Midterm Project
Kaipeng Wu

Abstract:

COVID-19 pandemic changed the lives of people over the world. And now more than half of the US resident took the COVID-19 vaccine. Also, the COVID-19 evolved into different variants which have different infection rate and death rate. In order to find out if COVID vaccines works well in different vaccines and during different COVID variants, I use the date from National COVID Cohort Collaborative(N3C) to analysis. For all patients, male have higher death rate after Covid-19 than female. Elder patients have lower infection rate but high death rate after Covid-19. Asian have the lowest infection and Hispanic/Latino have the lowest death rate. People in Midwest region have highest infection rate and lowest death rate. People in South region have highest death rate and people in Northeast region have lowest infection rate. For all different kinds of variants, the Death rate of the Infected patients unvaccinated patients is higher than vaccinated patients. The death rate of pre-Delta period patients is the highest and the death rate of Omicron period patients is relatively lowest. During the Omicron periods, the COVID patients who took the vaccine have nearly the same death rate of uninfected patients.During the pre-Delta period, US did not provide booster shot. So there is no date of booster vaccine patientes during pre-Delta periods.The infection rate during Omicron periods is higher than other variants in most cases. Patients who take partial vaccine (1dose) have lower infection rate than full vaccine (2 dose) during Omicron period. The death rate during Omicron periods is higher than other variants in most cases. Patients who take partial Moderna Vaccine(1 dose) and Full Janssen Vaccine(1 dose) have higher death rate during pre-Delta periods.

Introduction:

COVID-19 pandemic changed the lives of people over the world. And now more than half of the US resident took the COVID-19 vaccine. Also, the COVID-19 evolved into different variants which have different infection rate and death rate.
In order to find out if COVID vaccines works well in different vaccines and during different COVID variants, I use the date from National COVID Cohort Collaborative(N3C) to analysis.

Methods:

We define our vaccinate cases as patients who receive Pfizer-BioNTech COVID-19 vaccine between December 11, 2020 to June 30, 2022 or Moderna Vaccine between December 18, 2020 toJune 30, 2022 or Johnson & Johnson's Janssen COVID-19 vaccine between February 27, 2021 to June 30, 2022. The Booster dose defined as patients who received three doses which each separate 20 days apart or had booster dose in record.

Diabetes patients were defined as any of the Type 2 diabetes mellitus, Type 1 diabetes mellitus and Gestational diabetes mellitus recorded in condition file.

We followed N3C COVID-19 diagnosis definitions. Patients had positive test result in any of the COVID-19 test (including) in measurement file or had recorded as SARS-COVID-2 (OR) in condition file.

National COVID Cohort Collaborative (N3C), an open science community focused on analyzing patient-level data from many clinical centers to reveal patterns in COVID-19 patients. (https://covid.cd2h.org/about). The N3C Data Enclave is a secure platform through which harmonized clinical data provided by our contributing members are stored. The Enclave includes demographic and clinical characteristics of patients who have been tested for or diagnosed with COVID-19, and further information about the strategies and outcomes of treatments for those suspected or confirmed to have the virus. Additional data from individuals infected with pathogens such as SARS 1, MERS, and H1N1 are also included to support comparative studies. For more information on the inclusion and exclusion criteria, see the N3C Phenotype. (https://covid.cd2h.org/enclave)

