

COVID-19
(SARS-coV-2)

WHAT WE KNOW, WHAT WE DON'T AND
HOW TO BRIDGE THE GAP

WHERE WE GO FROM HERE

**IF DATA COULD SPEAK: PERSPECTIVES TO INFORM PUBLIC POLICY
AND ANYONE WITH AN INTEREST IN APPROACHABLE DATA SCIENCE**



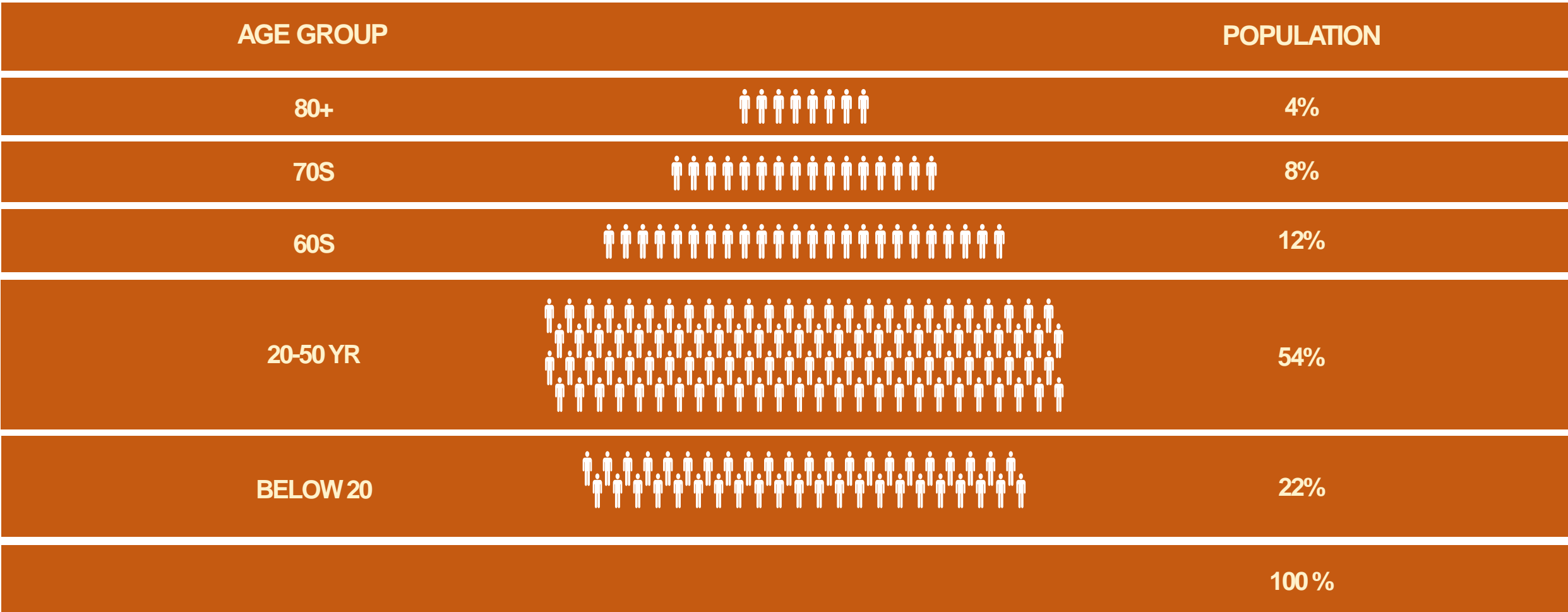
Jean-Manuel De Bané, MBA Ivey

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Perspectives in this paper are solely those of the author who found himself momentarily with more time than usual to analyze this complex global tragedy. The views presented herein should not be construed as official projections. Modeling estimates and projections are based on available data at a point in time and are subject to change. Prepared with love for friends, family, and everyone with an interest in developing a better comprehension of the challenges we face and explore some of the potential paths forward. Hoping this effort also adds value to the public policy reflection as we assess our options to properly mitigate this crisis.

WELCOME TO CANADA, OUR COUNTRY HAS A NICE CURVY SHAPED DEMOGRAPHIC



IF THE VIRUS SPREADS TO 10% OF THE POPULATION, WHICH AGE GROUP IS MORE LIKELY TO BE CONTAMINATED?

NO AGE GROUP IS MORE OR LESS LIKELY TO CATCH COVID-19. IT'S 100% BASED ON PROXIMITY WITH AN INFECTED PARTY OR HAVING BEEN IN CONTACT WITH A CONTAMINATED SURFACE.

80+ 10% OF THIS GROUP



70S 10% OF THIS GROUP



60S 10% OF THIS GROUP



20-50 YR 10% OF THIS GROUP



BELOW 20 10% OF THIS GROUP*

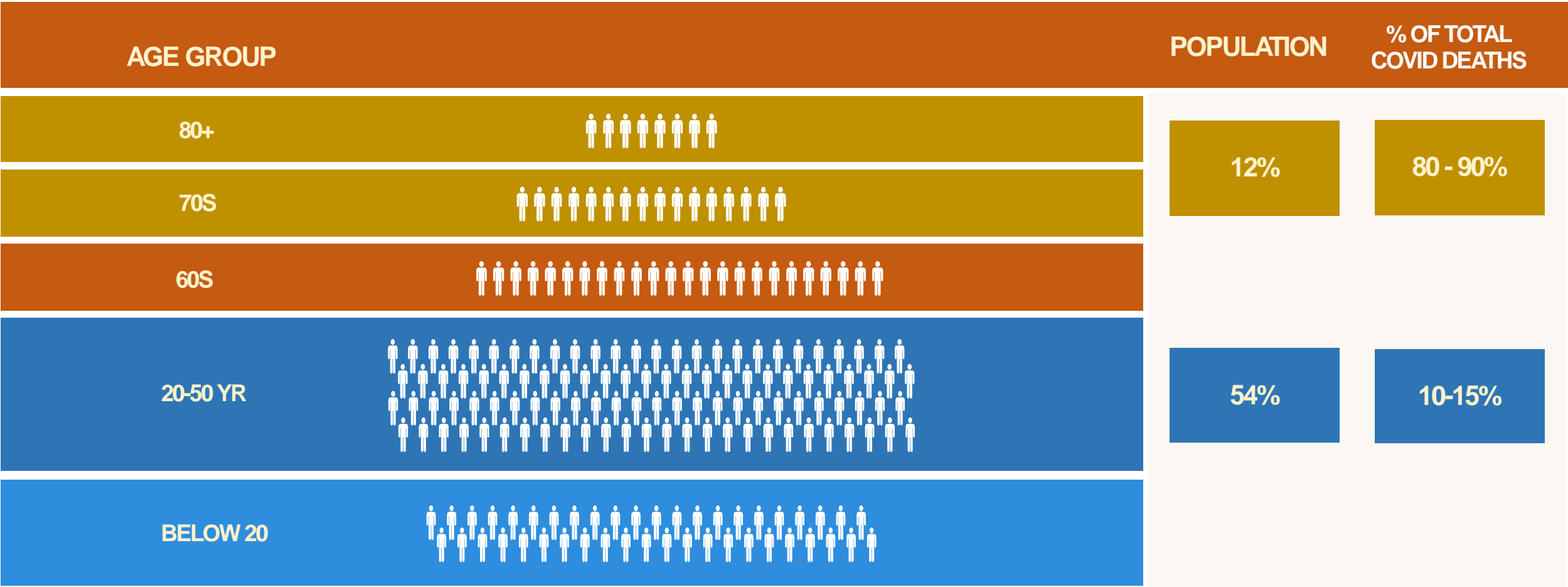


WE CATCH IT EQUALLY BUT WE DON'T DIE EQUALLY

MORTALITY ESTIMATES @ 10% INFECTION RATE

AGE GROUP	LIVES TAKEN	COVID-19 RELATED DEATHS	NATURAL CAUSES DEATHS
80+	2/3 OF 1% OF THIS AGE GROUP	12K	145K
70S	1/3 OF 1% OF THIS AGE GROUP	8K	60K
60S	1/10 OF 1% OF THIS AGE GROUP	2.5K	40K
20-50 YR	1/50 TH OF 1% OF THIS AGE GROUP	3.4K	34K
BELOW 20	Less than .01% OF THIS AGE GROUP	ALMOST NONE	3K
POP 37.6M		➡ 22-27K	➡ 285K

