

SOME OBSERVATIONS ON THE NATURE OF THE RISK  
OF DISABILITY, ITS MEASUREMENT AND CONTROL

JOHN H. MILLER AND SIMON COURANT

ABSTRACT

This paper explores available disability experience data in an effort to throw some light on the character and extent of the subjective influences which affect the frequency and duration of disability.

Selection at issue, including the important factor of deferment or elimination period selection, is analyzed on the basis of the limited data available. Recent Swedish studies bearing on selection by deferment period are compared with the experience compiled by the Society's Committee on Experience under Individual Health Insurance. Comparisons of disability experience over long periods of time point to the conclusion that the curve of disability claim rates has tended to move in a counterclockwise direction; that is, there has been a steepening of the age-incidence curves. A similar tendency in mortality experience has been due entirely to improvement in the experience at all ages, but in a ratio generally decreasing with advancing age. In disability experience, improvement at the younger and middle ages appears to be coupled with an increasing tendency at the higher ages.

Two studies are presented relating to predisposition to disability. These indicate that the disability rate is, to a considerable extent, dependent on the prior experience of the individual risk and that this relationship is persistent.

Analyses of the Society's studies of the 1930-50 disability experience reveal that the disability rate is a highly volatile variable in comparison with which the rate of termination of disability is relatively stable. This suggests that disability experience can be monitored on a more current basis and can be more readily analyzed with respect to various risk characteristics if experience studies are concentrated on the frequency of claim.

Finally, the paper offers some suggestions concerning actuarial notation and premium formulas and on the construction of a mathematical model capable of reflecting the principal elements of selection.

## SELECTION

IN A paper recently presented to the Institute of Actuaries [1], Hamilton-Jones has discussed selection, pointing out that there are three kinds of selection inherent in the disability risk, namely, "medical selection at outset; selection according to length of waiting period; and selection operating from date of disablement (reverse selection)." We shall consider each of these in turn.

*Initial Selection*

Little has been published to indicate the characteristics of select and ultimate rates of disability. The 1952 intercompany disability study [2]

TABLE 1  
INDIVIDUAL WAIVER OF PREMIUM BENEFITS  
EXPERIENCE BY AMOUNT FROM 1946 TO 1950  
Ratios of Claim Rates in Indicated Policy Years  
to Those for Policy Years 11 and Over

Attained Ages	Policy Years 2-5	Policy Years 6-10
25-39 .....	116%	107%
40-49 .....	92	100
50-59 .....	89	84

offers one bit of evidence, which is summarized in Table 1. From this it will be seen that the pattern of selection under the disability premium waiver benefit is quite different from that under ordinary life insurance.

The coefficient of selection at the younger ages is actually negative; at the middle ages it is positive, but hardly significant. Only at the older ages does it bear some resemblance to that observed in life insurance.

Two possible explanations are submitted. At the younger ages a large portion of disability is due to accident. If there is a correlation between accident proneness and a tendency to neglect one's financial undertakings, lapsation could result in improvement in the experience. Furthermore, the generally presumed inclination for the impaired or substandard lives to be more persistent than the healthy lives may be more than offset by a similar correlation between the management of one's budget and the observance of good health habits. That is to say, the person who lapses his policy because he loses his job or neglects his financial husbandry may also be negligent with respect to his health.

At the older ages attrition through lapsation may continue to exert a salutary effect on the experience, but, if so, this is more than offset by

the inevitable deterioration in health as chronic diseases take their increasing toll.

A study of the disability experience of a small Canadian insurance company tends to reinforce the theory that lapsation does not necessarily result in the loss of the healthier lives, on balance. The principal business of this company consisted of disability policies with first-day coverage and short benefit periods. When, in 1958, it became necessary to increase premium rates, the policyholders were given the alternative of requesting that their policies be modified to include a seven-day deferment or elimination period. As a result it became possible to divide the policy-

TABLE 2  
EXPERIENCE OF A CANADIAN DISABILITY INSURER  
Ratios of Actual to Expected Experience  
Years 1953-57  
(Period Preceding Premium Increase Date)

Category	No. of Policies	Actual Benefit Payments	Expected Benefit Payments	Ratio of Actual to Expected
1. Policies lapsed after announcement of premium increase . . . . .	1,002	\$ 55,999	\$ 50,031	112%
2. Policies on which increased premiums were paid . . . . .	5,220	257,886	249,809	103
3. Policies on which elimination period option was taken . . . . .	3,423	174,068	187,403	93

holders into three categories: (1) those who requested the deferment period, (2) those who paid the increased premium, and (3) those who lapsed their policies. An appraisal of the relative disability risk of each category could then be made by analyzing the prior experience in each of the three categories into which the policyholders had divided themselves by self-selection. The results, summarized in Table 2, did not indicate any antiselection on the part of those who lapsed. However, the policyholders who selected the elimination period were found to constitute the most favorable of the three categories. This study, while based on a very small volume of business, supports the hypothesis stated above with respect to the effect of lapsation and also offers some evidence of the selection exercised in the choice of deferment period.

