Summary of major changes to H1N1, H2N2 and H3N2 during human circulation:

**1918 H1N1**

* 1918 – Pandemic emergence, 1 glycan @ N104
* 1928 – Glycan switch: 1 glycan @ N286
* 1933 – Glycan addition: 2 glycans @ N286 and N179
* 1938 – Glycan addition: 3 glycans @ N286, N179, N104
* 1943 – Glycan addition: 4 glycans @ N286, N179, N104, N144
* 1948 – Glycan addition: 5 glycans @ N286, N179, N104, N144 and N172/N90

Sources: Glycan info from Altman et al. biorxiv unless otherwise noted.

Notes: I haven’t dug to see if we have antigenic cartography or other sources of info on drift of pre-1957 H1N1 over time.

**1957 H2N2**

* 1957 – Pandemic emergence, 0 Glycans (Double check this)
* 1962 – Apparent cluster jump (Schafer et al., 1993, Virology. This pre-cartography analysis tested many variants against the ’57 strain, but later variants were not used as references, so we can only ID the 1st cluster jump.)
* 1966 – Possible cluster jump (Lindstrom et al. 2004, Virology. Supported by strong tree branching in ‘66 but no antigenic analysis done).

Notes: H2N2 never added a glycan (Altman et al.). A lab study showed it had potential to add a glycan, but that fitness cost of the added glycan prevented this phenotype from emerging in nature (see ref. in Altman et al.). I spent a few hours on lit review and didn’t find any comprehensive antigenic map of H2N2, but I may be missing something.

**1968 H3N2**

* 1968 – Pandemic emergence, 2 glycans @ N165 and N63/N81
* 1972 – Cluster jump
* 1974 – Glycan addition: 3 glycans @ N165, N63, N126
* 1975 – Cluster jump
* 1979 – Cluster jump
* 1980 – Glycan addition: 4 glycans @ N165, N63, N126, N246/N122
* 1987 – Cluster jump
* 1989 – Cluster jump
* 1992 – Glycan addition: 5 glycans @ N165, N63, N126, N246, N276
* 1992 – Cluster jump
* 1995 – Cluster jump
* 1997 – Cluster jump
* 1998 – Glycan replace and add: 6 glycans @ N165, N63, N126, N246, N122, N133
* 2002 – Cluster jump
* 2004 – Glycan addition: 7 glycans @ @ N165, N63, N126, N246, N122, N133, N144
* 2005 – Cluster jump
* 2011 – Cluster jump (Victoria/11 emerged, WHO later updates vaccine)
* 2013 – Cluster jump (Switzerland/13 emerged, WHO later updates vaccine)
* 2014 – Glycan replacement: 7 glycans @ @ N165, N63, N126, N246, N122, N133, N158
* 2014 – Cluster jump (HongKong/14 emerged, WHO later updates vaccine)
* 2018 – Likely cluster jump (Based on how bad the vaccine is this year and how strong circulation is).

Sources: Glycan info from Altman et al. biorxiv, and cluster info from Bedford et al. eLife unless otherwise noted as referencing WHO report.

Notes/open questions: Clusters are identified by the vaccine strain they contain, and vaccine strains are named for their year of isolation. Should we assume that a strain has already become dominant by the time it is isolated? (E.g.) for a cluster jump in 2011, that the new strain was dominant in circulation at the beginning of the 2011/2012 NH season? Or are isolated strains sometimes minor variants in circulation at the time of isolation (e.g. maybe Victoria/2011 was just beginning to emerge but not yet dominant at the beginning of the 2011/2012 NH season?)

**1977 H1N1**

* 1977 – Pandemic emergence, 5 glycans @ N286, N179, N104, N144 and N172 (same as ’48 variant)
* 1986 – Cluster jump
* 1987 – Glycan switch, 5 glycans @ N286, N179, N104, N142 and N71
* 1995 – Cluster jump
* 1997 – Glycan loss, 4 glycans @ N179, N104, N142 and N71
* 1999 – Cluster jump
* 2006 – Cluster jump

**2009 H1N1**

* 2009 – Pandemic emergence, 1 glycan @ N104
* 2014 – K🡪Q mutation (semi-cluster jump, leaves adults born from 1940-ish to 1985-ish unable to recognize major antigenic site, see Linderman et al., 2014, PNAS).
* 2015 – Glycan addition, 2 glycans @ N104, N179