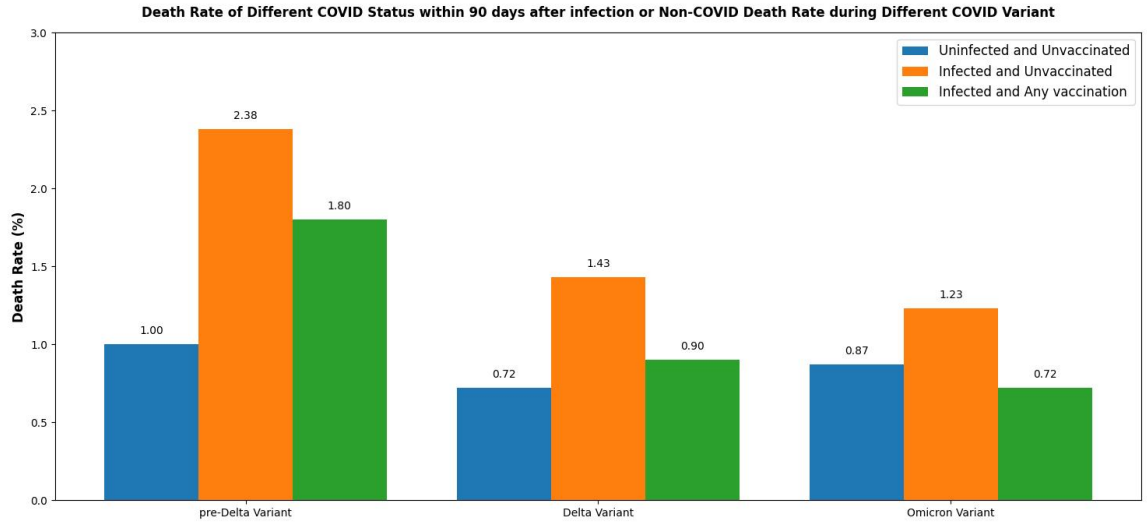
Descriptive statistics were used to examine the social characteristic of all patients by infection rate and death rate after infection of all patients included in this analysis. A chi-square test were used to compare variables according to study group.
The infection rate and death rate after infection of diabetes patients with or without vaccinated are been examined by different social characteristics.

breakthrough/Infection (After Dec 10 2020)	Total N	Percent	Overall Covid	Death after Covid	infection rate	Death rate
Total	10,412,853		1,945,155	36,058	18.68	1.85
sex						
male	4,426,520	**42.51**	774,423	20,210	17.50	2.61
female	5,979,567	**57.42**	1,169,652	15,847	19.56	1.35
other/unknown	6,766	**0.06**	1,080	1	15.96	0.09
age						
18 to <30	1,873,961	**18.00**	377,465	381	20.14	0.10
30 to <50	3,454,028	**33.17**	696,521	2,738	20.17	0.39
50 to <65	2,629,250	**25.25**	481,008	8,126	18.29	1.69
65+	2,455,614	**23.58**	390,161	24,813	15.89	6.36
race/enthicity						
White	6,485,202	**62.28**	1,317,174	25,424	20.31	1.93
Black/African-American	1,418,948	**13.63**	236,975	4,955	16.70	2.09
Hispanic/ Latino	1,106,041	**10.62**	180,152	2,437	16.29	1.35
Asian	286,272	**2.75**	36,312	586	12.68	1.61
Unknown/other	1,116,390	**10.72**	174,542	2,656	15.63	1.52
Region						
Midwest	3,772,621	**36.23**	991,144	15,765	26.27	1.59
South	2,152,775	**20.67**	297,166	7,623	13.80	2.57
Northeast	1,810,579	**17.39**	264,562	5,706	14.61	2.16
West	956,448	**9.19**	129,555	2,140	13.55	1.65
Other/unknown	1,720,430	**16.52**	262,728	4,824	15.27	1.84
Vaccine all						
non-vaccine	7,921,297	**76.07**	1,511,118	31,890	19.08	2.11
Pfizer Vaccine total	1,603,718	**15.40**	295,599	2,557	18.43	0.87
Pfizer vaccine 1st dose	593,337	**5.70**	109,649	1,082	18.48	0.99
Pfizer vaccine 2nd dose	706,377	**6.78**	149,611	1,252	21.18	0.84
Pfizer vaccine booster_P	285,441	**2.74**	34,599	214	12.12	0.62
Pfizer vaccine booster_M	18,563	**0.18**	1,740	9	9.37	0.52
Moderna Vaccine Total	815,976	**7.84**	128,556	1,472	15.75	1.15
Moderna Vaccine 1st dose	216,360	**2.08**	31,366	411	14.50	1.31
Moderna Vaccine 2nd dose	357,714	**3.44**	75,257	888	21.04	1.18
Moderna Vaccine booster_M	216,193	**2.08**	19,307	158	8.93	0.82
Moderna Vaccine booster_P	25,709	**0.25**	2,626	15	10.21	0.57
Janssen Vaccine Total	37,966	**0.36**	5,855	107	15.42	1.83
Janssen Vaccine	31,066	**0.30**	5,402	103	17.39	1.91
Janssen Vaccine booster_P	4,081	**0.04**	270	2	6.62	0.74
Janssen Vaccine booster_M	2,819	**0.03**	183	2	6.49	1.09
Mix full	17,128	**0.16**	1,938	24	11.31	1.24
Mix with any booster	1,691	**0.02**	179	3	10.59	1.68
unclassified	15,077	**0.14**	1,910	5	12.67	0.26

