amounts of $100,000 and greater. The experience is normalized to experience over policy years 6–10 to represent what experience would be in the absence of excess lapse.

Graph 1: Mortality experience on renewable term 10 policies



Tables 10 and 11 below show how the predicted relative mortality from VTP2 and DM1 compare to the actual relative mortality. Results for DM2 are not shown since DM2 generally produces lower mortality than VTP2.

To calculate the mortality, the excess lapse rate is applied at the end of policy year 10. The underlying lapse rate was assumed to be 5%. The modelled impact for deaths during a 30-day grace period is also included.

For sensitivity tests, a 4% underlying lapse rate (tables 12 and 13) and an additional 2.5% on the total lapse rate (table 14) were used.

Similar to the earlier results looking at U.S. experience, while VTP2 does come close to reproducing observed mortality in policy year 11 (table 10), it is unable to match it, even when using a 95% selective proportion over policy years 11–15.

Table 10: Relative mortality projected by VTP2 compared to actual with grace period effect

Policy year	A/E (97-04)	A/E (97-04)	Selective proportion		
	By number	By amount	85%	90%	95%
11	216%	236%	203%	208%	214%
12	199%	221%	174%	179%	183%
13	145%	184%	163%	167%	171%
14	143%	160%	156%	159%	162%
15	130%	146%	150%	153%	156%
11–15	167%	193%	172%	176%	180%

In comparison, DM1 (table 11) comes closer to reproducing observed mortality.

Table 11: Relative mortality projected by DM1 compared to actual with grace period effect

Policy year	A/E (97-04)	A/E (97-04)	Selective proportion		
	By number	By amount	85%	90%	95%
11	216%	236%	222%	228%	234%
12	199%	221%	186%	191%	196%
13	145%	184%	173%	177%	182%
14	143%	160%	164%	168%	171%
15	130%	146%	157%	160%	164%
11–15	167%	193%	184%	188%	193%

If the underlying lapse rate assumption was 4% instead of 5%, the relative mortality increases by 5% for VTP2 (table 12) and 1% for DM1 (table 13).

Table 12: VTP2 sensitivity to underlying lapse rate with a 90% selective proportion and grace period effect

Policy year	A/E (97-04)	Underlying lapse rate	
	$	4%	5%
11	236%	213%	208%
12	221%	182%	179%
13	184%	170%	167%
14	160%	161%	159%
15	146%	155%	153%
11–15	193%	179%	176%

Table 13: DM1 sensitivity to underlying lapse rate with a 90% selective proportion grace period effect

Policy year	A/E (97-04)	Underlying lapse rate	
	$	4%	5%
11	236%	229%	228%
12	221%	193%	191%
13	184%	179%	177%
14	160%	169%	168%
15	146%	161%	160%
11–15	193%	189%	188%

To account for the possibility that total lapses underlying the CIA experience were higher than indicated, 2.5% was added to the total lapse rates for the policy years 11, 13, and 15 cohorts (total lapse rates are 72.5%, 70%, and 67.5% respectively). While this brought VTP2 closer to experience, in order to get even closer, the underlying lapse rate would have to be reduced to 4% (this would add approximately 3% to the results shown in table 14).

Table 14: Relative mortality projected by VTP2 using total lapses 2.5% higher and a grace period effect

Policy year	A/E (97-04)	Selective proportion		
	$	85%	90%	95%
11	236%	215%	221%	227%
12	221%	183%	188%	193%
13	184%	171%	175%	179%
14	160%	162%	166%	169%
15	146%	155%	159%	162%
11–15	193%	180%	185%	189%

9. Application of VTP2

While the mortality evidence is not credible (only 142 claims at duration 11) and the estimation methods are crude, VTP2 appears to be unable to replicate current levels of mortality observed in recent CIA experience studies.

VTP2 depends on selective lapse rates, additional lapse rates, underlying lapse rates, and a base mortality table consistent with the underlying lapse rates and therefore free of mortality resulting from additional lapses. The underlying table corresponds to mortality experience consistent with level premium term business. VTP2 and the other similar methods such as DM and BK then rely on applying the conservation of deaths principle to solve for the mortality of the persisting lives. While all these methods ignore the material impact of deaths during the grace period, this will not be further addressed here since all the methods implicitly assume that the grace period is zero days.

As mentioned earlier, VTP2 formulas assume that the average and selective lapses are applied to the population just prior to the anniversary, while the underlying lapse rate is assumed to apply continuously. A consequence to those assumptions is that the total lapse rate for a policy year is not simply the sum of the three component lapse rates.

The important question is therefore: what is the size of the in force block immediately prior to the renewal date?

With respect to the occurrence of selective lapses, it is known that for monthly premium policies, a significant proportion of these additional lapses will occur in the first few policy months of policy year 11. This is important from a premium cash flow perspective, but it is not as important from a mortality deterioration perspective since the calculations as if all the additional lapses occurred at the end of policy year 10.