Another interesting comparison of the behavior of claim rates over a long period of years may be found in the experience of fourteen United States and Canadian insurers under the group total and permanent disability clause providing payment of the face amount on total and

presumably permanent disability, either in a lump sum or in several instalments certain. This benefit, commonly included in group life insurance prior to the early 1930's, produced a very adverse experience during the Great Depression. As a result it was removed from most group policies, except where the experience had been favorable and the employer desired to retain it. Table 3 compares the experience under this benefit in three periods: 1925-27, 1932-33, and 1955-64. The claim rates for the

TABLE 3  
GROUP TOTAL AND PERMANENT DISABILITY EXPERIENCE—  
NONHAZARDOUS INDUSTRIES  
Payment of Face Amount in One Sum or Instalments Certain

CENTRAL AGE	EARLY EXPERIENCE					LATEST REPORTED EXPERIENCE	
	Rate of Dis- ability Expected 1,000 p <sup>2</sup> * (1)	Actual to Expected†		Actual Rate of Disability		Actual Rate of Disability 1955-64 (6)	Actual to Ex- pected 1955-64 (7)
		1925-27 (2)	1932-33 (3)	1925-27	1932-33		
				[(1) × (2)] (4)	[(1) × (3)] (5)		
18.....	0.35	102%	329%	0.36	1.15	0.05	14%
23.....	0.50	102	221	0.51	1.11	0.07	14
28.....	0.62	101	209	0.63	1.29	0.10	16
33.....	0.66	102	245	0.68	1.62	0.18	27
38.....	0.73	100	279	0.71	2.04	0.25	34
43.....	0.93	105	256	0.98	2.38	0.48	52
48.....	1.34	101	245	1.36	3.29	0.95	71
53.....	2.14	103	255	2.20	5.46	2.07	97
58.....	3.56	104	224	3.71	7.98	5.73	161

\* See Ref. [3].

† See Ref. [4].

first two periods were developed by applying ratios of actual to expected to the expected rate of disability. Those for the third period were taken directly from *TSA, 1965 Reports*. Of course, during this long period of years many changes took place in the composition of the groups included in this experience and in the relative importance of different causes of disability. For these reasons only guarded conclusions can be drawn from the comparison of the third column with the earlier experiences. It will be noted, however, that there has been dramatic improvement at the younger ages, no doubt due in large part to the virtual elimination of tuberculosis and many other infectious diseases. At the other extreme is the rather usual tendency of disability rates at the higher ages to increase persistently over long periods of time.

Table 4 presents more recent intercompany data based on a modern benefit and covering a shorter period, one during which there was relatively little change either in the pattern of disability by cause or in the economic and employment conditions. From the claim rates shown on a cumulative basis in the committee reports on group long-term disability [5] we have deduced the rates for each separate experience year. Here again will be noted the general tendency for the rates at the younger ages to decline and the rates at the older ages to increase from year to year. Paralleling our supposition that, at least at the younger ages, the policyholders who lapse their individual policies are on the average not the

TABLE 4  
GROUP LONG-TERM DISABILITY EXPERIENCE—MEN  
Six-Month Deferment Period  
Crude Rates of Disablement per 1,000

PERIOD OF EXPOSURE	ATTAINED AGES					
	Under 40	40-44	45-49	50-54	55-59	60-64
1962-65...	0.75	1.43	2.31	4.59	8.62	12.96
1962-68...	0.60	1.35	2.72	4.76	8.12	15.35
1966.....	0.75	1.67	2.98	4.78	4.76	11.55
1967.....	0.49	0.98	3.45	4.90	10.11	15.17
1968.....	0.44	1.32	2.49	4.85	8.36	19.74

better disability risks, we also suggest that labor turnover may tend to eliminate the poorer risks and thus contribute to the decreasing secular trend in the claim rates at the younger ages. In judging the data in Tables 3 and 4, it should be kept in mind that Table 3 is based on an essentially closed block of groups, most of which were initially underwritten over forty years ago. In contrast, the business underlying Table 4 is of recent origin, and the volume has been increasing at a substantial rate.

While the data in Tables 1, 3, and 4 are from disparate sources, there is one common feature, namely, that as the experience matures the curve representing disability rates by age tends to rotate in a counterclockwise direction, that is, to become steeper. The pattern of mortality over the last forty years shows some similarity, since the curve of death rates has likewise steepened. Obviously the changing distribution by cause of both disability and death has affected both curves. Also, an improving mortality results in a progressive postponement of the final illness.

For another comparison we present in Table 5 the graduated invalidity claim rates among the federal employees of Switzerland, the EVK experience. Although the rates have dropped at all ages except the highest, the improvement diminishes generally with advancing age. The low rates at the younger ages and their marked improvement are largely explained by two facts. First, this is an invalidity benefit for clearly permanent or long-term disabilities. Second, for a high percentage of illnesses and injuries, which would otherwise require disability payments, a very effective rehabilitation program has provided a better solution.

