Summary of neuraminidase (NA) amino acid substitutions assessed for their effects on inhibition by NA inhibitors (NAIs).

Type/subtype *Comments*	Amino acid substitution[a]	N2 numbering[b]	Susceptibility assessed by NA inhibition assays (IC_{50} fold change)[c]				Source of viruses/ selection with[d]	References
			Oseltamivir	Zanamivir	Peramivir	Laninamivir		
Type A								
A(H1N1)pdm09	S110F	110	RI (10)	RI (17–18)	?[e]	?	Sur	(1, 2)
	I117R	117	NI (1)	RI (10)	?	?	Sur	(3)
	E119A	119	NI/RI (8–17)	RI (58–90)	NI/RI (7–12)	RI (82)	RG	(4, 5)
	E119D	119	RI (25–94)	HRI (583–2731)	HRI (104–402)	HRI (649–702)	Clin/Zan; RG	(5–7)
	E119G	119	NI (1–7)	HRI (113–1306)	RI/HRI (51–167)	HRI (112–327)	RG; Clin/Zan	(5, 7–9)
	E119V	119	RI (60)	HRI (571)	RI (25)	?	RG	(8)
Cell culture-selected	Q136K	136	NI (1)	HRI (86–749)	HRI (143)	RI (42–45)	Sur; RG; in vitro	(4, 10, 11)
Cell culture-selected	Q136R	136	NI (1)	HRI (200)	HRI (234)	RI (33)	Sur	(12)
	R152K	152	RI (18–43)	NI/RI (4–12)	NI (4-7)	RI (16)	RG	(5, 7)
	D199E	198	RI (16–26)	NI (7–8)	NI (3)	NI (3)	Sur; RG	(7, 13)
	D199G	198	RI (17)	NI (6)	NI (2)	NI (2)	Sur; in vitro; RG	(4, 8)
	D199Y	198	RI (37)	RI (28)	NI (4)	NI (7)	Sur	(14)
	I223K	222	RI (12–39)	NI (5–6)	NI (1–4)	NI (4)	Sur; RG	(13, 15, 16)
	I223R	222	RI (13–45)	NI/RI (8–12)	NI (5)	NI (2)	Clin/No; Clin/Ose/Zan; RG	(13, 16-19)
	I223T	222	NI/RI (9–15)	NI (3)	NI (2)	NI (2)	Clin/Sur	(4)
	I223V	222	NI (6)	NI (2)	NI (2)	NI (1)	RG	(4, 8)
	S247G	246	RI (15)	NI (1)	NI (1)	NI (1)	Clin/Sur	(13)
	S247N	246	NI (4–8)	NI (2–5)	NI (1)	?	Sur	(20)
	S247R	246	RI (36–37)	RI (51–54)	RI/HRI (94–115)	RI/HRI (90–122)	Clin/No	(3)
	H275Y	**274**	**HRI (221–1637)**	**NI (1–6)**	**RI/HRI (50–751)**	**NI (1–2)**	Clin/Ose; Sur; in vitro	(21–30)
	R293K	292	RI (33)	NI (4)	NI (8)	?	RG	(5, 9)
	N295S	294	RI/HRI (64–208)	NI (2–9)	NI/RI (3–12)	NI (3)	RG	(4, 5, 8, 12)
	I427T	427	RI (37)	RI (41)	NI (6)	RI (11)	Sur	(14)
	I436N	436	RI (31)	RI (71)	RI (20)	RI (19)	RG	(31)
	P458T	459	HRI (280)	HRI (808)	HRI (148)	HRI (211)	RG	(7)
	H275Y+I436N	274+436	HRI (4811)	RI (36)	HRI (10460)	RI (22)	RG	(31)
Some IC_{50}s were given for mixed virus populations; to be assessed	D199N+H275Y	198+274	HRI (318–744)	NI (2–3)	HRI (108)	?	Sur; Clin/Ose	(28, 32)

using recombinant NA								
	G147R+H275Y	147+274	HRI (2649)	NI (5)	HRI (1427)	NI (1)	Clin/Lan+Per	(3)
	E119A+H275Y	119+274	HRI (1173)	RI (56)	NI (3)	?	RG	(5)
	E119D+H275Y	119+274	HRI (790–3381)	HRI (136–903)	HRI (5958–33333)	HRI (366)	RG	(5, 6)
