Comparison of Actual and Expected Losses as a Means of Loss Analysis.

BY

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Since life insurance practice has long been based upon established mortality tables, it is natural that there should have grown up the practice of comparison from time to time of actual mortality with tabular expected. And the habit of making such comparisons having been fixed, it is no occasion for surprise to find the actuary using the principle for many purposes for which it at first seems in no wise adapted, for example, the construction and graduation of mortality tables based upon limited data by such comparison with a standard table and graduation of the ratio of actual to expected.

The practice of comparing actual and expected occurrences or losses is not unknown to the casualty business. In 1914 Mr. J. H. Woodward caused not a little commotion by discovering through such a comparison the unconscious loading introduced by underwriting judgment into the first New York compensation rates. Since that time the test has been made with respect to the basic pure premiums at each revision of the manual. More recently, in the revision of the Pennsylvania manual, the partial differentials between New York, Massachusetts and Pennsylvania were found by taking the sectional pure premiums from the experience of one state, applying them to the payroll exposures in the other and comparing actual and expected losses over a range of classifications, and then reversing the process to avoid error from magnification of eccentricities which arose when one state had a large exposure in one classification and the other a very small one with an apparently erratic loss. The two approximations gave an excellent basis for a final judgment on the problem.

Probably because we have no set tables as in life insurance and are afraid of being misled by erratic indications which may be lost sight of in the mass, we do not in casualty insurance frequently make use of such a comparison, and I think we are losing a great

deal thereby. It is true we must always take precautions, as was done in the Pennsylvania work, against being misled; but if we do not use the method blindly and have a sufficient volume of data, we may expect erratic indications to offset each other and very useful conclusions to be pointed out to us. I believe that a number of troublesome, apparently almost hopeless problems, in casualty insurance may be very successfully attacked in this way, such as the proper credit or charge for certain types of items in the schedule rating plans in compensation insurance, the proper charge for certain benefit conditions in personal accident and health insurance, or the reduction in compensatable disability from more extended medical treatment.

I have recently used the method to secure a very satisfactory solution of a problem of the latter nature which at first sight seemed hopeless. The problem itself is not a practical one for us from the rate-making point of view, although the result obtained may assist us in determining reserves for individual accidents. It has, however, a general interest for us all as a phase of the problem of industrial accidents. I am, therefore, giving a brief account of the investigation both on this account and to call attention to the applicability of the method above referred to. The problem was to determine the average increase in disability from accidental injury which occurs when infection is present. This was for an address on the subject before a safety congress.

My solution of this problem was made possible by the extensive tables published by the Industrial Insurance Department of the State of Washington, particularly those in the fifth and sixth annual reports, for the years ending, respectively, September 30, 1916, and September 30, 1917. Washington statistics are unusually complete in many ways. It is the practice in that jurisdiction to study statistically not the cases which arise during a given period but the cases which are closed ("finaled") during that period. Under this system much more is known about the cases which are studied than where the statistical data is tabulated with respects to the accidents occurring during the calendar period. There are some disadvantages to this system which will occur to all members of the Society, and this is particularly true during the early years of the institution making the tabulations. After the lapse of a sufficient time, however, to enable matters to get on a stable basis, this basis of study seems for many purposes to be much the better.

Among other tables contained in the Washington report are a series of tables dealing with the more common types of injuries, wherein are tabulated the number of such injuries according to the several parts of the body affected, the number of days' time lost, and the average number of days per case, together with the amount of compensation awarded for lost time and the number of awards and amount of compensation awarded for permanent partial disability cases. In this connection it should be borne in mind that there is no waiting period under the Washington Act, and, therefore, compensation is awarded from the date of injury. The following types of injuries are so studied: Bruises, cuts, punctures, dislocations, sprains, amputations, fractures, scalds and burns, and infections, and there is a further table designated as unclassified. In addition, there is a table entitled "Causes of Infection," in which the cases are tabulated according to the part of body affected and the primary injury. A comparison of this latter table with the tabulated data preceding indicates that the infected cases are not tabulated in the earlier tables, but that the earlier tables deal solely with uninfected cases. The two tables relating to infections and the causes of infections in the sixth annual report are reproduced in the appendix to this paper. The tables in the fifth report are similar.