COVID-19 CASUALTIES ARE INVERSELY PROPORTIONAL WITH AGE GROUP DEMOGRAPHICS



MODELING PROJECTIONS ARE SUBJECT TO CHANGE AS NEW INFORMATION BECOMES AVAILABLE.
RISK OF COMPLICATIONS, RISK OF DEATH, IMPACT BY AGE GROUP & HEALTH PROFILE WILL VARY BY COUNTRY, CIRCUMSTANCES
AND MEDICAL CAPABILITY / CAPACITY TO RESPOND.

IT'S EASY TO LOSE SIGHT THAT MOST WILL MAKE IT THROUGH
ESTIMATES @ 10% INFECTION RATE

AGE GROUP	COVID-19 INFECTED	SURVIVED	%
80+	162K	150K	93%
70S	300K	290K	97%
60S	460K	457K	99%+
20-50 YR	2M	2M*	99%+
BELOW 20	813K	813K*	ALMOST 100%
	➡ 3.76M	➡ 3.73M	➡ 99% +/-

CASUALTIES: CFR, IRF AND CAUSE OF DEATH

THOSE WHO DIED:



THE VAST MAJORITY
ABOVE 70 YRS OLD

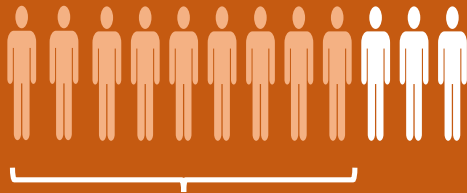


THE MINORITY
LESS THAN 69 YEARS OLD



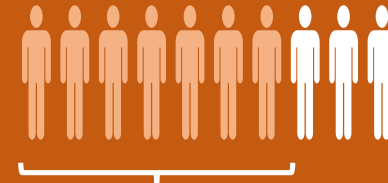
PRESENCE OF HEALTH COMPLICATIONS BEFORE CONTRACTING COVID-19

THOSE WHO DIED



THE MAJORITY

ABOVE 70 YRS OLD



THE MAJORITY

LESS THAN 69 YEARS OLD



ALMOST EVERYONE

LET'S ANALYZE THE WAY WE REPORT THE RISK OF DYING: CFR VS IFR

DEFINITIONS

CFR THE CASE FATALITY RATE

If we open **10** “cases” and **2** people die, the CFR is $2/10 = 20\%$

CFR **20%**



IFR THE INFECTION FATALITY RATE

This is a much more accurate measure.

If we take the same example, we have **2** deaths, we open **10** cases and we may have **20** people who were infected but **not** tested.

IFR **7%**



IFR is $2 / 30 = 7\%$ VS **20%** CFR

MOST OF THE CASUALTIES HAD PRE-EXISTING CONDITIONS
LET’S REVISE THE WEIGHTED RISK OF DYING BY AGE GROUP (IFR)

AS REPORTED **CFR** RISK OF DYING 70 YEARS AND UP: **14%**
*BASED ON THE NUMBER OF “OPEN CASES”
(THE CFR METHOD)*

LET’S MAKE SOME ASSUMPTIONS: **250 SENIORS CONTRACTED THE VIRUS**

	N# OF CASES	DEATHS		CFR	IFR
200 IN GOOD HEALTH	5	3	➡	60%	1.5%
50 IN BAD HEALTH	<u>50</u>	<u>7</u>		<u>14%</u>	<u>14%</u>
TOTAL CASES OPEN:	55	10	➡	18%	4%

THE REAL RISK OF DYING IS VERY DIFFERENT DEPENDING ON YOUR

HEALTH PROFILE:	IFR	SURVIVAL
HEALTHY	99 %	<1%
POOR HEALTH	86%	
14%		
BLENDED MORTALITY RATE BY AGE GROUP IS MISLEADING		

REPORTED AVG RISK OF DYING: **18%** REAL RISK OF DYING: **4%**
WITH CFR, THE **HEALTHY** FOLKS HAVE AN EVEN GREATER CHANCE OF DYING.

DURING THE **SARS** OUTBREAK, THE **CFR** PROJECTIONS WERE **10 TIMES HIGHER** THAN THE ACTUAL **IFR**.
COVID-19 OFFICIAL CFR PROJECTION (W.H.O.) IS CURRENTLY **3.6%**. ICELAND TEST MORE THAN ANY OTHER COUNTRY AND THEIR CURRENT CFR IS **ONE FIFTH OF ONE PERCENT (.2%)**

WE BUSTED THE CFR BIAS WHICH UNDERESTIMATES SURVIVAL RATES
BUT WE'RE NOT OUT OF THE WOOD YET

MODELING A 10% OUTBREAK IN A COUNTRY LIKE CANADA

AGE GROUP	COVID-19 RELATED DEATHS	NATURAL DEATHS LEVELS EXCLUDING COVID-19	INCREMENTAL? % DIE WITH COVID-19 VS DUE TO COVID-19?
80+	12K	145K	LESS INCREMENTAL
70S	8.6K	60K	LESS INCREMENTAL
60S	2.6K	40K	MORE INCREMENTAL
OTHERS	3.5K	35K	MORE INCREMENTAL

27K POTENTIAL DEATHS IS SIGNIFICANT BUT WE CAN'T ATTRIBUTE ALL DEATHS TO COVID-19 ESPECIALLY
IN THE HIGHER AGE POPULATION BRACKETS.
PEOPLE DO DIE WITH COVID-19 BUT NOT ALL DIE BECAUSE OF COVID-19.

EVERY DEATH IS A TRAGEDY

- WE MUST SAVE AS MANY LIVES AS WE CAN
- WE MUST ALSO REMEMBER THAT THE VAST MAJORITY WILL MAKE IT THROUGH
- EARLY DETECTION / RAPID MEDICAL INTERVENTION DIRECTLY INFLUENCE SURVIVAL RATES
- BETWEEN 98% AND 99.8%* SURVIVAL RATE IS THE BEST ESTIMATE AT THIS TIME

SURVIVAL RATES SHOULD GO UP AS THE EFFORT TO IDENTIFY SUITABLE DRUGS TO COMBAT PULMONARY INFLAMMATION START DELIVERING RESULTS COMBINED WITH THE ADOPTION OF TARGETED PLASMA DONOR STRATEGIES