	E119G+H275Y	119+274	HRI (225–2483)	HRI (225–1546)	HRI (3333–93433)	HRI (650)	Clin/ Zan; Sur; RG	(5, 9)
	I223K+H275Y	222+274	HRI (>10822)	RI (11)	HRI (5343)	RI (11)	Sur; in vitro	(24)
	I223R+H275Y	222+274	HRI (>9100)	RI (22–27)	HRI (>7500)	RI (17)	Clin/Ose; RG	(15, 19, 24)
	I223V+H275Y	222+274	HRI (1733)	NI (2)	HRI (1331)	?	Clin/Ose; RG	(8, 33)
	S247N+H275Y	246+274	HRI (5880)	NI (5)	HRI (334)	?	Sur	(20)
	Q313K+I427T	313+427	RI (10–43)	NI/RI (3–20)	NI (4)	?	Sur	(22, 34)
A(H1N1)	E119V	119	RI/HRI (15/1727)	HRI (136/2144)	HRI (5050)	?	RG	(35, 36)
Host cell selected in both studies; not found in clinical specimens	Q136K	136	NI (1)	RI/HRI (36–327)	RI (75–80)	?	Sur	(22, 37)
This result is virus specific	Y155H	155	HRI (123)	HRI (555)	?	?	Sur	(38)
	I223M	222	NI (8)	NI (1)	NI (1)	?	RG; in vitro/Zan	(39)
	I223V	222	NI (3)	NI (2)	NI (1)	?	RG; in vitro/Zan	(39)
	S247G	246	NI (5)	NI (1)	?	?	Sur	(40)
	H275Y	**274**	**HRI (321–2597)**	**NI (1–2)**	**HRI (111–1095)**	**?**	Sur; RG	(22, 36, 40, 41)
	R293K	292	NI (1)	RI (18)	?	?	RG	(36)
	N295S	294	RI/HRI (40/197)	NI (1/5)	RI (12)	?	RG	(35, 36)
	I117V+E119V	117+119	NI (7)	HRI (391)	?	?	RG	(36)
	I117M+E119V	117+119	RI (20)	HRI (181)	?	?	RG	(36)
	I117V+H275Y	117+274	HRI (683)	NI (1)	?	?	RG	(36)
	I117M+H275Y	117+274	HRI (395)	NI (1)	?	?	RG	(36)
	I117V+N295S	117+294	RI (60)	NI (1)	?	?	RG	(36)
	I117M+N295S	117+294	RI (52)	NI (4)	?	?	RG	(36)
	E119V+H275Y	119+274	RI (21)	HRI (132)	?	?	RG	(36)
Both changes were host cell selected	Q136K+D151E	136+151	NI (1)	RI (25)	RI (18)	?	Sur	(22)
Q136K was host cell selected	Q136K+H275Y	136+274	HRI (198)	RI (15)	HRI (1805)	?	Sur	(22)
D151E/N was host cell selected	D151E/N+H275Y	151+274	HRI (231–799)	NI (1–3)	RI/HRI (80–718)	?	Sur	(22)
D151G was host cell selected	D151G+H275Y	151+274	HRI (1189)	RI (14)	HRI (1161)	?	Sur	(22)

	I223M+H275Y	222+274	HRI (1943)	NI (1)	HRI (400)	?	RG; in vitro/Zan	(39)
	I223V+H275Y	222+274	HRI (584/971)	NI (1/2)	HRI (893)	?	RG; in vitro/Zan	(36, 39)
	I223V+N295S	222+294	RI (97)	NI (2)	?	?	RG	(36)
	R293K+H275Y	292+274	HRI (207)	NI (1)	?	?	RG	(36)
	N295S+H275Y	294+274	HRI (108)	NI (1)	?	?	RG	(36)
	S334N+H275Y	336+274	HRI (415)	NI (1)	?	?	RG	(36)
	I117V+N295S+H275Y	117+294+274	HRI (336)	RI (12)	?	?	RG	(36)
	I117M+N295S+H275Y	117+294+274	HRI (121)	RI (11)	?	?	RG	(36)
Q136K+D151N were host cell selected	Q136K+D151N+H275Y	136+151+274	HRI (356)	NI (4)	HRI (2300)	?	Sur	(22)
	I223V+N295S+H275Y	222+294+274	HRI (300)	RI (13)	?	?	RG	(36)
A(H5N1)	V96A	116	RI (11–18)	RI (10–63)	NI (4)	?	Sur	(42, 43)
	I97T	117	RI (19)	RI (12)	?	?	Sur	(44)