Since we have tabulated, for example, the number of cases where the injury was a bruise of the foot and where infection had not occurred, together with the time lost on such cases and the amount paid for permanent partial disability, we are able to determine an average period of disability corresponding to such injury, and then, having the number of foot bruises which became infected, we are able to determine what the total disability on account of such cases would probably have been had they not become infected. The tables we have do not enable us to compare this directly with the loss for similar injuries where infection took place. We can, however, make the comparison with respect to all injuries to certain members of the body or with respect to all cases. It would appear entirely reasonable to assume that the excess of the actual over the expected is to be attributed to the presence of infection.

Two points in connection with this proposed method require some further discussion. The first is as to permanent partial disability cases, how they should be brought in. The Washington Law provides, among other things:

"For any permanent partial disability resulting from an injury, the workman shall receive compensation in a lump sum in an amount equal to the extent of the injury, to be decided in the first instance by the department, but not in any case to exceed the sum of fifteen hundred dollars. The loss of one major arm at or above the elbow shall be deemed the maximum permanent partial disability. Compensation for any other permanent partial disability shall be in the proportion which the extent of such disability shall bear to the said maximum."

Acting upon this provision, the Washington Commission has adopted a scale of benefits for each type of permanent disability, basing this scale upon a study of the scale of benefits in the acts of various other states and countries and the U. S. Pension Board. This scale of awards is expressed in dollars. A comparison of the lost time in the temporary cases with the amount of the time awards discloses that the compensation runs very close to $1.35 per day. In the study I have made, therefore, I have reduced the partial permanent disability awards into terms of "days' lost time" by taking three fourths of the amount of such award as the corresponding number of "days' lost time" and adding this amount to the actual days' lost time on temporary cases. Of course, the correctness of this process depends upon the correctness of the scale used by the Washington Commission, and if the scale is considered badly out of line, then to make a more correct study it would be necessary to obtain, by correspondence with the Commission, further particulars regarding these awards and evaluate them in accordance with our judgment of a better scale and the facts in each case. For the purposes in hand this did not seem necessary.

The second point requiring consideration arises from the fact that there were not a sufficient number of certain types of injuries to clearly indicate the average duration of disability when no infection was present, so that the expected loss in a particular type of injury to some member might be based upon an average that was very much too high or very much too low. In view of the number of divisions of the data, the fact that there was no reason to expect an error continuously on one side, and the large number of cases entering into the total, it seems a reasonable assumption that the errors will balance each other and that the average expected so brought out will not be far from the true expected loss from such injuries where no infection takes place. I have the greater confidence in this conclusion in view of the fact, as noted

below, that the studies based upon the data in the fifth report and sixth report quite closely agree in the final result.

The tables referred to above do not include fatal cases, but the fatal cases are elsewhere discussed in the report. The one difficulty, however, with the treatment of fatal cases in the report is that sufficient particulars are not given from which to forecast what the results would have been but for the intervention of infection. From our general knowledge of the nature of infections it seems reasonable to assume that the cases would not otherwise have been fatalities, and it is perhaps not unreasonable to assume they would have been cases of temporary disability of average duration. Following the treatment of permanent partial cases, it may be proper to assign a weight equal to 3,000 days to a fatal case ($4,000) in getting the actual losses and the average duration of all non-fatal cases for determining the expected losses with which these are to be compared. If this is done, the comparison method furnishes a very neat solution of the problem.

The results of this investigation are shown in the following table:

	Data from Fifth Report. Closed Cases, Oct. 1, 1915, to Sept. 30, 1916.			Data from Sixth Report. Closed Cases, Oct. 1, 1916 to Sept. 30, 1917.		
	Actual Time Lost.	Expected.	Ratio Actual to Expected, Per Cent.	Actual Time Lost.	Expected.	Ratio Actual to Expected, Per Cent.
All non-fatal.....	38,566	20,801	185.4	37,431	26,020	143.1
Infection fatalities ...	15,000	232	6,465.5	33,000	546	6,044.0
Total infected cases ..	53,000	21,033	254.7	70,431	26,566	264.4

From this it seems a reasonable conclusion that, allowing for possible fatal consequences, the average disability cost in infection cases is approximately two and one-half times that in uninfected cases.