TABLE 5  
INVALIDITY BENEFITS OF SWISS FEDERAL EMPLOYEES  
EVK Experience—Men

AGE	CLAIM RATES PER 1,000			RATIO OF		
	EVK—1949 (1)	EVK—1960 (2)	EVK—1970 (3)	(2) to (1) (4)	(3) to (2) (5)	(3) to (1) (6)
23.....	1.03	0.50	0.10	49%	20%	10%
28.....	0.69	0.52	0.10	75	19	14
33.....	0.70	0.57	0.13	81	23	19
38.....	1.25	0.84	0.24	67	29	19
43.....	1.81	1.64	0.63	91	38	35
48.....	5.70	3.73	2.00	65	54	35
53.....	15.66	9.24	5.60	59	61	36
58.....	38.86	23.66	17.49	61	74	45
63.....	112.81	60.74	54.15	54	89	48
64.....	132.78	73.19	74.65	55	102	56

This state rehabilitation program, introduced in the late 1950's, offers remedial medical treatment, prosthetics, vocational training, and facilities for getting to work such as specially equipped cars for handicapped drivers. Furthermore, a full-employment situation, generally prevailing since World War II, has doubtless contributed to the reduction and low level of claim rates, and, with the measures recently taken to check the flow of immigrants, a very tight labor market has developed in Switzerland. For ages under 46 the improvement per year is somewhat of the order of that shown in Table 3 for the group total and permanent disability experience.

#### *Selection according to Length of Deferment Period*

"Deferment period" is used in this paper rather than "elimination period" or "waiting period." In connection with a benefit period of stated length, it is more accurately definitive. The expression "waiting

period" has often been used to denote a probationary period. Deferment period selection may be attributed in part to malingering after a disability has occurred and in part to selection at issue.

As to the first hypothesis, one may conjecture that a person already on claim often tends to stretch it out a bit. For example, if in fact recovery occurs on a Thursday or Friday, it is not improbable that benefits will be claimed through Sunday. On the other hand, an employee under identical circumstances except that his deferment period is longer may not bother to make claim for one or two days of actually compensable disability. While malingering may be involved in many cases, we prefer to use the term "inertia," which covers both a claimant's reluctance to terminate a claim once it has been established and an insured's reluctance to enter a claim for only one or a few days.

The earliest evidence, to our knowledge, of deferment period selection was noted in the experience under group weekly disability benefits presented by Fitzhugh [6]. In the 1931-35 experience on the thirteen-week benefit the disability prevalence among employees disabled eight days or longer was 157.5 per 1,000 exposed if benefits started on the fourth day, but only 88.5 if benefits started on the eighth day. As would be expected from the inertia theory, the continuance tables for different deferment periods tend to converge. However, substantial convergence is achieved only after three weeks or longer.

In a similar study of group weekly indemnity [7] Miller suggested that "the explanation probably lies in the somewhat indefinite selection process . . . [which results in] . . . a grouping of employers and employees by plan of benefit in such a way that the combined effect of such factors as the kind of establishment, locality, the type of employer administration, the age, education, economic level and other characteristics of the employed group, together with the specific plan provisions as to waiting period and maximum duration of benefits, produces the variations in incidence of claim continuance observed."

When we examine the experience under individual policies, we find that, in addition to the influence of inertia, there is evidence of strong self-selection at the time of application for insurance. A striking example may be seen in the experience under individual loss-of-time policies [8] covering the years 1966-67, from which the comparison shown in Table 6 has been developed. There is a slight disparity in coverage between lines 1 and 2, since line 1 is based on benefits paid for a full year, that is, through the 379th day of disablement. This difference is negligible, however, in comparison with the much higher cost under the shorter deferment and tends to understate the effect of lengthening the deferment period.

The experience presented in Table 2 may also be cited as evidence of self-selection in respect to the deferment period.

In 1953 a study of experience in Sweden [9], on a benefit payable for disability rated at least 50 per cent, also brought out the fact that the prevalence of disability of the same duration decreased with an increase in deferment period. For example, after thirteen weeks of disablement among insureds aged 35-45 there were sixteen disabilities per 1,000 with a deferment period of eight weeks or less, as compared to only eight per 1,000 with a thirteen-week deferment. This third dimension in disability insurance was introduced in the 1965 technical bases for noncancelable individual sickness insurance in that country, as described in a paper by Dillner [10]. For deferment periods of less than three months, the "inten-

TABLE 6  
EXPERIENCE UNDER INDIVIDUAL LOSS-OF-TIME POLICIES  
Annual Claim Cost per \$1 of Monthly Benefit—Men, Group I

DEFERMENT AND BENEFIT PERIOD	AGE GROUP				
	20-29	30-39	40-49	50-59	60-69
1. 14-day deferment, 1st year of benefit period.....	\$0.058	\$0.061	\$0.099	\$0.188	\$0.308
2. 7-day deferment, excluding disablement before 15th day and after 365th day of disability from accident, 372d from sickness.....	0.078	0.092	0.128	0.214	0.349
3. Ratio of line 2 to line 1.....	134%	151%	129%	114%	113%

sity of disability," which corresponds to the claim rate, includes a multiplicative factor,  $r(k)$ , where  $k$  is the deferment period. The value of  $r$  is 1.721 for a seven-day deferment, 1.595 for fourteen days, and 1.308 for one month. This factor, which is a constant for all ages and durations, is applied to an intensity rate based on age and duration of disability. Experience presented in Mr. Dillner's paper indicates substantially higher  $r$  ratios than those adopted in the new technical bases.

