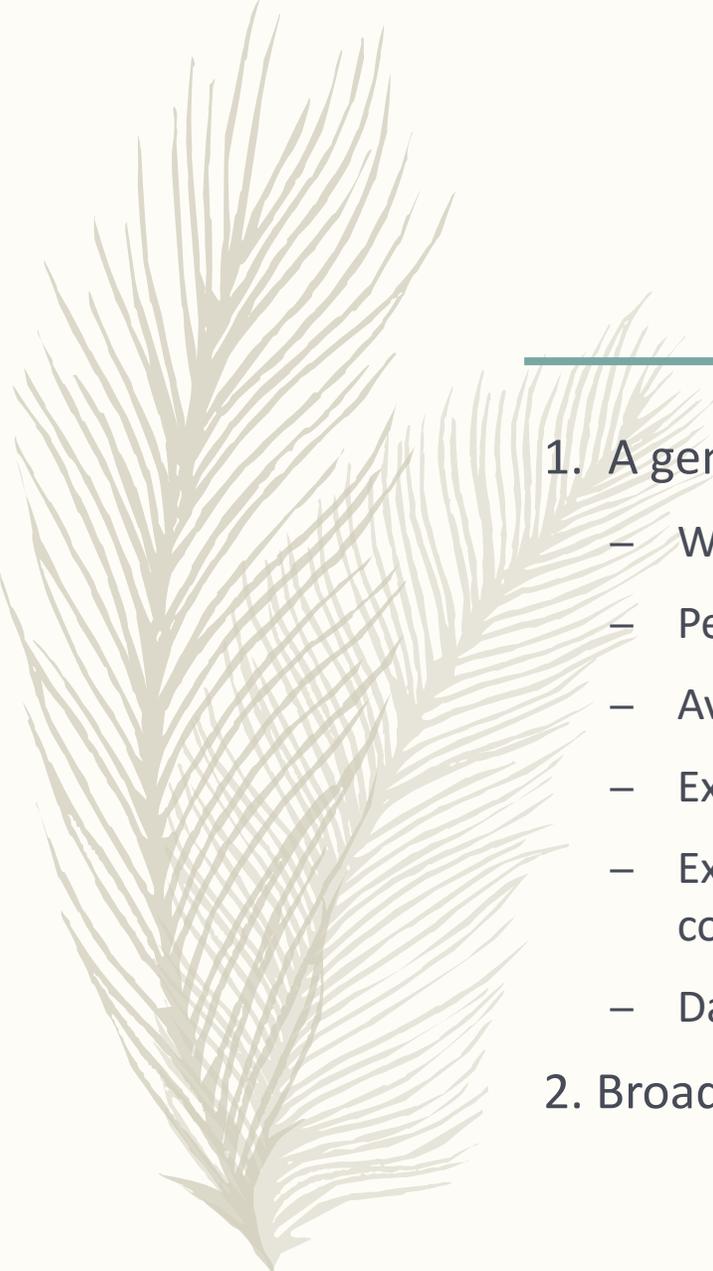


The background is a vibrant blue digital scene. On the left, a portion of a globe is visible, showing continents and oceans. The right side of the image is dominated by a bright, glowing light source that creates a lens flare and illuminates the scene. Below the light, there are several layers of binary code (0s and 1s) that appear to be floating or scrolling across the space. The overall effect is one of high-tech, data-driven digital connectivity.

# Modelling in Light of COVID-19

Terry Narine FSA, FCIA



# *EXECUTIVE SUMMARY*

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1. A generalized model for use in pandemic modelling for life insurance:
  - Worldwide model to predict extra deaths as a result of COVID-19
  - Peer reviewed by other actuaries
  - Available on the SOA and Canadian Institute of Actuaries' (CIA) websites
  - Excel-based model will little input required
  - Extra Deaths are illustrated per 100,000 by age and sex and in total by age for the country selected.
  - Data taken from Johns Hopkins, CDC, WHO and Stats Canada.
2. Broader issues and ideas related to pandemic modelling: Q&A

# CAVEATS

- 
- 
- All models are wrong (some models are useful)
  - A model is only as good as the input
  - Use care when using this generalized model (as in any model)
  - The author takes no responsibility for the accuracy or completeness of the data provided
  - This model may not be sold for commercial purposes and is free for all actuaries to use
  - This model may not be modified without the author's permission
  - Contact: [terrinarine@actuwit.com](mailto:terrinarine@actuwit.com)