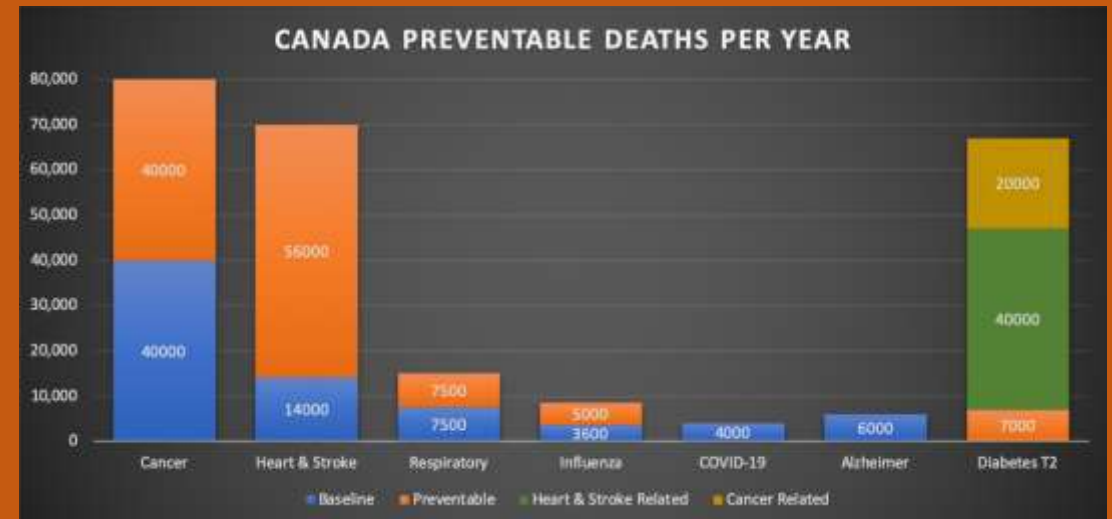
EVERY DEATH IS A TRAGEDY

FROM A PUBLIC POLICY PERSPECTIVE, ALL LIVES SHOULD HAVE AN EQUAL VALUE. IDEALLY, WE SHOULD EXERT SIMILAR EFFORT TO REDUCE ALL PREVENTABLE, LIFE-SHORTENING TRAGEDIES: CANCER, DIABETES, HEART DISEASES, COVID-19, OTHER VIRUSES, ETC.

WE MUST BE AWARE OF THE POTENTIAL BIAS OF ASSIGNING A DIFFERENT VALUE TO NEW PREVENTABLE CASUALTIES VS THOSE ALREADY IN OUR BASELINE.

FOR EXAMPLE, THE SEASONAL FLU VIRUS KILLS BETWEEN 2,000 TO 9,000 CANADIANS EVERY YEAR.

DIABETES TYPE 2, A PREVENTABLE DISEASE, KILLS MORE CANADIAN EVERY 5 YEARS THAN THE WORST POSSIBLE SCENARIO FOR COVID-19 (@60% INFECTION RATE)

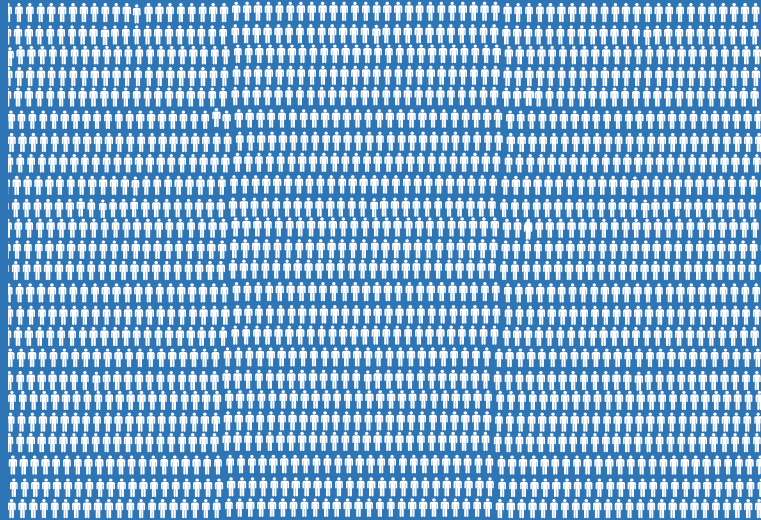


DIRECTIONAL ESTIMATES. **DIABETIC TYPE 2 PROFILES:** 25% DIE WITH THIS CONDITION, 50% OF THEM DIE FROM HEART DISEASE AND CANCER RISK IS 14 PER 100 VS 7 PER 100 FOR THE REST OF THE POPULATION

MODELED SCENARIO AT 10% INFECTION RATE

THE SURVIVORS AND NON-SURVIVORS

THOSE WHO SURVIVED: 3.7M PEOPLE



THOSE WHO DIED: 27K PEOPLE

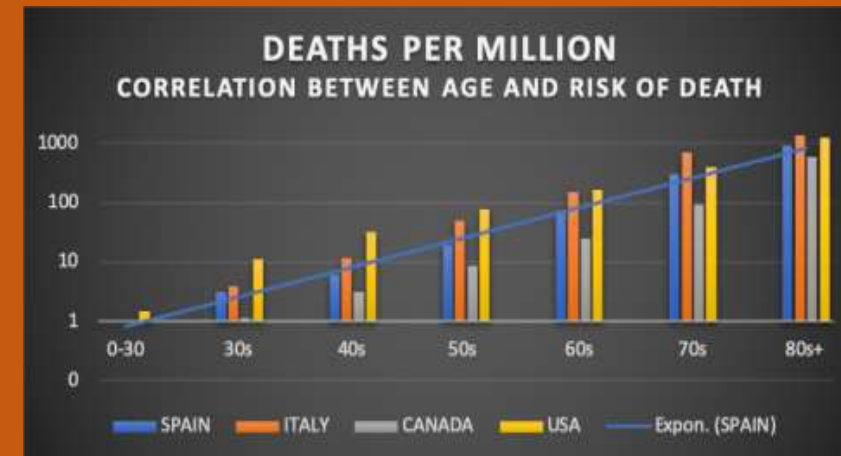


SURVIVAL RATES ARE ALWAYS HIGHER THAN REPORTED DURING AN OUTBREAK AS CASUALTIES ARE ALWAYS REPORTED BUT SURVIVORS ARE MISSED IN LARGE NUMBERS.

THE RISK IS HIGHLY CORRELATED WITH AGE

- SIMILAR TO THE PROPAGATION CURVE, THE RISK OF DEATH GROWS EXPONENTIALLY AS WELL.
- THE RISK OF DEATH INCREASES ROUGHLY BY 300% EACH DECADE.
- AS WE AGE OUR IMMUNE SYSTEM WEAKENS AND PREVALENCE OF CHRONIC DISEASES COMPOUNDS THE RISKS

RISK OF DEATH BY AGE GROUP				
APRIL 2020 (DATE AVAILABILITY DIFFER BY COUNTRY)				
	SPAIN	ITALY	CANADA	USA
DEATH PER MILLION OF SAME AGE				
Less than 30 years old	0.5	0.4	0.4	1.5
30s	3	4	1	11
40s	6	12	3	33
50s	19	51	9	78
60s	74	155	25	168
70s	316	707	92	395
80s+	934	1,406	602	1,290
Under 60	6	15	3	21
60 and over	361	653	150	434
60s & 70s	195	431	59	281
Average	97	202	38	113



WHY EVERYONE IS TRYING TO “KNOCK” THE CURVE DOWN

- WITHOUT INTERVENTION, EACH INFECTED PERSON TRANSMITS THE VIRUS TO 2 OTHER PEOPLE ON AVERAGE. CASES **DOUBLE** EVERY WEEK OR SO.
- IF THERE ARE **500** NEW ICU PATIENTS THIS WEEK, IT WILL BE **1000** NEXT WEEK AND **2000** IN 2 WEEKS. IT WILL CONTINUE TO GROW EXPONENTIALLY UNTIL WE TAME THE CURVE AND / OR WE REACH HERD IMMUNITY CRITICAL MASS.
- OUT OF CONTROL, CASES GROW BY **1500%** EVERY MONTH

DOUBLING EVERY WEEK, THE COUNT GROWS AT **LIGHTNING** SPEED

WEEK 0	WEEK 4	WEEK 8	WEEK 12	WEEK 16
100	800	12,000	200,000	3.2 MILLIONS

WHAT WILL IT TAKE TO “FLATTEN THE CURVE”?