In some experimentation with a disability model we have considered the construction of a family of curves representing a spectrum including all the standard deferment periods. For this purpose we have used for the thirty-day deferment period a continuance table reflecting the inter-company loss-of-time experience of 1966-67 [8]. For the three-month deferment period we have used Benefit 2, Period 4 claim rates [11] with the 1930-50 termination rates, and for six months' deferment we have



developed figures from the intercompany group long-term disability experience [5]. Our tentative results are compared in Table 7 with the Swedish assumptions and the actual data.

Mattsson and Unneryd [12] have observed that deferment period selection "is mainly explained by the fact that persons from different risk groups choose different waiting periods." It may be that those who are paid weekly and operate on a weekly budget, a more or less hand-to-mouth existence, would consider a deferment period of more than one week to be excessive, whereas people on a monthly salary are accustomed

TABLE 7  
RATIO OF DISABILITY PREVALENCE AT DURATION SIX MONTHS  
WHEN DEFERMENT PERIOD IS 30 DAYS COMPARED TO  
THAT WITH THREE MONTHS' DEFERMENT

	AGE		
	30	40	50
Swedish experience:*			
Observed data†	1.92	1.53	1.75
$r(k)$ factor	1.308	1.308	1.308
North American data‡	1.52	1.45	1.34

\* See Ref. [10].

† For ages 20 and 50 Mattsson and Unneryd's data produce ratios of 1.67 and 1.32, respectively.

‡ Based on authors' analysis and interpretation of data published in the *Transactions*.

to planning ahead and also may be more likely to have substantial savings or credit facilities. Thus there is probably a correlation between deferment period and socioeconomic class.

Another factor, undoubtedly, is the attitude of the individual insured, or, to use Lundberg's term [13], his "insurance morality." The person who looks on this disability insurance as an investment will generally seek the shortest deferment available, while the individual who is prudent and conscientious will see that economy and family security can both be served by accepting as long a deferment as his circumstances permit.

#### *Selection after Disablement*

The third type of selection is reflected in the pattern of disability termination rates, which typically decrease both by age at inception of disability and, for a number of years, by duration. The decrease with duration is naturally most pronounced with respect to recoveries, but

North American experience indicates that, for at least ten years, the death rates also decrease, except at the youngest and oldest ages of disability. This reflects the fact that most disabilities result in fairly early recovery, while the comparatively few terminal disabilities cause high mortality in the early months and years following disablement.

Somewhat tempering this reverse selection is the tendency of many claimants to malingering, once entitlement to benefits has been established. Evidence of this may be found in the Society's *1952 Reports* number. On page 119 it is indicated that termination rates for Benefits 2 and 3 combined were approximately 17 per cent lower in Period 1 than in Period 4. The explanation, of course, is that in Period 1 there were few jobs to return to and wages were seriously depressed; thus the incentive to admit recovery and terminate the status of total disability was affected. Other evidence may be seen in a comparison of termination rates under Benefit 5, providing premium waiver only, with benefits providing income. Despite the fact that the claim rates, adjusted to a uniform deferment period, were much higher where cash benefits were payable, the rates of recovery were lower than those under the waiver benefit. Thus the payment of a cash benefit appears not only to increase the frequency of claims but to prolong them as well.

#### FACTORS AFFECTING THE INCIDENCE OR THE DURATION OF DISABILITY

Myriad factors affect the rate of disability and the rate of termination of disability. We would, however, like to suggest several categories and mention some examples.

##### *Personal Characteristics*

Both the incidence and the duration of disability are obviously affected by such objective factors as age, sex, physical health, and strength and some much more subjective but nonetheless important attributes such as the individual's emotional or neurological characteristics and attitudinal instincts which determine his "insurance morality." Another set of influences which, to some extent at least, are within the control of the individual, include his occupation and the risks it involves or the environment to which it subjects him. Also, the location of the individual's home and place of work with the wide range of climatic, social, and environmental differences involved may have a very significant effect on the incidence of disability and its prognosis. As stated by Mattsson and Unneryd [12], "It is not only the risk of contracting a disease or being subject to an accident that varies but also the conse-

quence of a disease or an accident on the insured's ability or will to work."

There is also evidence that the amount of the benefit affects the duration of claim. This is suggested by some data contained in a paper by Grange and Miller [14]. One of the fundamentals of disability underwriting is that, on a basis net of taxes and business or occupational expense, substantially less than 100 per cent of net earnings should be indemnified, but we have not found any other experience which attempts to measure this important factor.