# LIVE DATA

iso_code	location	date	total_cases	new_cases	new_cases_smoother	total_deaths	new_deaths	new_deaths_smoother	total_cases_per_million	new_cases_per_million	new_cases_smoother_per_million	total_deaths_per_million	new_deaths_per_million
AFG	Afghanistan	2020-09-09	38520	26	45	1418	3	1.714	989.51	0.668	1.156	36.426	0.077
ALB	Albania	2020-09-09	10553	147	135.286	321	2	4.429	3667.037	51.081	47.01	111.544	0.695
DZA	Algeria	2020-09-09	46938	285	300.714	1571	9	7.571	1070.396	6.499	6.858	35.826	0.205
AND	Andorra	2020-09-09	1261	0	11	53	0	0	16320.46	0	142.367	685.951	0
AGO	Angola	2020-09-09	2981	16	46.714	120	3	1.714	90.701	0.487	1.421	3.651	0.091
AIA	Anguilla	2020-09-09	3	0	0	0	0	0	199.973	0	0	0	0
ATG	Antigua and Barbuda	2020-09-09	95	0	0.143	3	0	0	970.1	0	1.459	30.635	0
ARG	Argentina	2020-09-09	487994	9215	10038.86	10179	267	207	10797.34	203.891	222.119	225.22	5.908
ARM	Armenia	2020-09-09	44953	108	153.571	903	3	3.143	15170.25	36.447	51.826	304.735	1.012
ABW	Aruba	2020-09-09	2589	107	69.286	15	0	0.714	24249.29	1002.192	648.949	140.494	0
AUS	Australia	2020-09-09	26374	52	79.286	770	8	16.143	1034.279	2.039	3.109	30.196	0.314
AUT	Austria	2020-09-09	30200	325	351.286	747	1	1.857	3353.171	36.085	39.004	82.941	0.111
AZE	Azerbaijan	2020-09-09	37557	139	139.857	552	1	2.286	3704.148	13.709	13.794	54.442	0.099
BHS	Bahamas	2020-09-09	2657	72	54.429	63	4	2.429	6756.551	183.091	138.408	160.204	10.172
BHR	Bahrain	2020-09-09	56076	0	586.286	202	2	1.714	32955.2	0	344.553	118.713	1.175