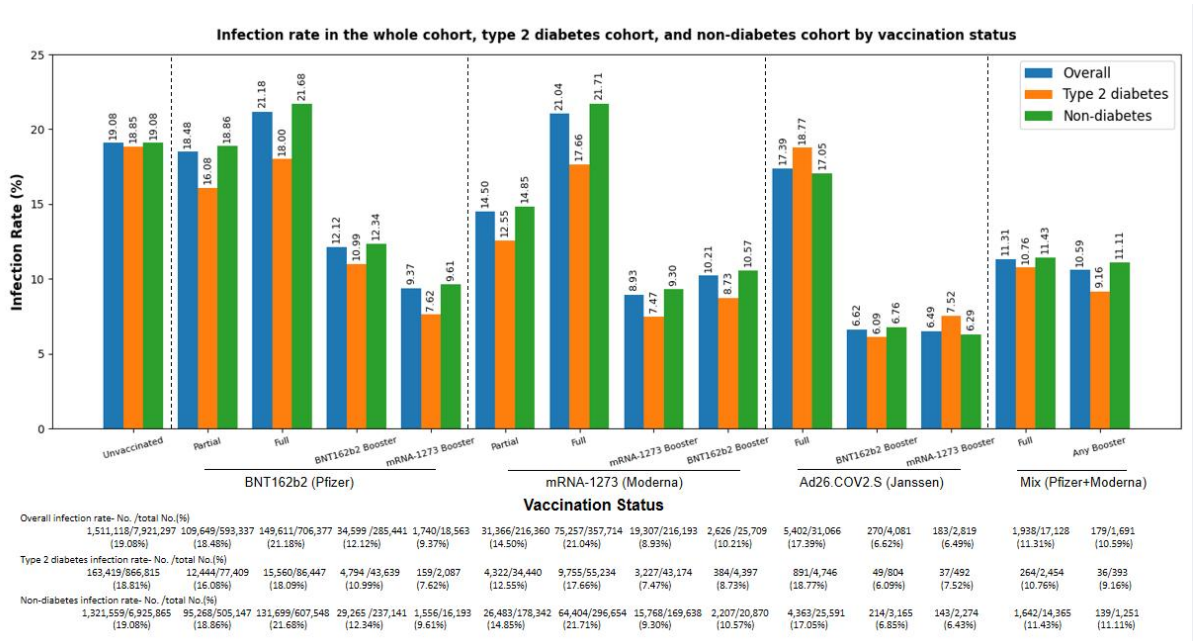
Variant	Follow up Paitents					
Pre_Delta	7,205,581	**69.20**	431,369	15,045	**5.99**	**3.49**
Delta	8,980,373	**86.24**	788,935	12,453	**8.79**	**1.58**
Omicron	9,192,549	**88.28**	724,851	8,560	**7.89**	**1.18**

Result:
For all patients, male have higher death rate after Covid-19 than female. Elder patients have lower infection rate but high death rate after Covid-19. Asian have the lowest infection and Hispanic/Latino have the lowest death rate.

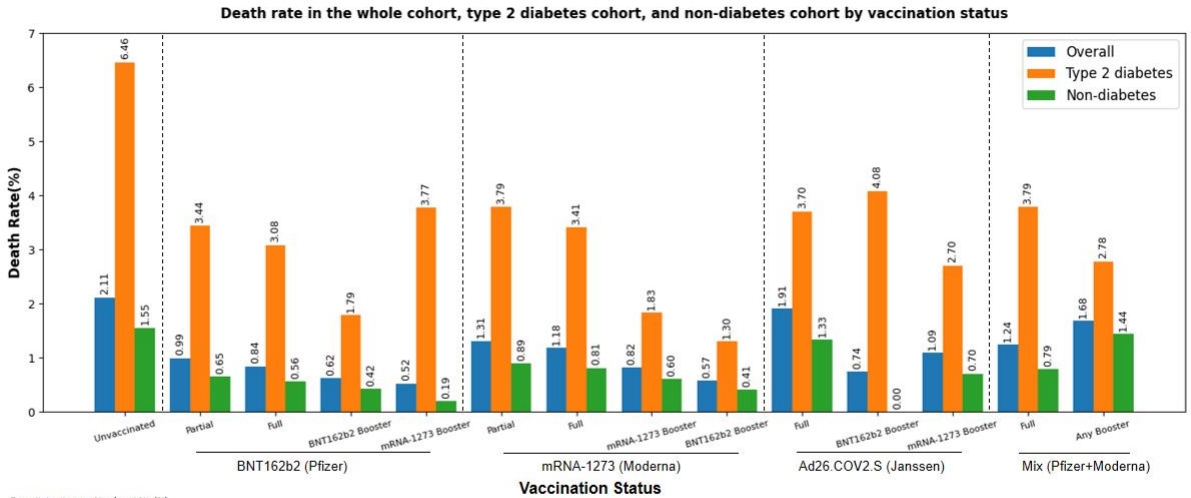
People in Midwest region have highest infection rate and lowest death rate. People in South region have highest death rate and people in Northeast region have lowest infection rate.