	I97V	117	NI (5–9)	NI (2–4)	?	?	RG; Sur	(44-46)
	E99A	119	RI (10–35)	HRI (51–1254)	NI (7)	?	RG	(5, 45)
	E99D	119	RI (87)	HRI (132)	HRI (1436)	?	RG	(5)
	E99G	119	NI (3–6)	HRI (438–1485)	RI/HRI (12–164)	?	RG; in vitro/Zan	(5, 39)
	Q116L	136	RI (26)	HRI (350)	?	?	In vivo/Zan	(47)
	V129A	149	NI (4)	NI (8)	?	?	Sur	(48)
	D179G	198	RI (32)	RI (44)	NI (4)	?	RG; in vitro/Zan	(39)
	I203M	222	RI (36)	NI (1)	NI (1)	?	RG; in vitro/Zan	(39)
	I203V	222	NI (7)	NI (1)	NI (1)	?	RG; in vitro/Zan	(39)
	S227N	246	RI (24)	NI (2)	?	?	Sur	(42)
	H255Y	**274**	**RI/HRI (44–2502)**	**NI (1–3)**	**RI/HRI (23–533)**	**NI (6)**	Sur; Clin/Ose; RG; in vitro/Zan	(5, 39, 45, 49, 50)
	N275S	294	RI/HRI (12–138)	NI/RI (1–27)	NI/RI/HRI (1–130)	?	Clin/Ose; RG	(5, 45, 49, 51)
	K412T	432	NI (9)	RI (12)	NI (5)	?	Sur; in vitro	(52)
	I97V+I294V	117+314	RI (16)	NI (1)	NI (1)	?	Sur	(43)
	E99A+H255Y	119+274	HRI (1530)	RI (50)	HRI (2686)	?	RG	(5)
	E99D+H255Y	119+274	HRI (160)	RI (65)	HRI (1629)	?	RG	(5)
	E99G+H255Y	119+274	HRI (801)	RI (76)	HRI (>7692)	?	RG	(5)
	I203L+ S227N	222+246	RI (14)	NI (1)	NI (5)	?	Sur; in vitro	(52)
	I203M+H255Y	222+274	HRI (8024)	NI (3)	HRI (3340)	?	RG; in vitro/Zan	(39)
	I203V+H255Y	222+274	HRI (1925)	NI (2)	HRI (2106)	?	RG; in vitro/Zan	(39)
	K130N+I203L+S227N	150+222+246	RI (77)	NI (1)	?	?	Sur	(42)

A(H3N2)	E119D	119	NI (2)	RI (32)	NI (2)	?	RG	(53)
	E119I	119	HRI (208)	RI (17)	NI (3)	?	Clin/Ose; in vitro	(54)
	E119V	119	RI/HRI (18–2057)	NI (1–7)	NI (1–3)	NI (3–4)	Sur; Clin/Ose; in vitro; RG	(35, 41, 53–58)
Host cell selected, not found in clinical specimens	Q136K	136	NI (1–7)	RI/HRI (11–132)	NI (3-9)	NI (2)	Sur	(30, 59, 60)
Cell culture-selected	D151A	151	NI (2–3)	RI (29–43)	RI (10)	NI (7)	Sur	(40, 59)
Cell culture-selected	D151E	151	RI (11)	NI (2)	?	?	RG	(61)
Cell culture-selected	D151G	151	NI (1)	HRI (>1500)	?	?	RG	(62)
	I222L	222	NI (9)	NI (2)	?	?	RG	(63)
	R224K	224	HRI (>4000)	RI (>50)	?	?	RG	(61)
	Del 245–248[f]	245–248	HRI (157–222)	NI/RI (3-21)	NI (1)	NI (1)	Clin/Ose	(64, 65)
	Del 247-250[f]	247-250	HRI (235)	RI (17)	NI (5)	NI (1)	Sur/recNA	(65)
	K249E	249	RI (10–15)	NI (4–6)	NI (1–3)	NI (1–3)	Sur	(3)
	E276D	276	RI (15)	HRI (160)	?	?	RG	(61)
	R292K	292	HRI (>10 000)	NI/RI/HRI (3–134)	RI/HRI (14–719)	NI (2)	Clin/Ose; in vitro/Zan; RG	(12, 35, 40, 53, 55, 61, 66-68)
	N294S	294	HRI (300–1879)	NI (8)	NI (1)	?	Clin/Ose; RG	(35, 68)
Increased NA K_ms for MUNANA substrate[g]	N329K	329	NI/RI (5–21)	NI/RI (3–12)	?	?	Sur	(13, 69, 70)
Increased NA K_ms for MUNANA substrate[g]	N329R	329	RI (13)	NI (8)	?	?	Sur	(70)