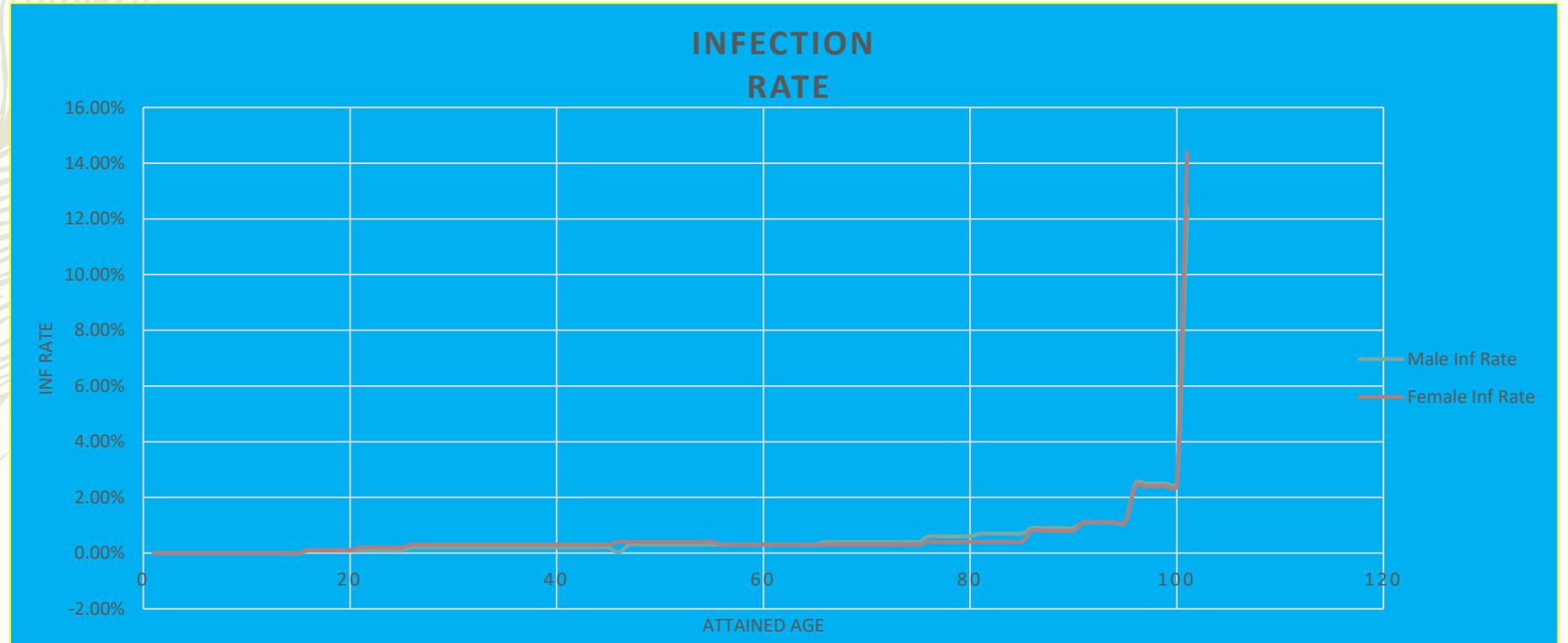
# RAW DATA



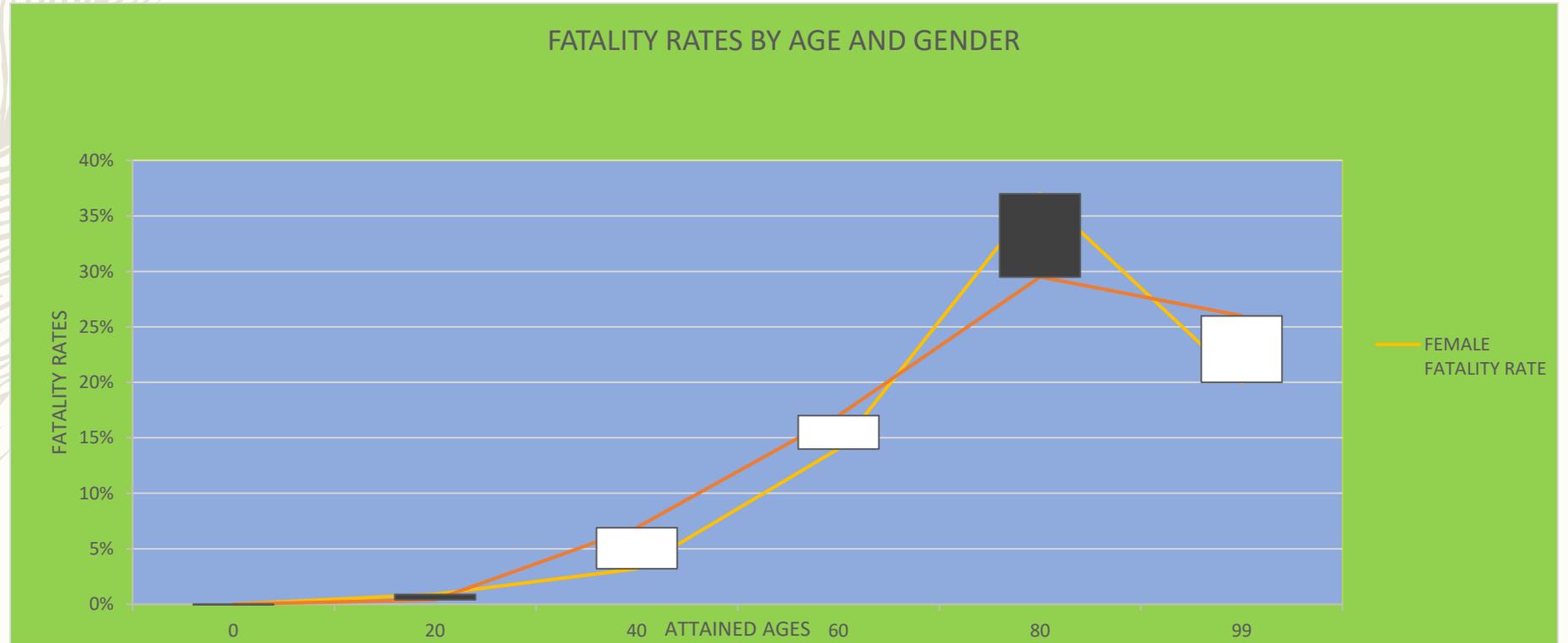
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Age	Female Inf Rate	Male Inf Rate		Age	Female Fatality rate	Male Fatality Rate
70	0.30%	0.40%		70	21.50%	26.30%
71	0.30%	0.40%		71	21.50%	26.30%
72	0.30%	0.40%		72	21.50%	26.30%
73	0.30%	0.40%		73	21.50%	26.30%
74	0.30%	0.40%		74	21.50%	26.30%
75	0.40%	0.60%		75	28.10%	29.60%
76	0.40%	0.60%		76	28.10%	29.60%
77	0.40%	0.60%		77	28.10%	29.60%
78	0.40%	0.60%		78	28.10%	29.60%
79	0.40%	0.60%		79	28.10%	29.60%
80	0.40%	0.70%		80	37.00%	29.50%
81	0.40%	0.70%		81	37.00%	29.50%
82	0.40%	0.70%		82	37.00%	29.50%
83	0.40%	0.70%		83	37.00%	29.50%
84	0.40%	0.70%		84	37.00%	29.50%
85	0.80%	0.90%		85	32.50%	35.80%
86	0.80%	0.90%		86	32.50%	35.80%
87	0.80%	0.90%		87	32.50%	35.80%