- A **50% REDUCTION** IN WEEK-OVER-WEEK TRANSMISSIONS WILL YIELD THE SAME NUMBER OF NEW CASES AS THE PREVIOUS WEEK IE FLAT GROWTH.
- IT WOULD TAKE A **75% REDUCTION** IN TRANSMISSION TO ACHIEVE FLAT RESULTS FOR 2 CONSECUTIVE WEEKS.

CONSIDERATIONS FOR PUBLIC POLICY

THE ONLY THING WE KNOW FOR SURE IS THAT WE ARE IN FOR THE LONG HAUL

- THE **OPTIMISTIC** SCENARIO IS 18-24 MONTHS BEFORE A VACCINE WOULD BE WIDELY AVAILABLE.
- IN THIS CONTEXT, CONTINUATION OF A GENERALIZED PROLONGED LOCKDOWN FOR 90% OF THE POPULATION WOULD LEAD TO POSSIBLE UNREST AND **PROFOUND** SOCIO-ECONOMIC CONSEQUENCES.
- THE CURRENT PHASE (MARCH-MAY) SHOULD TURN THE CLOCK **BACK** TO THE EARLY WEEKS OF THE CRISIS.
- IN PHASE II, THE FOCUS WILL BE ON PREVENTING NEW ECLOSIONS FROM GAINING A WEEK OR TWO OF **VELOCITY**. COMPLETE VICTORY WILL ONLY BE ACHIEVED IN **PHASE III** WITH THE AVAILABILITY OF A VACCINE.

CAREFUL & GRADUAL RETURN TO NORMALCY

- **SUCCESS IN PHASE II** IS PREDICATED ON OUR ABILITY TO **NEUTRALIZE** POTENTIAL FLARE UPS WITH ABSOLUTE RESOLVE.
- IN PHASE I, PEOPLE WERE IDENTIFIED **AFTER** THEY GOT SICK, IN **PHASE II** WE MUST IDENTIFY THEM **BEFORE** THEY GET SICK WITH A HIGH LEVEL OF SUCCESS.
- WE MUST AIM FOR **95%** TRANSMISSION DETECTION IN THE WEEK THEY OCCURRED AND DIAGNOSTIC CONFIRMATION IN 24HRS OF LESS. IN PHASE ONE, WE ACHIEVED LESS THAN **15%** OVERALL DETECTION, AND A SIGNIFICANT PROPORTION IN WEEK 2.

TWO PATHS FORWARD: WE MUST PICK OUR ROUTE CAREFULLY

PATH ONE RELY ON RECURRENT AND PROLONGED GENERALIZED LOCKDOWNS TO CONTAIN PROPAGATION

- IT WILL SAVE LIVES
- IT COULD TRIGGER MASSIVE COLLATERAL DAMAGES IN ALL ASPECTS OF PEOPLE LIVES, SOCIETY AND OUR ECONOMIC SYSTEM

PATH TWO RELY ON PREEMPTIVE TESTING AND PROPER ISOLATION OF CLIENTELES MOST AT RISK. EVERYONE ELSE EMBARKS ON A GRADUAL RETURN TO NORMALCY

- STRATEGY REQUIRES EXTREMELY RIGOROUS CONTROLS TO VIRTUALLY ELIMINATE EXPOSURE RISKS OVER THE NEXT 12-18 MONTHS
- STRATEGY RELIES HEAVILY ON EARLY DETECTION SUCCESS CAPABILITIES

BOTH SCENARIOS HAVE SIMILAR LIFE-SAVING POTENTIAL AND PROPAGATION CONTROL

- SENIORS FOCUSED STRATEGIES HAVE CLOSE TO A 1:1 IMPACT ON TOTAL CASUALTIES. IF WE CAN REDUCE SENIOR'S DEATH TOLL BY 80%, WE REDUCE OVERALL DEATHS BY 70%.
- ICELAND FOLLOWS THE SECOND STRATEGY WITH IMPRESSIVE RESULTS. PROPAGATION RISKS IS EXTREMELY WELL CONTROLLED VIA STRINGENT PREEMPTIVE TESTING AND CURRENT NFR / IFR PROJECTIONS STAND AT .2% AND .1% RESPECTIVELY - SIMILAR TO SEASONAL FLU CASUALTIES.

PATH TWO

SENIORS STRATEGY (INCLUDING OTHER CLIENTELES AT RISK)

REDUCE POTENTIAL EXPOSURE TO THE VIRUS BY 95% OR MORE UNTIL A VACCINE IS AVAILABLE

- **MOST SENIORS SHOULD REMAIN UNDER “LEVEL 1” LOCK DOWN**
- **ALTERNATE DAY TESTING FOR ALL STAFF IN CONTACT WITH SENIORS**
- **REDUCED VISITS, MOVEMENTS AND ADHERENCE TO SOCIAL DISTANCING PROTOCOLS REMAIN IN PLACE**
- **WORKERS BETWEEN 45 AND 65 WITH SIGNIFICANT HEALTH ISSUES SHOULD NOT RETURN TO WORK DURING PHASE II**

GENERAL POPULATION STRATEGY

- **AIM TO ACHIEVE 95% WEEK-ONE DETECTION, 24HR RESULT AVAILABILITY AND 100% COMMUNITY TRACING VIA VARIOUS MEASURES.**
- **ACHIEVE A BALANCE OF 75/25 PREVENTIVE VS SUSPECTED CASES TESTING VIA A MULTI-PRONG TESTING STRATEGY INCLUDING BUT NOT LIMITED TO MANDATORY LARGE WORKPLACE TESTING, AD HOC PERIODIC COMMUNITY TESTING, AND ENSURE COMPLIANCE WITH ISOLATION DIRECTIVES VIA ACTIVE MONITORING AND FORCED ISOLATION WHEN WARRANTED.**
- **MANDATORY “TRACED” CONTACTS TESTING WITHIN 24HRS.**

PATH TWO-B HERD IMMUNIZATION SCENARIO

IF STRONG TESTING / DETECTION PROTOCOLS ARE NOT CONSISTENTLY APPLIED, COVID-19 WILL SPREAD AGAIN IN THE GENERAL POPULATION.