TABLE 8  
CYCLICAL VARIATION  
Excess of Period 1 (1930-35) over Period 4 (1946-50)  
Benefits 2 and 3 Combined

Ages	Rate of Disability (1)	Rate of Termination (2)	Disabled Life Annuity* (3)	Net Annual Cost (4)
30-34.....	154%	-21%	27%	223%
35-39.....	184	-15	14	223
40-44.....	164	-25	22	222
45-49.....	132	-25	17	171
50-54.....	81	-20	12	103
55-59.....	51	-21	8	63
All ages.....	94%	-17%	12%	117%

\* Approximate change in claim value corresponding to col. 2.

### *External Influences*

Finally, there are external factors beyond the individual's control, the most important of which are changing economic conditions and employment opportunities. Political and social conditions or changes may affect a person's reaction to an illness or injury. The quality and availability of rehabilitation services also have an important influence on the amount of disability benefits claimed.

### *The Economic Cycle*

Among the external variables, considerable data are available with respect to economic conditions and levels of unemployment. We have already presented an indication of the marked change in disability incidence rates according to economic conditions. More extensive documentation of this is available in the *1952 Reports*, from which the comparisons shown in Table 8 have been drawn.

The data in Table 8 indicate the tremendous effect on claim rates of economic conditions and the considerably lesser effect on termination rates. Moreover, the decrease in termination rates proved to be temporary, so that much of the indicated cost increase in the depression was compensated by higher recovery rates thereafter. The fact that, at least historically, the major impact of depression conditions was on the claim rate is of great importance to the disability insurer, in that it suggests the possibility of maintaining a current and continuous surveillance of experience based only on the measurement of the influx of new claims. If we can conclude from the 1930-50 data that over four-fifths of the increase in costs from an economic recession is reflected in the claim rate, we need not wait for the development of a mature loss ratio or of the termination experience to judge the course of the disability underwriting results.

#### *Predisposition to Disability*

Probably there would be general agreement, based on observation, that among a group of people free from any chronic disease or impairment and basically enjoying normal health, some persons habitually suffer more acute sickness and incur more injuries than others. Doubtless some of this variation may be attributed to differences in their physical strength, their resistance to disease, or their innate caution or physical co-ordination. Beyond this there is the matter of attitude. Some people carry on despite an indisposition as a result of which another person would take to his bed. A striking example of the dependence of disability on the individual's history of illness or injury has been presented by Lundberg [13]. Using experience in the first two policy years of individuals insured for disability with a short deferment and a limited benefit period, he divided the policyholders into those who had suffered one or more claims and those who had been claim-free. The two groups were separately traced for three successive quinquennia, with the results shown in Table 9.

It seems clear from the above that the presentation of a claim in the first two years was, in a large number of cases, not a result of random chance but an indication of the individual's predisposition to disability or claim proneness, since there was no clear tendency for the experience of the two groups to converge.

Another analysis of the experience of the Canadian disability insurer referred to earlier also indicates the dependence of the individual disability risk on prior experience. The 1958 experience of this company was subdivided among policyholders according to whether they had been claim-free in specified prior periods. The findings, presented in Table 10,

TABLE 9  
STUDY OF "SMALL INSURANCE" IN SWEDEN

POLICY YEARS	A. POLICIES CLAIM-FREE FIRST TWO POLICY YEARS			B. POLICIES WITH ONE OR MORE CLAIMS IN FIRST TWO POLICY YEARS			RATIO OF GROUP B TO GROUP A		
	Claim Cost*	Claim Rate†	Average Duration*	Claim Cost*	Claim Rate†	Average Duration*	Claim Cost*	Claim Rate†	Average Duration*
3-7.....	3.27	0.92	3.55	6.85	2.06	3.33	209%	224%	94%
8-12.....	3.41	0.90	3.79	6.07	1.84	3.30	178	204	87
13-17.....	3.90	1.01	3.86	7.31	2.07	3.53	187	205	91

\* Number of weeks, during first thirteen weeks of disability.

† Number of claims per policy in the five-year period.

TABLE 10  
EXPERIENCE OF A CANADIAN DISABILITY INSURER, SHOWING DEPENDENCE OF EXPERIENCE ON CLAIMANT'S HISTORY OF DISABILITY

REFERENCE PERIOD AND LINE	PERCENTAGE OF POLICIES EXPOSED	1958 EXPERIENCE					RATIO OF LINE B TO LINE A		
		ACTUAL CLAIMS			Expected Claims	Actual to Expected	Claim Cost	Average Amount	Claim Rate [(7)÷(8)]
		No.	Average Amount	Total Amount					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
1957:									
A.....	86%	729	94.57	68,939	74,613	92.4%			
B.....	14	201	99.86	20,071	13,225	151.8	164%	106%	
1956-57:									
A.....	76	612	96.46	59,031	66,178	89.2			
B.....	24	318	94.27	29,979	21,660	138.4	155	98	
1955-57:									
A.....	68	515	95.41	49,137	59,114	83.1			
B.....	32	415	96.08	39,873	28,724	138.8	167	101	
1954-57:									
A.....	62	450	95.33	42,900	53,127	80.7			
B.....	38	480	96.06	46,110	34,711	132.8	165	99	
1953-57:									
A.....	56	386	95.60	36,901	48,263	76.5			
B.....	44	544	95.79	52,109	39,575	131.7	172	100	
Totals.	100%	930	95.71	89,010	87,838	101.3%			

NOTE.—Line A presents the experience on policies which were claim-free during the "reference period"; line B presents the experience on policies with one or more claims in the "reference period"; col. (1) shows the distribution of exposures between line A and line B.

reinforce the evidence of the Lundberg study and also again show the comparative uniformity of average claim durations in contrast to the variability of frequency rates.

