Blood Group and Vaccine Side Effects

Craig Paardekooper

November 9, 2023

Abstract

Does ABO bloodgroup have an effect on adverse reactions to vaccines? If particular blood group is reported disproportionately in the adverse reports for a vaccine, then this may indicate that this blood group confers greater susceptibility to side effects from this vaccine.

We can answer this question by calculating the Proportional Reporting Ratio (PRR) for each blood group with each vaccine.

Datasource

The dataset covers 33 years of VAERS data from 1990 to 2023 and includes data for 99 different vaccines and 16849 unique symptoms. The frequency of each symptom for each vaccine is counted and the proportional reporting ratio calculated for each symptom. The final dataset can be viewed here -

Safety Signal (online) : [1]
Downloadables (csv | excel) : [2]
About (pdf) : [3]
Coding (python) : [4]

Metric

Proportional Reporting Ratio as a Measure of Incidence

Proportional Reporting Ratio (PRR) is used as a measure of incidence of a symptom. PRR calculates the percentage of reports where a particular symptom is recorded following administration of a drug A, and sees if this varies significantly from the percentage of reports where the same symptom is recorded after administration of drug B.

The PRR is defined as the ratio between the frequency with which a specific adverse event is reported for the drug of interest (relative to all adverse events reported for the drug) and the frequency with which the same adverse event is reported for all drugs in the comparison group.

> *For example, suppose that nausea was reported 83 times for a given drug of interest, out of 1356 adverse events reported for the drug. Thus the proportion of adverse events of nausea for this drug is 83/1356 = 0.061. Suppose that we wish to compare the drug of interest to a class of drugs, for which nausea was reported as an adverse event 1489 times, out of 53789 total adverse events reported for drugs in the class. Thus, nausea was reported with proportion 1489 / 53789 = 0.028 for the class of drugs. The PRR in this case is 0.061 / 0.028 = 2.18. This tells us that nausea was reported more than twice as frequently (among all adverse event reports) for the drug of interest compared to drugs in the comparison group.* [5]

Cases	Drug of interest	Comparator
Event of interest	a	c
Other events	b	d

$$PRR = \frac{a/(a+b)}{c/(c+d)}$$

PRR is used by both the European Medical Association and by the Center for Disease Control as a valid measure of incidence of a symptom, and so is used to detect a safety signal when a disproportionate incidence of a symptom occurs. [6] [7]

> *CDC will perform Proportional Reporting Ratio (PRR) analysis [...], excluding laboratory results, to identify AEs that are disproportionately reported relative to other AEs. [...] To determine if results need further clinical review, consider if clinically important, unexpected findings, seriousness, specific syndrome or diagnosis rather than non-specific symptoms*

Method

Using the dataset - [2] , the PRR scores for 99 different vaccines were obtained for the blood group types "A", "B", "AB" and "O".

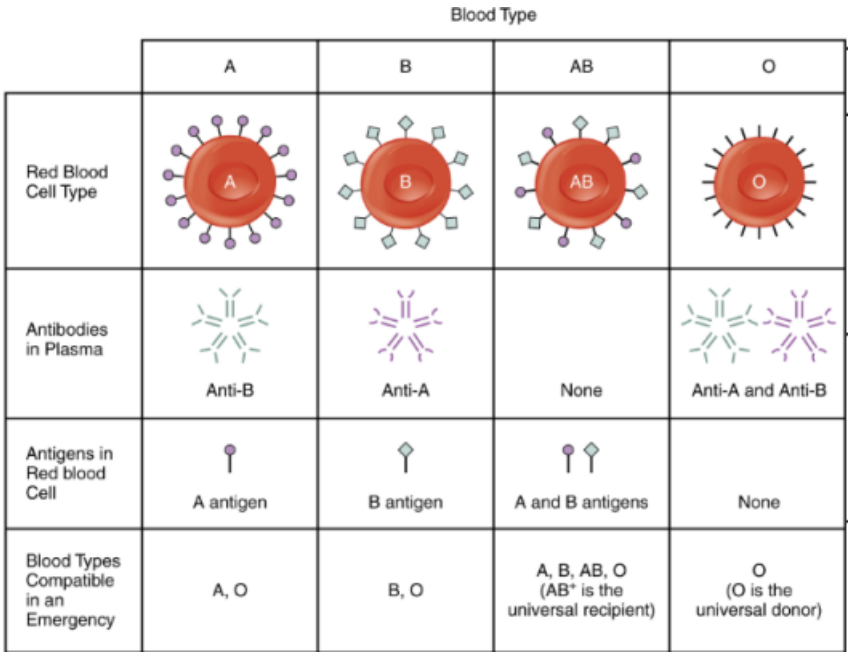

Figure 1: Blood types

Results

First Observation : Blood-group "AB" is not recorded in the VAERS database in relation to any vaccine. AB group is where the blood cells have both A and B antigens.