# *INFECTION RATE*



# FATALITY RATES



# COUNTRY FATALITY RATE



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Country	Infections	Deaths	Fatality Rate
Afghanistan	38520	1418	3.68%
Albania	10553	321	3.04%
Algeria	46938	1571	3.35%
Andorra	1261	53	4.20%
Angola	2981	120	4.03%
Anguilla	3	0	0.00%
Antigua and Barbuda	95	3	3.16%
Argentina	487994	10179	2.09%
Armenia	44953	903	2.01%
Aruba	2589	15	0.58%
Australia	26374	770	2.92%
Austria	30200	747	2.47%
Azerbaijan	37557	552	1.47%
Bahamas	2657	63	2.37%
Bahrain	56076	202	0.36%
Bangladesh	329251	4552	1.38%
Barbados	180	7	3.89%
Belarus	73208	721	0.98%
Belgium	89047	9912	11.13%
Belize	1361	16	1.18%
Benin	2213	40	1.81%

# POPULATION DATA

US Popn by age latest census

(000's)

Age	Both sexes		Male		Female	
	Number	Percent	Number	Percent	Number	Percent
All ages	324,356	100.0	159,028	100.0	165,328	100.0
Under 5 years	19,736	6.1	10,094	6.3	9,642	5.8
5 to 9 years	20,212	6.2	10,328	6.5	9,884	6.0
10 to 14 years	20,827	6.4	10,650	6.7	10,177	6.2
15 to 19 years	20,849	6.4	10,545	6.6	10,304	6.2
20 to 24 years	21,254	6.6	10,716	6.7	10,538	6.4
25 to 29 years	23,277	7.2	11,792	7.4	11,485	6.9
30 to 34 years	21,932	6.8	10,935	6.9	10,997	6.7
35 to 39 years	21,443	6.6	10,629	6.7	10,814	6.5
40 to 44 years	19,584	6.0	9,628	6.1	9,956	6.0
45 to 49 years	20,345	6.3	9,993	6.3	10,351	6.3
50 to 54 years	20,355	6.3	9,930	6.2	10,425	6.3
55 to 59 years	21,163	6.5	10,046	6.3	11,117	6.7
60 to 64 years	20,592	6.3	9,819	6.2	10,773	6.5
65 to 69 years	17,356	5.4	8,198	5.2	9,158	5.5
70 to 74 years	14,131	4.4	6,691	4.2	7,440	4.5
75 to 79 years	9,357	2.9	4,233	2.7	5,124	3.1
80 to 84 years	6,050	1.9	2,519	1.6	3,532	2.1
85 years and over	5,893	1.8	2,282	1.4	3,611	2.2
Under 15 years	60,774	18.7	31,072	19.5	29,703	18.0
15 to 17 years	13,018	4.0	6,656	4.2	6,363	3.8
18 to 20 years	11,851	3.7	5,931	3.7	5,920	3.6
21 to 44 years	103,469	31.9	51,658	32.5	51,811	31.3
45 to 64 years	82,455	25.4	39,789	25.0	42,666	25.8
65 years and over	52,788	16.3	23,923	15.0	28,865	17.5
Median age	38.3	(X)	37.1	(X)	39.5	(X)

# *Input Area*

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<b><i>Input Section</i></b>	
<b>Input</b>	
Country	Canada
Final Total Pop'n Infection Rate	0.350%
Female Insured to Pop'n Adjustment	0.682
Male Insured to Pop'n Adjustment	0.630

# STATISTICS



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Statistics:	
Deaths	9,153
Fatality rate	6.84%
Infections	133,748
Population	37,411,047
Country infection rate	0.3575%
World fatality rate	3.2528%
Worldwide Deaths	898,087
Worldwide Infections	27,609,408