#### CONTROL OF EXPERIENCE THROUGH UNDERWRITING POLICY

The purpose of risk selection is not to deny anyone insurance but rather to assess the cost equitably among those insured. Only when the cost cannot be determined with satisfactory credibility, or when it is so high as to make the undertaking of insurance unattractive or impractical, should underwriting action result in a rejection. In view of the evidence that the individual's past pattern of health is a highly significant indication of his future disability experience, it may be that more attention should be paid to recent illnesses and disabilities. One possible method of assessing for a below-average disability history would be to impose an extra premium, or to increase the deferment period without compensating premium reduction, with the understanding that a future periodic review might permit transfer to a standard category.

What indications we have as to the nature and pattern of the select disability experience suggest that there is a strong self-selection adverse to the insurer but that this diminishes progressively with an increase in the deferment period. With noncontributory group insurance, of course, the opportunity for self-selection is removed. A comparison of the group long-term disability experience with experience under individual policies indicates that the inclusion under group insurance of lives which, if subject to individual underwriting, might be rejected or rated is more or less offset by the avoidance of self-selection.

#### MONITORING THE UNDERWRITING EXPERIENCE

It has been pointed out that historically something over four-fifths of the cyclical variation in disability experience appears to be attributable to the frequency rate, compared with which the average claim duration is relatively stable. If this relationship can be relied upon in the future, an insurer can maintain a very current gauge of experience by recording and analyzing the frequency of reported claims. Of course there is an inevitable lag where a long deferment period applies. One may wonder whether it would be advantageous to apply a much shorter deferment period to the premium waiver benefit in order to encourage earlier reporting of claims. This would permit more timely investigation of serious claims and, where early and complete recovery is not expected, could be extremely valuable in the prompt institution of a rehabilitation program.

In addition to the fact that deviations from expected results are largely concentrated in the claim frequency, the pattern of selection suggested by the evidence of Tables 1, 3, 4, and 5 indicates that the true level of experience will be revealed soon after issue, except at the higher ages.

While a simple index of the number of reported claims, adjusted for change in the volume of business in force, would be quite significant, this measure could be substantially improved by weighting each claim in relation to the age of the insured, since a claim in excess of the expected number is more significant if it occurs at a young rather than at an advanced age. Such a weighting can readily be done by use of the expected exposure method.<sup>1</sup> In this method the expected exposure for any statistical classification is equal to the number or amount of claims divided by the expected claim rate. Thus the ratio of expected exposures to actual exposures is analogous to the ratio of actual claims to expected claims. A virtue of the expected exposure method is that a ratio for all ages combined can be obtained when only the total amount or number of exposures is available. A comparative analysis of the two ratios will show that the results are identical if the ratio of actual to expected claim rates is uniform for all ages. In each method the ratio for all ages combined is a weighted average of the true ratio of actual to expected claims for each individual age. Whereas, in the conventional ratio, the weight at each age is the expected claims for the age, in the expected exposure method the weight at each age is the actual exposure. Thus, given some approximation to the age distribution of the exposures, it is possible to ascertain to what extent the results by the two methods would differ.

Another fact which contributes to the practical utility of the expected exposure method is that the pattern or distribution of exposures normally changes rather slowly. The actual or approximate distribution of exposures by age and other characteristics, such as occupation, occupational class, sex, length of deferment period, or medical impairment, can be prepared annually, or at less frequent intervals, and projected in proportion to the change in the total volume of business in force. This easily made projection of exposures can then be compared at frequent intervals with the expected exposures computed from claim records necessary for other purposes. This method has some similarity to the projection of expected mortality described by Moorhead [15] and offers some corresponding advantages. It is suggested that, by this method, more detailed company and intercompany studies of the effect of occupa-

<sup>1</sup> The expected exposure method is a conception of William M. Anderson. To the best of our knowledge, it has not been published.

tion, impairments, history of disabilities, indemnity ratio, and other factors would be feasible.

In connection with the analysis of experience, it should be pointed out that there is a tremendous difference in the credibility of a given number of risks according to the length of the deferment period. Some eyebrows may have been raised over the experience data presented in Tables 2, 9, and 10, based on approximately 10,000, 1,000, and 7,000 policies, respectively. One must consider, however, that the claim frequency on a disability policy with a seven-day deferment period is, at a typical average age, of the order of 75 times the frequency with a six-month deferment and 50 times the corresponding mortality rate. This fact makes possible a great deal of detailed analysis from a small exposure when short deferment periods are involved.