The assumption with respect to the underlying lapse rates says that by the end of the policy year, there are no further underlying lapses: they have already occurred. This assumption is reasonable for monthly premium policies but it is not reasonable for annual premium policies.

Therefore, it should be clear that the in-force block just prior to the excess lapses should be net of the underlying lapse rates, since the underlying lapse rates have been assumed to occur throughout the year.

However, this is not how VTP2 is being applied as can be seen in appendix 1 of the VTP2 paper as published in 1986 in the hypothetical valuation of a renewable term product. The top of page 17 is reproduced here for convenience.

Table 15: Excerpt from the 1986 VTP2 paper (top of page 17)

Duration of policy	Total lapse rate	Base lapse rate	Additional lapse rate at renewal	Selective lapse rate	Average lapse rate
1	15.0%	15.0%	0.0%	0.0%	0.0%
2	12.0	12.0	0.0	0.0	0.0
3	9.0	9.0	0.0	0.0	0.0
4	7.0	7.0	0.0	0.0	0.0
5	15.0	5.0	10.0	9.0	1.0
6–9	5.0	5.0	0.0	0.0	0.0
10	17.5	5.0	12.5	10.0	2.5
11–14	5.0	5.0	0.0	0.0	0.0
15	20.0	5.0	15.0	10.5	4.5

At policy year 10, the total lapse rate is 17.5%, the selective lapse rate is 10%, and the average lapse rate is 2.5%. The selective proportion was assumed to be 80%.

The selective lapse rate is calculated as (17.5% – 5%)*80% = 10%.

The average lapse rate is similarly calculated as (17.5% – 5%)*(100% – 80%) = 2.5%.

However, this calculation is not technically correct. Ignoring deaths throughout the year, the in force prior to the application of the additional lapses is really 950 per 1,000 and not 1,000 per 1,000, given that the underlying lapse rates are occurring continuously throughout the year.

Consequently, the selective and average lapse rates need to be grossed up by 5.26%, i.e., 1/(1 – 5%). The correct selective and average lapse rates are therefore ~10.53% and ~2.63% respectively.

In the above example, this would not be material. However, when total lapse rates are expected to be north of 70%, the difference is indeed material as will be shown below.

For example, let's assume that the total lapse rate is 85% and that the selective proportion is 86.25% as in the example in the VTP2 paper, a portion of which is reproduced below.

Table 16: Excerpt from the 1986 VTP2 paper (middle of page 21)

Duration	Selective proportion	Remark
5	95.00%	almost all still healthy
10	86.25	
15	77.50	
20	68.75	
25	60.00	
30	60.00	many healthy lives already gone
35	60.00	

In this specific example, the assumption is that the first application of selective lapsation will occur at the end of policy year 10. Furthermore, let's assume that for a specific age, the attained age mortality rate is 1.00 per 1,000 and that the select mortality rate for the same attained age is 0.40 per 1,000.

Now let's calculate the selective and average lapse rates using the same method as in the original VTP2 paper and as proposed herein.

	Original method	**Revised method**
Selective lapse rate (S)	(85% – 5%)*86.25% = 69%	(85% – 5%)*86.25%/0.95 = 72.63%
Average lapse rate (A)	(85% – 5%)*13.75% = 11%	(85% – 5%)*13.75%/0.95 = 11.58%

Now let's calculate the residual mortality in year 11. In general the equation is:
$q''_{[x]+t} = [(1 – A)*q'_{[x]+t} – S*q_{[x+t]}]/(1 – A – S)$

Original method $q''_{[x]+11} = [(1 – 0.1100)*1.00 – 0.6900*0.40]/(1 – 0.1100 – 0.6900) = 3.07$

Revised method $q''_{[x]+11} = [(1 – 0.1158)*1.00 – 0.7263*0.40]/(1 – 0.1158 – 0.7263) = 3.76$

The revised method results in a mortality rate in year 11 that is approximately 22% higher than with the original method. In fact, the calculation of the mortality rates over duration 12–20 shows that the increase in mortality relative to the original method is approximately as shown in table 17 below, depending on the underlying base mortality table:

Table 17: Relative ratio of mortality rates: revised method to original method

Duration	Relative ratio
11	1.22
12	1.21
13	1.20
14	1.19
15	1.19
16	1.18
17	1.17
18	1.16
19	1.15
20	1.14

On a present value basis, the impact is material (table 18). Let's suppose that the product under consideration is a renewable term 10 with a single renewal option for a further 10 years, so has a 20-year-term total. Even at issue, benefits are 6% higher.

Table 18: Relative ratio of the present value of benefits: revised method to original method

Present value (@ 3%) at the beginning of duration	Relative ratio
0	1.06
10	1.14
11	1.18

Examine the case where it is not reasonable to assume that underlying lapse rates occur throughout the year, as would be the case for annual premium policies. Does application of the original method calculate the residual mortality correctly?