At first sight it might appear that so much work was not necessary and that results approximately the same would have been obtained had I merely compared the average duration of disability in uninfected cases with the average duration in infected cases. Such a comparison for non-fatal cases gives the following results:

	Date from Fifth Report.	Date from Sixth Report.
Average duration all uninfected injuries.	47.24 days*	51.06 days*
Average duration infected injuries.....	37.48 days*	30.86 days*
Ratio average duration infected to uninfected cases.....	79.3 per cent.	60.4 per cent.
Corresponding ratio of actual to expected in infected cases.....	185.4 per cent.	143.1 per cent.

* Including adjustment for partial permanent disability.

This anomalous result shows the falsity of such reasoning and the need of such careful methods of comparison as I have suggested. It is explained by the more severe character of the basic injuries on the average for the uninfected group. The very severe injuries are usually under such medical care that infection does not often occur. It is the self-cared-for slight puncture that is the most likely to become infected.

It was at first my intention to separately study hand injuries, among which there were a large number of infected cases in the Washington experience, but as the contingency of fatal consequences is so important in connection with infections and the report did not give sufficient data with respect to them, this was impossible.

APPENDIX.

EXTRACT FROM

SIXTH ANNUAL REPORT, INDUSTRIAL INSURANCE DEPARTMENT, STATE OF WASHINGTON.
—INFECTIONS.

Members.	Number.	Days Time Loss.	Average.	Award Time Loss.	Average Award.	Permanent Partial Disability.		Total Awards.
						No. Awards.	Amount Awards.	
Foot	56	1,058	18.8	$1,432.80	$25.58	2	$1,200.00	$2,632.80
First toe	11	162	14.7	221.40	20.13	..	.....	221.40
One other toe	3	162	54.	227.80	75.93	..	.....	227.80
Two toes	1	31	31.	35.75	35.75	..	.....	35.75
Leg	58	3,414	58.8	4,572.25	78.83	4	1,075.00	5,647.25
Thigh	7	340	48.5	355.35	50.76	1	550.00	905.35
Ankle	8	282	35.00	362.95	45.37	..	.....	362.95
Knee	38	1,113	29.2	1,594.00	41.94	1	25.00	1,619.00
Hip	1	274	274.	270.75	270.75	1	750.00	1,020.75
Hand	341	5,286	15.5	7,567.94	22.19	9	2.412.50	9,980.44
Thumb	121	2,387	19.7	3,235.55	26.74	11	2,211.25	5,446.80
First finger	155	2,512	16.2	3,622.60	23.37	12	1,765.00	5,387.60
Second finger	135	2,431	18.	3,087.25	22.86	19	1,800.00	4,887.25
Third finger	69	1,082	15.6	1,577.75	22.86	4	425.00	2,002.75
Fourth finger	57	1,153	20.2	1,569.05	27.52	6	375.00	1,944.05
First and second fingers	4	99	25.	152.00	28.00	2	325.00	477.00
2nd and 3rd fingers	4	29	7.	38.05	9.51	..	.....	38.05
3rd and 4th fingers	8	160	20.	212.55	26.57	1	187.50	400.05
Four fingers	2	63	31.5	66.70	33.35	1	200.00	266.70
Thumb and one finger	5	137	27.4	226.30	45.26	1	262.50	488.80
Thumb and two fingers	1	28	28.	56.55	56.55	..	.....	56.55
Wrist	33	726	22.	1,020.50	30.92	1	300.00	1,320.50
Forearm	19	363	19.	506.95	26.68	..	.....	506.95
Elbow	6	250	41.6	323.75	53.96	..	.....	323.75
Arm	7	95	13.3	132.05	18.86	..	.....	132.05
Shoulder	1	6	6.	12.10	12.10	..	.....	12.10
Neck	1	13	13.	26.25	26.25	..	.....	26.25
Back	2	83	42.	95.75	47.87	..	.....	95.75
Buttock	1	40	40.	46.15	46.15	..	.....	46.15
Groin	1	22	22.	44.40	44.40	..	.....	44.40
Head	3	45	15.	80.50	26.83	..	.....	80.50
Scalp	1	9	9.	10.40	10.40	..	.....	10.40
Face	6	111	18.5	158.55	26.42	..	.....	158.55
Nose	1	3	3.	4.05	4.05	..	.....	4.05
Forehead	1	7	7.	10.10	10.10	1	150.00	160.10
Eye	43	619	14.4	874.50	20.33	6	2,675.00	3,549.50
Ear	1	19	19.	39.35	39.35	1	125.00	164.35
Multiple members	1	7	7.	8.65	8.65	..	.....	8.65
Totals	1,213	24,621	20.2	$33,879.34	$27.93	84	$16,813.75	$50,693.09