For all different kinds of variants, the Death rate of the Infected patients unvaccinated patients is higher than vaccinated patients. The death rate of pre-Delta period patients is the highest and the death rate of Omicron period patients is relatively lowest. During the Omicron periods, the COVID patients who took the vaccine have nearly the same death rate of uninfected patients.

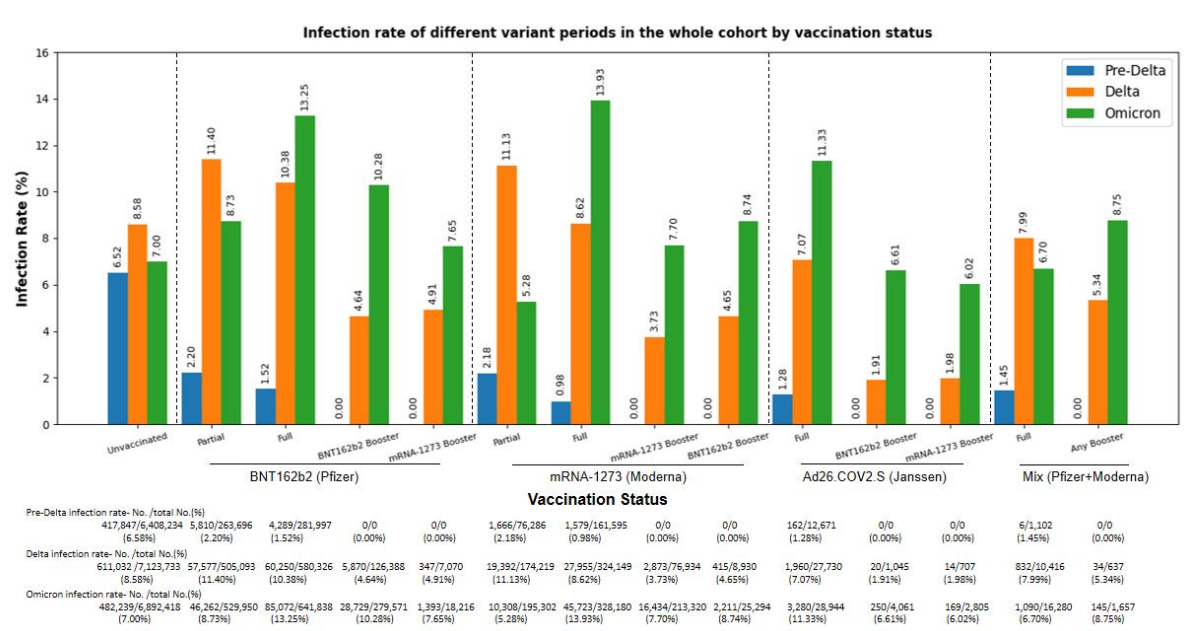


For the protection of total breakthrough, all kinds of vaccine and doses reduces the breakthrough rate of Covid-19 but it is not effectiveness enough. Moderna vaccine helps a little better than Pfizer vaccine for all doses and Janssen protects better than other two vaccines. Non-vaccine, Moderna and Pfizer shows that Diabetes patients have lower infection rate than non-diabetes patients. Instead, Janssen protects non-diabetes patients better than diabetes patients. For different doses, Pfizer and Moderna show the same pattern, the first dose patients have the lowest breakthrough rate and the second doses patients have the highest.