- ASSUMING THE POPULATION AT RISK HAS BEEN PROPERLY ISOLATED, WE COULD STILL ANTICIPATE AN 80% TO 90% REDUCTION IN HOSPITALIZATION INTAKES AND ASSOCIATED DEATH TOLL.
- AS COVID-19 SPREADS IN THE GENERAL POPULATION, THE HOSPITALIZATION INTAKES WILL NOT BE ELIMINATED, BUT WOULD BE AT A MUCH LOWER AND MANAGEABLE LEVEL.
- ASSUMING WE REFRAIN FROM IMPOSING ADDITIONAL LOCKDOWNS, ANY MISHAPS IN TESTING WILL TRIGGER HERD IMMUNITY WITHIN A WINDOW OF 6 MONTHS (50-70% SPREAD IN THE COMMUNITY).
- AS PARADOXICAL AS IT MAY SEEM, IF THIS SCENARIO WAS TO HAPPEN, IT MIGHT AS WELL HAPPEN SOONER THAN LATER:
 - MAINTAINING PROPER ISOLATION FOR THE POPULATION AT RISK HAS A HIGHER CHANCE OF SUCCESS IF WE CAN LIMIT ITS DURATION.
 - TESTING STRATEGY NOW INCLUDES ANTIBODIES DETECTION. THOSE WHO HAVE DEVELOPED ANTIBODIES ARE CLEARED AND CAN RETURN TO ATTEND SENIORS (PRE & POST HERD IMMUNITY).
 - ONCE WE ACHIEVE HERD IMMUNITY, RISK LEVELS DROP SUBSTANTIALLY AND WE CAN GRADUALLY RELAX CONSTRAINTS ON POPULATIONS AT RISK THAT ARE STILL UNDER LOCKDOWN.

PROTECTING SENIORS* OVER THE NEXT 18-24 MONTHS IS INDEED JOB N1

THE QUESTION IS HOW TO DO IT

WE HAVE THREE OPTIONS WHICH WE CAN COMBINE

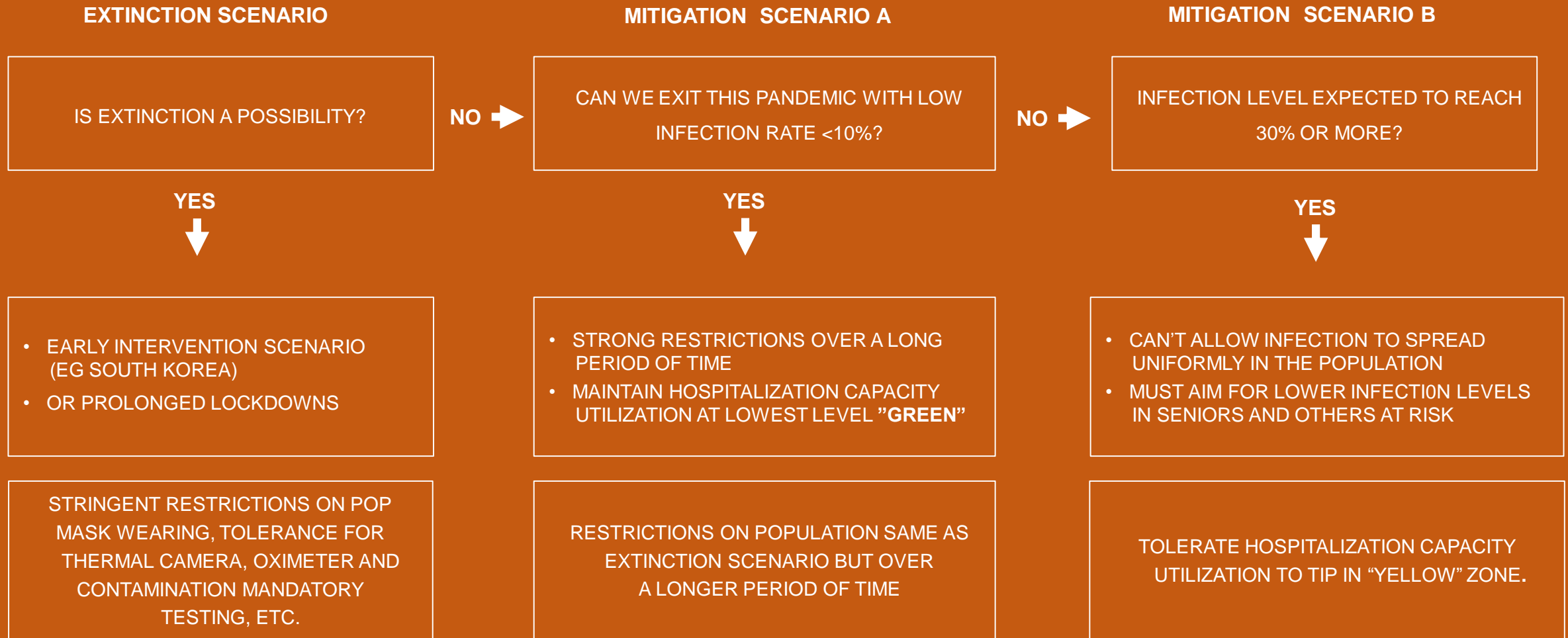
- OPTION 1: ENSURE ANYONE IN CONTACT WITH SENIORS **HAS NOT** BEEN EXPOSED TO COVID-19
- OPTION 2: ENFORCE PROACTIVE MEASURES TO PREVENT POTENTIAL SENIOR CONTAMINATION (MANDATORY MASK WEARING, MANDATORY WORK FROM HOME, ETC)
- OPTION 3: ENSURE ANYONE IN CONTACT WITH SENIORS **HAS BEEN** IMMUNIZED FROM COVID-19.

PUTTING IN PLACE ADEQUATE SENIOR SAFEGUARDS IS THE BEST WAY TO BALANCE THE TRADEOFFS BETWEEN SAVING LIVES AND ALLOWING THE MAJORITY TO RETURN TO NORMALCY.

ASSOCIATING SENIOR'S DEATH RISKS AS PRIMARILY A "LONG-TERM CARE" FACILITY PROBLEM IS SHORTSIGHTED

- DEATH TOLL WAS DISPROPORTIONALLY HIGH IN LTC FACILITIES IN MARCH-APRIL FOR TWO REASONS:
 - SENIORS IN THE GENERAL POPULATION HAD A LOWER RISK OF BEING INFECTED (MANDATED ISOLATION);
 - SENIORS CONFINED IN LTC FACILITIES HAD A MUCH HIGHER RISK OF CONTAMINATION COMPARED TO OTHER SENIORS OF THE SAME AGE AND THE GENERAL POPULATION.
- NINETY-FIVE PERCENT OF SENIORS ARE NOT IN LTCs; AS WE EASE RESTRICTIONS, DEATHS WILL RISE.
- AS WE DO IN HOCKEY, YOU DON'T SKATE TOWARDS THE PUCK, YOU GO WHERE THE PUCK WILL BE.
- SENIORS ARE ACTIVE AND IT IS ONE OF THE BIGGEST CHALLENGES AS WE REOPEN THE ECONOMY 60-65yr: 60% WORK, 66-70yr: 25% WORK. SENIORS SHOULD LIKELY REMAIN IN ISOLATION (WORK FROM HOME OR STAY HOME) UNTIL A VACCINE IS AVAILABLE.
- INITIATING A GRADUAL RETURN TO NORMALCY WITHOUT PUTTING IN PLACE STRONG SAFEGUARDS FOR ALL CITIZENS 60 YEARS AND OLDER WOULD BE RISKY.

BEST STRATEGY TO REDUCE TOTAL CUMULATIVE DEATHS DEPENDS TO A LARGE EXTENT ON FORECASTED EXIT INFECTION LEVELS (18-24 MONTHS OUT)



THE MODELING CHALLENGE

DEATH TOLL PROJECTIONS AND RISK OF DEATH (IFR)

IT IS VERY DIFFICULT TO MAKE PRECISE PROJECTIONS FOR COVID-19. WE HAVE TO START WITH WHAT WE KNOW AND USE JUDGMENT AND INFERENCES TO "BACK INTO" WHAT WE DON'T.