Second Observation : Blood-group "O" is associated with adverse reports for 8 vaccines, whereas blood-group "A" is associated with adverse reports for 4 vaccines, and blood-group "B" is associated with adverse reports for 3 vaccines. Group "O" has no antigens, where as Group "A" only has "A" antigens and Group "B" only has "B" antigens.

Third Observation : HPV4 and PPV vaccine adverse events (AEs) are uniquely associated with Blood-group "A".

Fourth Observation : HIBV and TDAP vaccine AEs are uniquely associated with Blood-group "B".

Fifth Observation : RV1, RV5, YF, HPV9, PNC13, HEP vaccine AEs are uniquely associated with Blood-group "O".

VAX_TYPE	Blood group A	Blood group B	Blood group O
VARCEL	28.72	17.23	5.38
MMR	8.52	0.00	12.50
HPV4	5.13	0.00	0.00
PPV	4.92	0.00	0.00
COVID19	0.40	0.40	0.09
HIBV	0.00	89.09	0.00
TDAP	0.00	20.03	0.00
RV1	0.00	0.00	133.12
YF	0.00	0.00	72.12
HPV9	0.00	0.00	29.23
RV5	0.00	0.00	18.17
PNC13	0.00	0.00	9.91
HEP	0.00	0.00	3.53
VARZOS	0.00	0.00	1.48

Figure 2: Blood type and Adverse Effects with Different Vaccines

Sixth Observation : VARCEL vaccine AEs are associated with all three blood groups but in descending order, where A > B > O.

Seventh Observation : MMR vaccine AEs are associated with Blood groups "A" and "O", where O > A.

Eigth Observation : COVID vaccine AEs are not associated with any particular blood group.

Ninth Observation : VARZOS vaccine has much weaker associations compared to VARCEL.

Discussion

Blood-Group-A people are targeted because the immune antibody generated against the vaccine antigen is similar to A-antigen. This would explain why Blood-group-A is adversely effected, but not Blood-group-B. But why isn't AB affected since it has both A and B antigens? That would be because the combination of A and B-antigens always blocks or repels the immune antibody. Perhaps AB makes the cell surface too crowded for the immune antibody to reach and bind to either A or B antigens. Blood group 0 has no antigens so the immune antibody has no antigen to bind to.

What about a situation where Blood groups A, B and 0 are all affected, but to different degrees? This would occur if A antigen and B antigen have different degrees of similarity to the viral antigen - so the immune antibody will attack them both to varying degrees. Blood-group 0 does not have an antigen, so here the immune antibody would attack Blood-group-O because the actual blood

cell surface was similar to the viral antigen to some degree. AB will not be affected because it is too crowded for the immune antibody to reach either A or B antigens or the cell surface.

What about a situation where only Blood groups A and O are affected? This would be where the viral antigen was similar to A-antigen, and also similar to parts of the cell surface, but not similar to B-antigen. Once again, the combination of A + B antigens presents a barrier to antibody attachment.
If this theory is correct, then I would expect -

1. PPV and HPV4 to generate antibodies that bind to A antigen
2. HIBV and TDAP to generate antibodies that bind to B antigen
3. RV1, YF, HPV9, RV5, PNC13, HEP to generate antibodies that bind directly to the surface of blood cells.
4. An antibody that targets cell surfaces directly might cause more damage than an antigen that only targets cells that carry a specific antigen on their surface. For this reason, vaccines that attack Blood-group-0 may cause additional damage to other cells besides blood cells. Vaccines that affect blood-group-0 will therefore by more systemic and should have a higher PRR for AEs.

Conclusion

What this study shows is that different blood-groups have a different response to different vaccines. There are 13 vaccines that elicit a different response from blood-groups. This most likely happens because the vaccine antigen shares similarities with the blood-group antigen or with a non-antigen part of the cell surface. Before taking any of these 13 vaccines, it is important to check your blood-group.

If a vaccine is not shown here, it may still cause adverse effects in ways other than through the mechanism described above.

References

[1] Paardekooper-Knoll-Frank, "Safety signal," 2023. Available at link.

[2] Paardekooper, "Downloadable datasets for prr safety signals for all vaccines in vaers," 2023. Available at link.

[3] Paardekooper, "About the dataset: pdf," 2023. Available at link.

[4] Paardekooper, "Detailed methodology for dataset creation : Prr safety signals for all vaccines in vaers," 2023. Available at link.

[5] Wikipedia, "Proportional reporting ratio," 2023. Available at link.

[6] EMA, "Guideline on the use of statistical signal detection methods in the eudravigilance data analysis system," 2006. Available at link.

[7] CDC, "Vaccine adverse event reporting system (vaers) standard operating procedures for covid-19 (as of 29 january 2021)," 2021. Available at link.