	Unvaccinated	Partial	Full	BNT162b2 Booster	mRNA-1273 Booster	Partial	Full	mRNA-1273 Booster	BNT162b2 Booster	Full	BNT162b2 Booster	mRNA-1273 Booster	Full	Any Booster
Overall death rate- No. /total No.(%)	31,890/1,511,118 (2.11%)	1,082/109,649 (0.99%)	1,252/149,611 (0.84%)	214/34,599 (0.62%)	9/1,740 (0.52%)	411/31,366 (1.31%)	888/75,257 (1.18%)	158/ 19,307 (0.82%)	15/2,626 (0.57%)	103/5,402 (1.91%)	2/270 (0.74%)	2/183 (1.09%)	24/1,938 (1.24%)	3/179 (1.68%)
Type 2 diabetes death rate- No. /total No.(%)	10,559/163,419 (6.46%)	428/12,444 (3.44%)	479/15,560 (3.08%)	86 /4,794 (1.79%)	6/159 (3.77%)	164/4,322 (3.79%)	333/9,755 (3.41%)	59/3,227 (1.83%)	5/384 (1.30%)	33/891 (3.70%)	2/49 (4.08%)	1/37 (2.70%)	10/264 (3.79%)	1/36 (2.78%)
Non-diabetes death rate- No. /total No.(%)	20,453/1,321,559 (1.55%)	622/95,268 (0.65%)	734/131,699 (0.56%)	122/29,265 (0.42%)	3/1,556 (0.19%)	236/26,483 (0.89%)	520/64,404 (0.81%)	95/15,768 (0.60%)	9/2,207 (0.41%)	58/4,363 (1.33%)	0/214 (0.00%)	1/143 (0.70%)	13/1,642 (0.79%)	2/139 (1.44%)

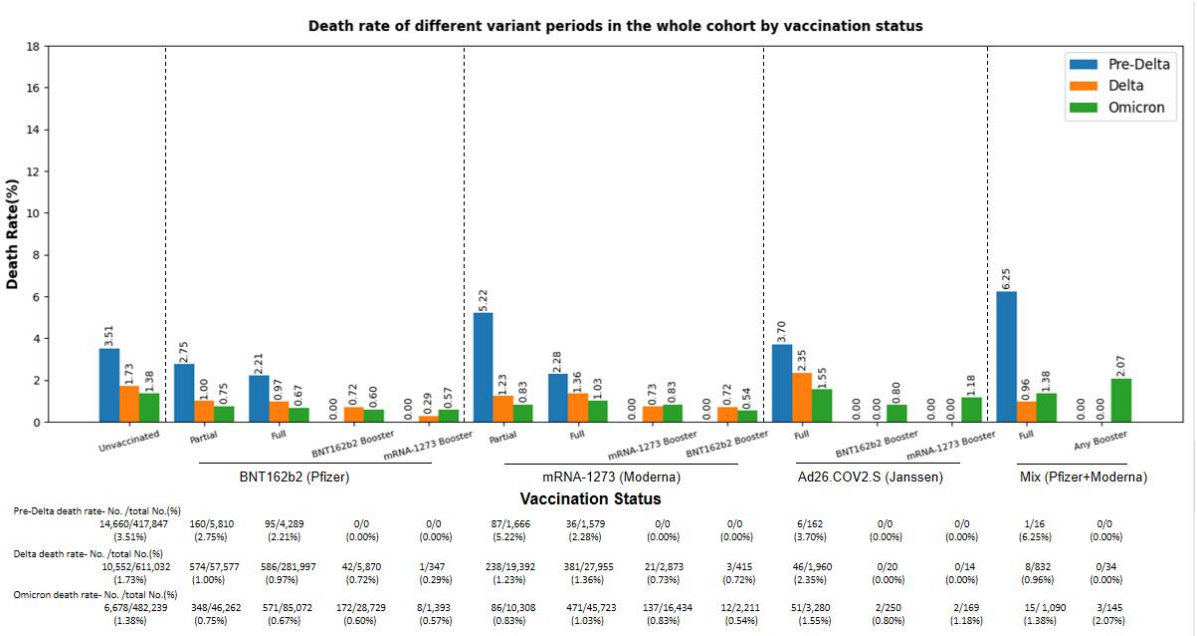
For the death rate after Covid-19 of patients who take different vaccines and doses. Diabetes patients have much higher death rate than non-diabetes ones. All Vaccines reduce the death rate of patients. Patients who take Pfizer Vaccine have lower death rate than others and Patients who take Janssen vaccine have higher death rate than other two vaccines.