- WHAT WE KNOW: NUMBER OF HOSPITAL ADMISSIONS AND DEATH TOLL
- WHAT WE DON'T KNOW: THE APPROXIMATIVE NUMBER OF PEOPLE WHO HAVE CONTRACTED THE VIRUS. WHAT WE KNOW IS TREND RELATED: ACCELERATION/ DECELERATION PATTERNS, ETC.
- BASED ON WHAT WE KNOW, WE ARE LIMITED TO SHORT-TERM PROJECTIONS PERTAINING TO IMMINENT HOSPITALIZATION INTAKES AND PROBABLE CASUALTIES.
- TO ESTIMATE THE RISK OF DEATH FROM CONTRACTING THE DISEASE, WE REQUIRE DATA THAT OUR SYSTEMS DO NOT CAPTURE: THE TOTAL COUNT OF INFECTED PEOPLE THAT RELATES TO THE NUMBER OF CASES WE DO CAPTURE.
- WHEN WE HAVE TO "BACK INTO" A NUMBER, WE USE DIFFERENT PROBING METHODS WITH A VIEW TO FIND ENOUGH CONVERGING EVIDENCE TO INCREASE OUR CONFIDENCE THAT WE CAN RELY ON THE PROXIES TO PROVIDE DIRECTIONALLY CORRECT PERSPECTIVES TO INFORM DECISION MAKING.

HIGH-LEVEL MODEL OBJECTIVES

THE PRIMARY FOCUS OF THE MODELING EFFORT AROUND THE WORLD IS TRACKING PROPAGATION TRENDS WITH A VIEW TO PREDICT FUTURE HOSPITALIZATION INTAKE SPIKES AND DEATH TOLL.

THIS MODEL AIMS TO ANSWER TWO VERY DIFFERENT QUESTIONS:

- WHAT IS THE TOTAL AND ACTUAL **COUNT** OF INDIVIDUALS **INFECTED** BY THE VIRUS (+/- 20%)
- PROVIDE A REASONABLY ACCURATE **IFR** ESTIMATE BY **AGE GROUP** AND **HEALTH PROFILE**.

QUANTITATIVE VS **INFERENCE** MODELS

- MODELS SUCH AS THIS ONE AIM TO ARRIVE AT A REASONABLE ESTIMATE FOR THE SUM OF “SOMETHING” VIA **INFERENCES** AND ANALYSIS OF AVAILABLE & RELEVANT DATA / RATIOS.
- AS SUCH, WE RELY TO A GREAT EXTENT ON **JUDGMENT** AND **OBLIQUE TESTING** TO BRIDGE KNOWLEDGE GAPS.
- MIXING HARD DATA AND INFERENCES HAS THE POTENTIAL TO BE MANY TIMES MORE ACCURATE THAN RELYING ON TRACKED DATA, SUCH AS **CASE COUNT**, AND APPLYING **PLUG MULTIPLICATORS** TO DERIVE THE TOTAL INFECTED COUNT AND PROVISIONAL IFRs.
- WITH HINDSIGHT, WE'RE ALWAYS SURPRISED OF THE EXTENT TO WHICH THESE MULTIPLICATOR-BASED APPROACHES MISS THEIR TARGETS. IN THE CASE OF SARS IT WAS **1,000%**.

BASELINE: HIGH-LEVEL MODEL

CHOICE OF BASELINE TO ESTIMATE THE NUMBER OF PEOPLE WHO HAVE CONTRACTED THE VIRUS.

LEVERAGING DIAMOND PRINCESS CRUISE DATA

THE DIAMOND PRINCESS DATA IS THE ONLY EXTENSIVE DATASET WHERE WE KNOW WITH CERTAINLY THE OUTCOME DISTRIBUTION FOR A LARGE GROUP OF PEOPLE

BY AGE GROUP WE KNOW:

- HOW MANY HAD SEVERE COMPLICATIONS
- HOW MANY DIED
- HOW MANY HAD MINOR DISCOMFORT
- HOW MANY HAD NO SYMPTOMS AT ALL

THE MODEL USE THIS DATASET AS A BASELINE.

MODEL: BASELINE ADJUSTMENTS

BUILDING THE MODEL

THE DIAMOND PRINCESS DATASET IS THE BEST COMPLETE SAMPLE AVAILABLE TO ANALYZE OUTCOMES FOR A POPULATION THAT HAS CONTRACTED THE VIRUS. IT IS AN INCREDIBLY VALUABLE STARTING POINT BUT THE DATA REQUIRES ADJUSTMENTS AND CALIBRATION.

- WHILE 700 OF THE 3,700 PEOPLE ON THE SHIP CONTRACTED THE VIRUS AND ALL AGE GROUPS WERE INFECTED, THERE WERE NO CASUALTIES FOR PASSENGERS UNDER 60 YEARS OF AGE.
- WHILE DEATHS UNDER 60 REPRESENT A MINORITY OF CASUALTIES, INJECTING ZERO IN THE MODEL IS NOT APPROPRIATE BASED ON WHAT WE DO KNOW.
- WE MUST USE TRIANGULATION AND DIVERSE METHODS TO COME AS CLOSE AS POSSIBLE TO THE PROBABLE TRUTH FOR AGE GROUPS 60 AND UNDER.

MODEL: BASELINE ADJUSTMENTS

SEARCH FOR A PROPER METHODOLOGY TO ESTIMATE INFECTION COUNTS FOR AGE GROUPS UNDER / OVER 60

TESTING DIFFERENT POPULATION STRATIFICATION RATIOS TO HELP BRIDGE THE GAP BETWEEN WHAT WE KNOW AND WHAT WE DON'T FOR AGE GROUPS UNDER 60.

APPROACH 1 EXTRAPOLATION FROM POPULATION 60+ (HYPOTHETICAL EXAMPLE)

- THIS AGE GROUP: 15% OF THE POPULATION
 10% DO REQUIRE HOSPITALIZATION WHEN INFECTED
 3,000 HOSPITALIZATION COUNT TO DATE
- UNDER THIS METHOD, FOR 3,000 HOSPITALIZATIONS TO DATE, THE INFECTED LEVEL AS OF 2 WEEKS AGO WOULD HAVE BEEN 200K, INCLUDING 30K SENIORS AND 170K OTHERS.
- WE CAN USE SUCH A RATIO AS A REFERENCE POINT TO CROSS-VALIDATE WITH OTHER METHODS, INCLUDING THE MODEL OUTPUT, TO ESTIMATE TOTAL INFECTION COUNT.

MODEL: IFR BASELINE FOR POPULATION 60+

IFR - THE RISK OF DYING UNDER 60 VS ABOVE 60

FOR THE POPULATION OVER 60, OUR MODEL IS CURRENTLY CALIBRATED ON THE DIAMOND PRINCESS DATA (WEIGHTED IFR 2.55%)

	CANADIAN POPULATION (M)	IFR DIAMOND PRINCESS
60-70	4.6	0.6%
70-80	2.9	3.0%
80 AND UP	1.6	7.4%
TOTAL	9.1	2.55%

APPROACH 2 ESTIMATING TOTAL INFECTION COUNT BASED ON 60+ IFR
1,000 SENIORS DEATHS @ 2.55% = 40K SENIORS INFECTED
IF SENIORS REPRESENT 15% OF POPULATION
POPULATION INFECTION: 250K-275K (AS OF TWO WEEKS AGO)

MODEL: IFR ESTIMATES UNDER 60

IFR - THE RISK OF DYING UNDER 60 VS ABOVE 60

OUR MODEL MAKES ONE MAJOR ASSUMPTION: THE VIRUS DOES NOT DISCRIMINATE
WE ALL HAVE AN EQUAL CHANCE TO BE INFECTED

IF YOU ACCEPT THIS ASSUMPTION, THE DATA IS VERY CLEAR: THE RISK OF DYING UNDER 60 IS 95% TO 98% LOWER.
FOR EXAMPLE, IF THERE ARE 1 DEATH PER 50 INFECTED OVER 60, IT WILL BE 1 PER 1,000 UNDER 60.