#### ACTUARIAL NOTATION

There are basically three forms of disability notation and formulas. The Continental or Hamza method uses double decrement tables but assumes that there are no recoveries from disability and that the mortality of disabled lives is independent of the duration of disability. The Friendly Society method, generally applied to the Manchester Unity Tables, uses weeks of sickness per member per annum as the basic function. The pension fund method employs claim rates or probabilities and select disabled life annuities from which net annual costs are derived. Continuance tables are often derived from the underlying rates of occurrence and termination of disability. Conversely, the observed data may be arranged in the form of a continuance table and other values derived therefrom.

Another approach will now be outlined which is related to the last-mentioned method but takes into account not only the age of the insured and the duration of disability but also the deferment period.

Let  $l_{[x]+t}^i$  be the number of lives disabled at age  $x$  and remaining disabled for duration  $t$  or longer,  $l_x^{aa}$  the number of lives of an active life table, and  ${}^e r_{[x]+e}$  the claim rate for insured lives with a deferment period  $e$  and age  $x$  at disablement. Then

$${}^e l_{[x]+e}^i = l_{x-1/2}^{aa} {}^e r_{[x]+e} ; \quad (1)$$

$${}^e l_{[x]+t}^i = {}^e l_{[x]+e}^i {}_{(t-e)} p_{[x]+e}^i . \quad (2)$$

Unlike the Commissioners Disability Table but following the method outlined by Cammack [16] in his ingenious reconstruction of the AHJ Section of the Manchester Unity Table, all values of  $l_{[x]+t}^i$  are related to



a common radix, namely  $l_{x'}^a$ , the number of active lives at the lowest age  $x'$  of the table.

To avoid fractional ages in the numerators of the premium formulas, it is assumed that disability commences at exact age  $x$ . This necessitates the assumption that the insurance year begins at age  $x - \frac{1}{2}$ , which further simplifies calculations based on age last or next birthday. If age nearest birthday is to be used, an adjustment is made as a final step in the calculations.

It has been demonstrated [17] that for purposes of premium computation a mixed life table can be assumed to be an active life table with no significant error. In fact, this assumption produces more accurate premiums than various formulas which have included a corrective factor to recognize that disabled lives are not currently subject to the risk of disability and, ordinarily, are not paying premiums. In formula (1) any suitable mixed life table may therefore be used for  $l_{x-1/2}^a$ .

From the basic functions of disability prevalence the following formulas are derived for intervals of one-twelfth of a year, except for formulas (6) and (7), for which yearly values are computed after the first twenty-four months.

$${}^e D_{[x]+t}^i = v^{x+t} {}^e l_{[x]+t}^i; \quad (3)$$

$${}^e D_{[x]+t}^{i(12)} = \frac{1}{12} {}^e D_{[x]+t}^i; \quad (4)$$

$${}^e \bar{D}_{[x]+t}^{i(12)} = \frac{1}{2} ({}^e D_{[x]+t}^{i(12)} + {}^e D_{[x]+t+1/12}^{i(12)}); \quad (5)$$

$${}^e H_{[x]+t} = \sum_{z=12t}^{z=12(u-x-1/12)} {}^e \bar{D}_{[x]+z/12}^{i(12)}; \quad (6)$$

$${}^e K_{[x]+t} = \sum_{z=x}^{z=u-t-1} {}^e H_{[x]+t}. \quad (7)$$

From the above commutation functions annual premiums or single premiums can be computed directly for any elimination period and any benefit period up to the limiting age by dividing the appropriate  $H$  or  $K$  values by the active life function appropriate to the terms of the policy.

Disabled life annuity values need not be determined for premium calculation, but, where needed for claim valuation, they may be obtained from the following formula:

$$\frac{{}^e H_{[x]+t} - {}^e H_u}{{}^e D_{[x]+t}^i}, \quad (8)$$

where  $t$  is the duration of disablement including the elimination period and  $u$  is the age at termination of the benefit period.

## A MATHEMATICAL MODEL

From a consideration of the personal factors and economic influences bearing on disability, it is clear that the concept of a single disability table serving all purposes is unrealistic. However, while we can expect neither stability nor homogeneity among the various rating classifications in a universe of disability experience, we can discern patterns among certain relationships which appear to have a degree of universality, such as the  $r$  factor used in Sweden, the age-incidence relationship of disability claim rates or frequencies, and the age- and duration-incidence relationships of disability termination rates. It is believed that a mathematical model incorporating these relationships would be a useful instrument. Although it should not be looked upon as an experience table in the traditional life insurance sense, it could be used in comparing trends in different types of business. For example, the trends in group long-term disability experience and those in the individual loss-of-time experience, subdivided by deferment period, might be compared by using such a comprehensive mathematical model as a common measuring device.

In conclusion, we would like to state that it has not been our purpose to solve any of the riddles of disability underwriting but rather, hopefully, to suggest areas for further exploration and to stimulate research, especially into the subjective aspects of disability claim experience.

## ACKNOWLEDGMENTS

We wish to express our sincere appreciation to Louis Levinson and David H. Young, Jr., for reviewing the paper and offering a number of helpful suggestions.