# CRUDE DEATHS

Age	C-19 Projected Crude Deaths	C-19 crude female fatality rate by age distribution	C-19 crude male fatality rate by age distribution	C-19 crude female infections by age distribution	C-19 crude male infections by age distribution
57	452	9.1%	14.3%	0.3%	0.3%
58	448	9.1%	14.3%	0.3%	0.3%
59	435	9.1%	14.3%	0.3%	0.3%
60	536	14.0%	17.0%	0.3%	0.3%
61	528	14.0%	17.0%	0.3%	0.3%
62	503	14.0%	17.0%	0.3%	0.3%
63	479	14.0%	17.0%	0.3%	0.3%
64	461	14.0%	17.0%	0.3%	0.3%
65	792	19.5%	24.2%	0.3%	0.4%
66	767	19.5%	24.2%	0.3%	0.4%
67	748	19.5%	24.2%	0.3%	0.4%
68	742	19.5%	24.2%	0.3%	0.4%
69	731	19.5%	24.2%	0.3%	0.4%
70	659	21.5%	26.3%	0.3%	0.4%
71	619	21.5%	26.3%	0.3%	0.4%
72	597	21.5%	26.3%	0.3%	0.4%
73	563	21.5%	26.3%	0.3%	0.4%
74	509	21.5%	26.3%	0.3%	0.4%
75	814	28.1%	29.6%	0.4%	0.6%
76	747	28.1%	29.6%	0.4%	0.6%
77	706	28.1%	29.6%	0.4%	0.6%
78	657	28.1%	29.6%	0.4%	0.6%
79	608	28.1%	29.6%	0.4%	0.6%

# *EXTRA DEATHS PER 100,000*



Age	Female proportion of C-19 crude insured deaths per 100,000 lives	Male proportion of C-19 crude insured deaths per 100,000 lives	Total C-19 estimated crude insured deaths per 100,000 lives
57	15	22	18
58	15	22	18
59	15	22	18
60	23	26	25
61	23	26	25
62	23	26	25
63	23	26	25
64	23	26	25
65	32	49	41
66	32	49	41
67	32	49	41
68	32	49	41
69	32	49	41
70	36	54	44
71	36	54	44
72	36	54	44
73	36	54	44
74	36	54	44
75	62	91	75
76	62	91	75
77	62	91	75
78	62	91	75
79	62	91	75
80	82	105	92
81	82	105	92



# *FOR CONSIDERATION*

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- Update LiveData for latest information
- Replace US population data with census data of other countries except Canada
- Crude deaths ratio country fatality rate to US fatality rate
- Extra Deaths not mortality rate
- Upcoming research will give breakdown by province and Toronto, Montreal, Vancouver
- Use with valuation and pricing models
- Testing with ORSA models

# Links

## **Links to Useful Information**

<https://www.soa.org/globalassets/assets/files/resources/research-report/2020/connecting-emerging-covid-19.pdf>

provides insured to population influenza ratios broken down by sex

<https://ourworldindata.org/covid-deaths>

provides the live data

[https://ccs.ca/images/Guidelines/Tools\\_and\\_Calculators\\_En/FRS\\_eng\\_2017\\_fnl1.pdf](https://ccs.ca/images/Guidelines/Tools_and_Calculators_En/FRS_eng_2017_fnl1.pdf)

<https://www.worldometers.info/coronavirus/coronavirus-age-sex-demographics/>

provides Coronavirus parameters

<https://www.businessinsider.com/coronavirus-death-age-older-people-higher-risk-2020-2>

<https://epidemic-stats.com/coronavirus/>

provides Coronavirus statistics

<http://weekly.chinacdc.cn/en/article/id/e53946e2-c6c4-41e9-9a9b-fea8db1a8f51>

CDC China data on infections and death by age for China, Wuhan and Hubei province



# *INSURANCE IMPACTS*

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- Auto insurance
- Business Interruption
- Health products
- Travel Insurance
- Investments
- Directors and Officers
- Capital
- Overall cost to the insurance industry
- Profitability impacts



# **INSURANCE IMPACTS** **CONTINUED**

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- General Insurance
- Surety
- Medical malpractice
- Sales
- Unemployment
- Operations
- Claims
- Underwriting
- Actuarial



# **HEALTH INSURANCE** **EFFECTS**

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- Increased claims – higher frequency and severity
- Delayed claims
- Currently issued policies did not price COVID-19 into the premium
- Deferral of policyholder premiums
- Delays in cancellation
- Liquidity challenge – delays in premium while trying to pay more claims
- Increased loss ratios?
- Insolvency?

# *ROLE OF THE ACTUARY*

- 
- 
- Collect and manage data
  - Quantify the impact of COVID-19 when pandemic ends
  - Compare 2019 to 2020
  - Include in Stress Testing and ORSA work
  - Pricing and valuation
  - New products – Corona coverage
  - Additions to existing products
  - Pay-as-you-drive

# *Q&A / DISCUSSION*

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# *Q&A / DISCUSSION*