	Unvaccinated	Partial	Full	BNT162b2 Booster	mRNA-1273 Booster	Partial	Full	mRNA-1273 Booster	BNT162b2 Booster	Full	BNT162b2 Booster	mRNA-1273 Booster	Full	Any Booster
Pre-Delta infection rate- No. /total No.(%)	417,847/6,408,234 (6.58%)	5,810/263,696 (2.20%)	4,289/281,997 (1.52%)	0/0 (0.00%)	0/0 (0.00%)	1,666/76,286 (2.18%)	1,579/161,595 (0.98%)	0/0 (0.00%)	0/0 (0.00%)	162/12,671 (1.28%)	0/0 (0.00%)	0/0 (0.00%)	6/1,102 (1.45%)	0/0 (0.00%)
Delta infection rate- No. /total No.(%)	611,032 /7,123,733 (8.58%)	57,577/505,093 (11.40%)	60,250/580,326 (10.38%)	5,870/126,388 (4.64%)	347/7,070 (4.91%)	19,392/174,219 (11.13%)	27,955/324,149 (8.62%)	2,873/76,934 (3.73%)	415/8,930 (4.65%)	1,960/27,730 (7.07%)	20/1,045 (1.91%)	14/707 (1.98%)	832/10,416 (7.99%)	34/637 (5.34%)
Omicron infection rate- No. /total No.(%)	482,239/6,892,418 (7.00%)	46,262/529,950 (8.73%)	85,072/641,838 (13.25%)	28,729/279,571 (10.28%)	1,393/18,216 (7.65%)	10,308/195,302 (5.28%)	45,723/328,180 (13.93%)	16,434/213,320 (7.70%)	2,211/25,294 (8.74%)	3,280/28,944 (11.33%)	250/4,061 (6.61%)	169/2,805 (6.02%)	1,090/16,280 (6.70%)	145/1,657 (8.75%)

During the pre-Delta period, US did not provide booster shot. So there is no date of booster vaccine patientes during pre-Delta periods.

The infection rate during Omicron periods is higher than other variants in most cases. Patients who take partial vaccine (1dose) have lower infection rate than full vaccine (2 dose) during Omicron period.



Pre-Delta death rate- No. /total No.(%)													
	14,660/417,847 (3.51%)	160/5,810 (2.75%)	95/4,289 (2.21%)	0/0 (0.00%)	0/0 (0.00%)	87/1,666 (5.22%)	36/1,579 (2.28%)	0/0 (0.00%)	0/0 (0.00%)	6/162 (3.70%)	0/0 (0.00%)	0/0 (0.00%)	1/16 (6.25%)	0/0 (0.00%)
Delta death rate- No. /total No.(%)													
	10,552/611,032 (1.73%)	574/57,577 (1.00%)	586/281,997 (0.97%)	42/5,870 (0.72%)	1/347 (0.29%)	238/19,392 (1.23%)	381/27,955 (1.36%)	21/2,873 (0.73%)	3/415 (0.72%)	46/1,960 (2.35%)	0/20 (0.00%)	0/14 (0.00%)	8/832 (0.96%)	0/34 (0.00%)
Omicron death rate- No. /total No.(%)													
	6,678/482,239 (1.38%)	348/46,262 (0.75%)	571/85,072 (0.67%)	172/28,729 (0.60%)	8/1,393 (0.57%)	86/10,308 (0.83%)	471/45,723 (1.03%)	137/16,434 (0.83%)	12/2,211 (0.54%)	51/3,280 (1.55%)	2/250 (0.80%)	2/169 (1.18%)	15/ 1,090 (1.38%)	3/145 (2.07%)

The death rate during Omicron periods is higher than other variants in most cases. Patients who take partial Moderna Vaccine(1 dose) and Full Janssen Vaccine(1 dose) have higher death rate during pre-Delta periods.

Discussion:

In most cases taking COVID vaccine helps patients reduce the infection rate and death rate after infection. However, in some cases patients who only take 1 or 2 doses of vaccine have higher infection rate and death rate than unvaccinated ones. Does this means only 1 or 2 doses of vaccine do not protect the patients or even bad for patients?