The in force is defined as what exists prior to the application of the total lapses (the underlying lapses under annual premium policies would occur at the end of the year and at the same time as the additional lapses). The correct formulation for the conservation of deaths equation for policy year 11 is then as follows:

$$q'_{[x]+11} = S*q_{[x+11]} + A*q'_{[x]+11} + U*q'_{[x]+11} + (1 – A – S – U)*q''_{[x]+11}$$

This leads to

$$q''_{[x]+11} = [(1 – A – U)*q'_{[x]+11} – S*q_{[x+11]}]/(1 – A – S – U)$$

For example, the following shows the result of the calculation of the policy year 11 residual mortality rate under identical assumptions except that all the lapses occur at the end of the policy year rather than just the additional lapses:

$$q''_{[x]+11} = [(1 – 0.11 – 0.05)*1.00 – 0.69*0.40]/(1 – 0.11 – 0.69 – 0.05) = 3.76$$

This is exactly the same result as the one obtained under the revised method. This is as it should be, since if all the additional lapses occur at the end of the policy year, it should not make any difference if the underlying lapses occurred throughout the year (e.g., monthly premium policies) or at the end of the year (i.e., annual premium policies).

For mortality calculated after the first renewal date, the formulation is similar to DM1. Mortality would differ under subsequent renewal dates between VTP2–revised and DM1, since DM1 would continue to use the original underlying mortality rates for average lapses whereas VTP2 (and VTP2–revised) would use the previous iteration of persisters' mortality (see table 2).

Application of the revised method along with an adjustment for deaths during the grace period leads to better overall fit as can be seen in table 19:

Table 19: Relative mortality projected by VTP2–revised compared to actual with a grace period effect

Policy year	A/E (97-04)	Selective proportion		
	$	85%	90%	95%
11	236%	231%	239%	246%
12	221%	186%	191%	196%
13	184%	173%	177%	182%
14	160%	164%	168%	171%
15	146%	157%	160%	164%
11–15	193%	189%	191%	196%

In conclusion, VTP2 is not inappropriate, but instead, appears to have been misinterpreted or misunderstood. Since VTP2 assumes that the underlying lapses occur throughout the policy year for all policies regardless of premium mode, then the parameters would be adjusted and VTP2–revised must be used to produce theoretically correct results. VTP2–revised also results in higher residual mortality and, together with grace period adjustments, will come much closer to being able to replicate observed residual mortality levels.

10. Margins for Adverse Deviations

Regardless of the method, the purpose is to determine a mortality assumption when there are excess lapses.

Paragraph 2350.09 of the Standards of Practice (SOPs) provides guidance on the level of the margins for adverse deviations (MfADs) for the mortality rates. There is hence no need to have specific MfADs on the assumptions used to determine the mortality assumption.

For the purpose of paragraph 2350.09 of the SOPs, the curtate expectation of life at the life insured's projected attained age is based on the expected average mortality for the group of insured at the same age. To be more precise, if the projected attained age is before the renewal date, the mortality rates after the renewal date do not need to take into account the deteriorated mortality after the renewal date for the purpose of calculating the life expectancy at the projected attained age.

11. Conclusion

The objectives of this educational note supplement are to

- Review the relevant topics in the 2002 educational note to support a narrow range of practice;
- Summarize the findings of recent SOA publications;
- Analyze the experience available in Canada;
- Identify different methods to estimate deteriorated mortality;
- Assess the appropriateness of those methods considering the evolution of product design; and
- Clarify the implementation of the methods to ensure they are appropriately applied.

When using any of the methods, it is important to use a base mortality assumption that reflects the same experience as the one used to determine the underlying lapse rate assumption.

The key unobservable parameter that needs to be estimated from mortality experience is the selective proportion.

Renewable term products issued today will very likely experience much higher lapse rates than the products currently renewing, since premium jumps on today's products are significantly higher. There are factors other than the premium jump, but this is the most significant.

The appropriateness of the methods discussed in this paper was assessed and the conclusion is that the methods remain theoretically sound. Nevertheless, CLIFR suggests that some aspects require additional considerations:

- Deaths during grace period: When lapse rates are low, modelling deaths during the grace period has an insignificant impact on mortality deterioration. This may not be the case when lapse rates are very high.
- Skewness of lapses: There is skewness in lapses throughout a policy year, and particularly in the year following the renewal date where lapses tend to be concentrated near the beginning of the next policy year. If the skewness in lapses in the year following renewal is not considered in the model, the projected mortality may be underestimated in the year following the renewal date.
- Underlying lapses: Not reflecting the underlying lapse timing has an insignificant impact on mortality deterioration when the lapse rates are low. This may not be the case when lapse rates are very high.

Since there is little data available, no strong conclusion can be drawn about the predictive ability of the different methods, but the limited evidence available here suggests that VTP2 as currently formulated understates deteriorated mortality. VTP2–revised (as per section 9) appears to better replicate the limited observed experience.