EXTRACT FROM

SIXTH ANNUAL REPORT, INDUSTRIAL INSURANCE DEPARTMENT, STATE OF WASHINGTON.
—CAUSES OF INFECTIONS.

Members.	No. of Bruises.	No. of Cuts.	No. of Punctures.	No. of Dislocations.	No. of Fractures.	No. of Amputations.	No. of Scalds and Burns.	No. of Poisons, Oak, etc.	Foreign Substance.	Total Number of Injuries.
Foot	19	10	24	..	..	..	3	..	..	56
First toe	7	1	3	..	..	..	..	..	..	11
One other toe	2	1	..	..	..	..	..	..	..	3
Two toes	1	..	..	..	..	..	..	..	..	1
Leg	27	17	2	..	4	..	8	..	..	58
Thigh	2	1	3	..	1	..	..	..	..	7
Ankle	5	1	..	..	..	..	2	..	..	8
Knee	13	15	9	..	..	..	1	..	..	38
Hip	..	..	..	1	..	..	..	..	..	1
Hand	75	86	172	..	1	..	4	3	..	341
Thumb	32	28	58	..	..	..	3	..	..	121
First finger	28	51	71	..	..	1	4	..	..	155
Second finger	25	30	71	..	1	..	7	1	..	135
Third finger	17	10	42	..	..	..	..	..	..	69
Fourth finger	12	17	26	..	..	1	1	..	..	57
1st and 2nd fingers	1	2	..	..	..	..	1	..	..	4
2nd and 3rd fingers	1	1	2	..	..	..	..	..	..	4
3rd and 4th fingers	2	5	1	..	..	..	..	..	..	8
Four fingers	..	1	1	..	..	..	..	..	..	2
Thumb & 1 finger	1	3	1	..	..	..	..	..	..	5
Thumb & 2 fingers	1	..	..	..	..	..	..	..	..	1
Wrist	8	7	17	..	..	..	1	..	..	33
Forearm	1	8	5	..	..	..	4	1	..	19
Elbow	5	1	..	..	..	..	..	..	..	6
Arm	2	2	2	..	..	..	1	..	..	7
Shoulder	1	..	..	..	..	..	..	..	..	1
Neck	1	..	..	..	..	..	..	..	..	1
Back	1	..	1	..	..	..	..	..	..	2
Buttock	1	..	..	..	..	..	..	..	..	1
Groin	..	..	1	..	..	..	..	..	..	1
Head	..	3	..	..	..	..	..	..	..	3
Scalp	1	..	..	..	..	..	..	..	..	1
Face	1	3	..	..	..	..	2	..	..	6
Nose	1	..	..	..	..	..	..	..	..	1
Forehead	..	1	..	..	..	..	..	..	..	1
Eye	6	4	..	..	..	..	..	..	33	43
Ear	..	..	..	..	..	..	1	..	..	1
Multiple members	..	..	..	..	..	..	..	1	..	1
Totals	300	309	512	1	7	2	43	6	33	1,213