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## DISCUSSION OF PRECEDING PAPER

MR. E. PAUL BARNHART:

Once again we are indebted to John Miller, and to his coauthor Simon Courant, for what I consider to be an extremely valuable and informative study of the disability risk.

I think that this paper has particular value in disability underwriting. In Table 1 the authors summarize data indicating a negative coefficient of selection at younger ages, and a coefficient that is only minimally positive in the middle ages. I have seen other select disability experience showing the same phenomenon.

This evidence seems particularly surprising in view of the data summarized in the authors' Tables 9 and 10, which indicate a pronounced dependence of future disability upon prior history, suggesting that the selection of disability risks ought to respond far more effectively to reasonably proficient underwriting.

I would suggest that a possible explanation of this may be that too much underwriting is directed toward evaluation of specific past conditions regarded as "significant," without enough attention being paid to the possibility of a general predisposition to disability on the part of some applicants. Thus, if an application reveals one or two brief periods of disability within the past couple of years resulting from acute conditions without long-term or chronic significance and from which "full recovery" has been realized, the underwriter is apt to approve the case. The evidence in the paper suggests that recent history of disability from almost any cause, however temporary, may well have much more long-term meaning than many underwriters have supposed.

The authors give us convincing evidence of what a remarkable degree of selection is associated with the "deferment" or elimination period. I have recently spent considerable time in analyzing the Society's individual loss-of-time experience along the same line as that undertaken by the authors in their Table 6, using the same 1966-67 experience and studying the data for all four of the 0-, 7-, 14-, and 30-day elimination periods. My efforts were directed toward the construction of a continuance table based on these data, and the conclusions were absolutely startling.

If one constructs a continuance curve for a given age group that will

reproduce both the claim rate and the 12-month benefit period claim cost for any one of the four deferment periods contained in the Society data, one will find that this curve passes through values which come nowhere close to those of any of the other three deferment periods. For example, a continuance curve that will reproduce the 0-day rate and the 0-day/12-month cost will develop a thirtieth-day incidence of disability that ranges as high as 500 per cent of the actual claim rate shown in the data, for that age group, for the 30-day deferment period. The claim cost, developed from the 0-day curve but for a 12-month benefit period following a 30-day deferment period, will usually exceed 200 per cent of the actual data 30-day claim cost. One comes closer working from the 7-day or the 14-day data, but still so far off target that the conclusion one is forced to is that no one continuance curve can be constructed that even remotely approximates the underlying continuance implicit in any two of the periods!

It does appear to be possible to construct a very distorted single continuance curve that will approximate the claim costs only, but, when this is done, all four of the claim rates themselves become grotesquely exaggerated, so that one must carefully avoid applying the table in any way that depends on direct or implied validity of the tabular incidence of disability at any one point of duration, as determined from the curve. Hence, while such a table may be used (with considerable caution) to construct certain claim costs, it will be absolutely invalid even for the roughest sort of approximation of claim rates.

One obvious possible explanation for this extreme divergence of the continuance implicit in the actual data for each successive deferment period is that the data for each period may involve heavy concentrations of experience from different contributors, thus representing drastically different underwriting characteristics, from one period to the next. However, I have observed a closely similar effect in analyzing the experience of one company at successive deferment periods. Using a single-curve continuance table as a standard for expected claims, I found the actual/expected ratio for 0- and 7-day deferment periods to be well over 100 per cent, that for 14 days to be well below 100 per cent, and that for 30 days to fall as low as 20-30 per cent of expected, based on the single curve as a standard. One is therefore led to conclude that the deferment period is a very powerful selective factor even in the business written by a single company and subjected to presumably consistent underwriting.

Thus the pronounced effect of the deferment period on the incidence of disability may well be even more dramatic than is suggested by the data in the authors' Table 6.

## (AUTHORS' REVIEW OF DISCUSSION)

JOHN H. MILLER AND SIMON COURANT:

We are very grateful to Mr. Barnhart for his comments. His discussion of any paper on disability is always an important contribution.

The method of analyzing the Society's individual loss-of-time experience which he describes is essentially the procedure used for the 30-day deferment period in our development of the "North American Data" shown in Table 7. It is gratifying to learn that his findings support our conclusions.

It is perhaps worth noting that, in 1937, a committee appointed to investigate the morbidity experience under group weekly indemnity policies produced an artificial "composite table" to accomplish the objective of the "distorted single continuance table" conjectured by Mr. Barnhart. This is described in reference [6]. In a subsequent study separate tables for each major deferment period were constructed (ref. [7]).

We might add that experience published since the paper was written tends to reaffirm the conclusions drawn from the earlier data. On page 169 of the *1971 Reports* number of the *Transactions*, the group total and permanent disability experience, presented in our Table 3, is updated for the years 1965-69. Again we see a continuation of the long-term trend toward lower claim rates at the younger ages and increases at the advanced ages. The experience under individual loss-of-time policies for the years 1968-69 is published in the *1971 Reports*. The evidence of marked deferment period selection is substantially the same as in the earlier experience.