IF YOU HAVE MORE PRECISE INFORMATION ON THE IFR ABOVE 60 (WHICH WE DO), YOU CAN DERIVE A PRECISE IFR RANGE UNDER 60.

IF THE IFR 60+ is:	59 & YOUNGER IFR is:
6%	.003
4%	.002
2.5%	.0012
1%	.0005

	SPAIN	BRAZIL	ITALY	CHINA*	CANADA	USA
APRIL 2020 (DATE AVAILABILITY DIFFERS BY COUNTRY)						
BELOW 60						
% POP	74%	89%	71%	84%	76%	78%
% DEATHS	5%	15%	5%	19%	5%	14%
60+						
% POP	26%	11%	29%	16%	24%	22%
% DEATHS	95%	85%	95%	81%	95%	86%
DEATHS PER MILLION OF SAME AGE						
BELOW 60	6	0.3	15	0.5	2.5	20.8
60+	361	12	653	12	150	434
OVERALL PER 1M POP	97	2	202	2	38	113
RELATIVE RISK OF DYING UNDER VS OVER 60						
FOR EVERY DEATH UNDER 60	1	1	1	1	1	1
NBR OF DEATHS ABOVE 60	60	45	45	22	59	21
% LOWER RISK OF DYING UNDER 60	98%	98%	98%	95%	98%	95%
(NOT WEIGHTED - ASSUMES 50/50 POP DIST.)						
* CHINA DEATH TOLL REFLECTS APRIL 2 2020 DATA. AGE DISTRIBUTION BASED ON CASE REPORT ISSUED MARCH 11 2020.						

MODEL: RECAP

THE DIAMOND PRINCESS IFR ADJUSTED FOR OUR POPULATION MIX IS LESS THAN 1% (.7%)

IN OTHER TERMS, IF PEOPLE ON THAT SHIP REFLECTED CANADA'S AGE MIX PROFILE, WE HAVE GOOD REASONS TO BELIEVE THAT FOR EVERY 140 CANADIANS THAT CONTRACTED THE VIRUS, 1 WOULD HAVE DIED. NOT 1 IN 5 NOR 1 IN 10, BUT RATHER 1 PER 140. THIS IS A DIRECTIONAL MODEL; COULD BE 1 PER 125 OR 160, BUT IT'S DEFINITELY NOT 1 PER 60 OR 25.

THIS BASELINE DATA PROVIDES ANOTHER ANCHOR POINT TO ESTIMATE THE TOTAL NUMBER OF INFECTED INDIVIDUALS AND RECALIBRATE OUR IFR PREDICTIONS BASED ON ADMISSIONS AND DEATH TOLL DATA.

BASED ON 1,006 DEATHS AS OF APRIL 15th AND 522 DEATHS OVER THE LAST 7 DAYS:

- THE TOTAL POPULATION INFECTION LEVEL @ .7% IFR: 125-150K CANADIANS
- CONTAGIOUS INDIVIDUALS: 60-75K AS OF TWO WEEKS PRIOR

THE DIAMOND PRINCESS BASELINE HAS BEEN ADJUSTED AS FOLLOWS:

- DISTRIBUTION OF POPULATION TO REFLECT CANADA DEMOGRAPHICS
- ADJUSTMENTS TO YOUNGER POPULATION IFR TO REFLECT BEST AGGREGATE INFORMATION AVAILABLE
METHOD MOSTLY WEIGHTED ON THE RATIO OF DEATHS UNDER VS OVER 60 PER MILLION OF POPULATION ADJUSTED FOR POPULATION MIX
- REFINEMENTS WILL CONTINUE TO BE MADE AS NEW INFORMATION BECOMES AVAILABLE
- THIS REPRESENTS A STARTING POINT AS GOOD AS WHAT ANY AI SYSTEMS COULD GIVE YOU 😊

MODEL DATA RESULTS (1 OF 2)

BASE CASE: WEIGHTED IFR: .7%

THE MODEL THE DIAMOND PRINCESS HAD 3,700 PASSENGERS ON BOARD WHEN THE CORONAVIRUS STRUCK
ONLY AVAILABLE DATASET WHERE 100% OF AN INFECTED COMMUNITY WAS STUDIED AND OUTCOME IS KNOWN FOR ALL
THE MODEL IS USING DIAMOND PRINCESS IFR OUTCOMES FOR AGE GROUPS 60+
IFRS FOR AGE GROUPS UNDER 60 WERE MODELED BASED ON AN ANALYSIS OF RELATIVE IFR DIFFERENCES BELOW VS ABOVE 60

SCENARIO ASSUMES DEATH RATE BY AGE GROUP IN LINE WITH DIAMOND PRINCESS PASSENGER OUTCOME

AGE DISTRIBUTION	PRINCESS	DEATH RATE PRINCESS TRUE IFR	CANADA	ADJUSTED IFR APPLIED TO CANADA	CANADIAN POPULATION (M)	NATURAL DEATHS NO CORONAVIRUS	TRANSMISSION RATE 10%	25%	50%	75%	DEATH DISTRIBUTION	WHO FORECAST
LESS THAN 20	1%	0.0%	22%	0.01%	8.1	3,092	81	203	406	610	0%	
20-59	41%	0.0%	54%	0.2%	20.4	34,974	3,460	8,651	17,302	25,954	13%	
60-70	25%	0.6%	12%	0.6%	4.6	40,231	2,604	6,509	13,018	19,528	10%	
70-80	27%	3.0%	8%	3.0%	2.9	60,143	8,589	21,471	42,943	64,414	32%	
80 AND UP	6%	7.4%	4%	7.4%	1.6	145,266	12,037	30,092	60,184	90,276	45%	
TOTAL	100.0%	1.7%	100.0%	0.71%	37.6	283,706	26,771	66,927	133,854	200,781	100%	3.6%

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NOTE: ANALYSIS SUBJECT TO CHANGE AS NEW DATA BECOMES AVAILABLE. ACTUAL OUTCOMES MAY DIFFER.

MODEL DATA RESULTS (2 OF 2)

MODEL PROJECTIONS AT DIFFERENT INFECTION LEVELS

CASE #1 CANADIAN PROJECTIONS BASED ON DIAMOND PRINCESS DATA
NUMBER OF DEATHS AT DIFFERENT INFECTION LEVELS. DIAMOND PRINCESS DEATH RATE (IFR) =1.7%, CANADA= .7%

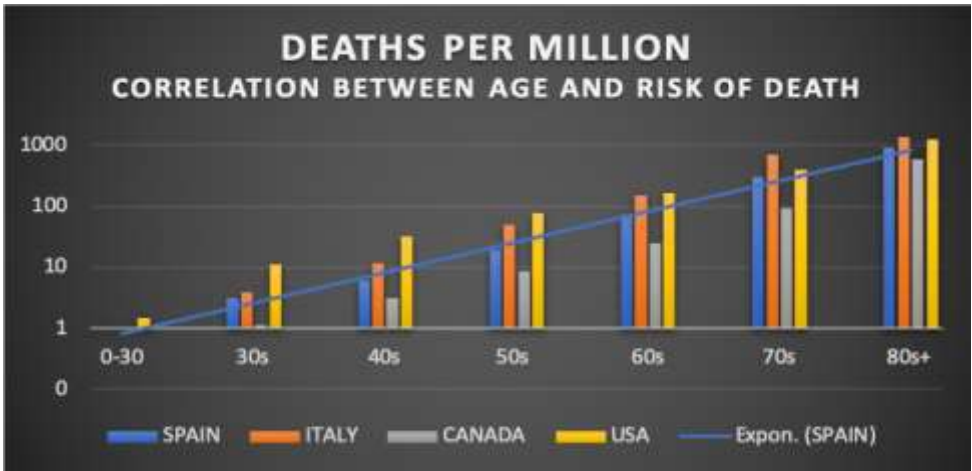
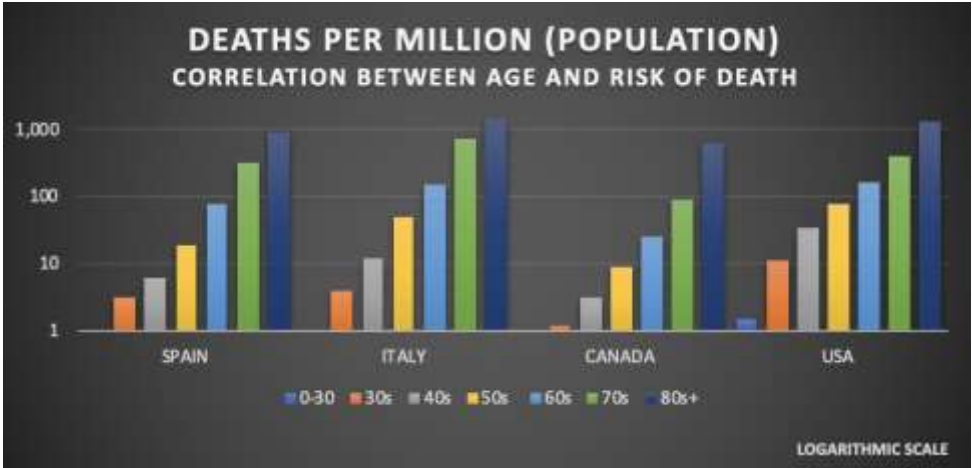
INFECTION RATE:		% POPULATION LOSS	TOTAL COVID-19 RELATED DEATHS	NATURAL DEATHS NO CORONAVIRUS	INCREMENTAL "BEST GUESS"	% INCREMENTAL	IF WE PREVENT 80% OF SENIOR'S DEATHS	INCREMENTAL	% INCREMENTAL
	75%	0.5%	200,781	283,700	96,319	48%	57,772	40,440	70%
	50%	0.4%	133,854	283,700	46,849	35%	38,514	23,109	60%
	25%	0.2%	66,927	283,700	20,078	30%	19,257	9,629	50%
	10%	0.1%	26,771	283,700	6,693	25%	7,703	3,081	40%

RELATIVE RISK OF DEATH UNDER VS OVER 60 (1OF 2)

RISK OF DEATH BY AGE GROUP

APRIL 2020 (DATE AVAILABILITY DIFFER BY COUNTRY)

	SPAIN	ITALY	CANADA	USA
DEATH PER MILLION OF SAME AGE				
Less than 30 years old	0.5	0.4	0.4	1.5
30s	3	4	1	11
40s	6	12	3	33
50s	19	51	9	78
60s	74	155	25	168
70s	316	707	92	395
80s+	934	1,406	602	1,290
Under 60	6	15	3	21
60 and over	361	653	150	434
60s & 70s	195	431	59	281
Average	97	202	38	113



NOTE: NOT SUITABLE FOR DEATH TOLL COMPARISON BETWEEN COUNTRIES DUE TO TIMING DIFFERENCES IN DATA AVAILABILITY.
ONLY THE RATIOS BETWEEN AGE GROUPS ARE RELEVANT FOR THIS ANALYSIS.

RELATIVE RISK OF DEATH UNDER VS OVER 60 (2 OF 2)

RELATIVE RISK FOR THE POPULATION OVER 30 VS UNDER 30 YEARS OLD

EG 3 = 3 TIMES MORE RISK OF DEATH VS 30 YEARS OLD AND YOUNGER

	SPAIN	ITALY	CANADA	USA
HOW MANY TIMES "MORE RISK OF DEATH" VS UNDER 30 YEARS OLD				
40s vs <30	3	6	4	5
50s vs <30	11	24	11	12
60s vs < 30	41	72	33	27
70s vs < 30	176	329	120	62
80s+ vs < 30	520	655	784	204
60 and older vs 30 and younger	201	304	195	69
60s & 70s vs less than 60	32	30	21	12

NOTE: NOT SUITABLE FOR DEATH TOLL COMPARISON BETWEEN COUNTRIES DUE TO TIMING DIFFERENCES IN DATA AVAILABILITY.
ONLY THE RATIOS BETWEEN AGE GROUPS ARE RELEVANT FOR THIS ANALYSIS.

CURVE FLATTENING CHALLENGE (1 OF 2)

MODEL INPUT

POPULATION:	37,600,000
WEEKLY INFECTION RATE:	200%
COMPLICATION RATE:	2%
DEATH RATE	1%

FLATTENING THE CURVE	EVOLUTION PER WEEK										
	BASELINE	1	2	4	8	12	13	14	15	16	17
CURRENTLY CONTAGIOUS	0	100	200	800	12,800	204,800	409,600	819,200	1,638,400	3,276,800	6,553,600
NEW CASES (INFECTED)	100	200	400	1,600	25,600	409,600	819,200	1,638,400	3,276,800	6,553,600	13,107,200
CASES CUMULATIVE	100	300	700	3,100	51,100	819,100	1,638,300	3,276,700	6,553,500	13,107,100	26,214,300
NEW COMPLICATIONS THIS WEEK			2	8	128	2,048	4,096	8,192	16,384	32,768	65,536
ALL ACTIVE COMPLICATIONS @ 14 DAY HOSPITALIZATION			2	14	254	4,094	8,190	16,382	32,766	65,534	131,070
COMPLICATIONS CUMULATIVE			2	22	494	8,166	16,356	32,738	65,504	131,038	262,108
POPULATION - INFECTIONS %	0%	0%	0%	0%	0%	2%	4%	9%	17%	35%	70%
INFECTIONS CUMULATIVE	100	300	700	3,100	51,100	819,100	1,638,300	3,276,700	6,553,500	13,107,100	26,214,300
DEATHS				6	126	2,046	4,094	8,190	16,382	32,766	65,534
DEATHS AS PERCENTAGE OF POPULATION				0%	0%	0%	0%	0%	0%	0.1%	0.2%

CURVE FLATTENING CHALLENGE (2 OF 2)

ONE TIME KNOCKDOWN: MAINTAINING FLAT RESULTS

	BASELINE	WEEK 2	WEEK 3	WEEK 4
BASELINE				
NEW COMPLICATIONS PER WEEK	64	128	256	512
CURRENTLY CONTAGIOUS	1,600	3,200	6,400	12,800
REDUCTION IN TRANSMISSIONS TO MAINTAIN ZERO GROWTH				
1 week	50%	1,600		
2 weeks		75%	1,600	
3 weeks			88%	1,600