Increased NA K_ms for MUNANA substrate[g]	S331R	331	NI/RI (5–77)	NI/RI (3-30)	?	?	Sur	(13, 69, 70)
Increased NA K_ms for MUNANA substrate[g]	S334R	334	NI (<2)[h]	NI (<2)[h]	?	?	Sur	(70)
	R371K	371	RI (45)	RI (15)	?	?	RG	(61)
	Q391K	391	RI (87)	RI (32)	RI (16)	NI (9)	Sur	(3)
T148I was host cell selected	E119V+T148I	119+148	HRI (>6000)	HRI (>800)	HRI (>110)	HRI (>250)	Sur; in vitro; RG	(58)
	E119V+I222L	119+222	HRI (1571)	RI (5)	?	?	RG	(63)
	E119V+I222V	119+222	HRI (293–2286)	NI (2)	NI (7)	?	Clin/Ose	(57, 71)
	I222T+S331R	222+331	RI (12–31)	NI (3–7)	NI (2)	NI (3–4)	Sur/Clin	(59)

A(H3N2)v	S245N	245	NI (1)	NI (1)	NI (1)	NI (1)	Sur; recNA	(72)
	S247P	247	RI (42)	HRI (266)	NI (2)	NI (9)	Sur; recNA	(72)
	S245N+S247P	245+247	RI (31–40)	RI/HRI (66–235)	NI (1–2)	NI (7–9)	Sur; recNA	(30, 72)
A(H7N9)	E115A	119	RI (19)	HRI (228)	RI (20)	RI (62)	In vitro; recNA	(73)
	E115D	119	RI (14)	HRI (1436)	HRI (411)	HRI (383)	In vitro; recNA	(73)
	E115G	119	NI (2)	HRI (419)	RI (48)	HRI (124)	In vitro; recNA	(73)
	E115V	119	RI/HRI (84–169)	NI (6–9)	NI (1–2)	NI (2–5)	Sur; P-p; in vitro; recNA; RG	(73-75)
	Q132K	136	NI (1)	HRI (702)	HRI (131)	HRI (313)	In vitro; recNA	(73)
	R148K	152	NI (1)	NI (5)	NI (3)	RI (16)	In vitro; recNA	(73)
	I219K	222	RI (32–46)	NI/RI (8–17)	NI/RI (6–11)	RI (13–27)	In vitro; recNA; sur; P-p	(73, 74)
	I219L	222	NI (5)	NI (2)	NI (1)	NI (2)	RG	(75)
	I219R	222	RI/HRI (37–143)	RI (12–38)	RI (12–44)	RI (14–63)	In vitro; recNA; sur; P-p	(73, 74)
	T244P	247	RI (27)	RI (69)	NI (4)	NI (9)	In vitro; recNA	(73)
	H271Y	274	HRI (105)	NI (2)	NI (9)	NI (2)	In vitro; sur	(73)
	E273D	276	RI (13)	HRI (427)	RI (25)	RI (90)	In vitro; recNA	(73)
	R289K	292	HRI (>4600)	RI (11–67)	HRI (405–2487)	RI (16–35)	In vitro; recNA Sur; P-p	(73, 74, 76, 77)
	N291S	294	NI (2)	RI (10)	NI (1)	NI (3)	In vitro; recNA	(73)
	R367K	371	RI (70)	RI (64)	RI (29)	RI (19)	In vitro; recNA	(73)
	E115V+I219L	119+222	HRI (306)	NI (8)	NI (2)	NI (4)	RG	(75)
Type B								
Not found in clinical specimen	H101L	103	NI (2–3)	RI (30–34)	HRI (688–791)	RI (4–5)	Sur: RG	(78)
	G104E	106	HRI (87)	HRI (1220)	HRI (17724)	HRI (701)	Sur	(3)
	E105K	107	NI/RI (4–10)	NI/RI (1-42)	RI/HRI (6–681)	NI/RI (1–12)	Clin/No; RG	(79, 80)
	G108E	110	RI/HRI (5–215)	RI/HRI (5–4493)	HRI (55)	NI /HRI (3–7310)	Sur; Clin/Ose; RG	(78)
	E117A	119	HRI (>300-3171)	HRI (>560–12538)	HRI (>1598–13780)	HRI (421–2163)	Sur; RG	(80–83)
	E117D	119	HRI (>300)	HRI (>560)	HRI (>1598)	?	RG	(83)
	E117G	119	RI/HRI (6–53)	RI/HRI (33–4612)	HRI (>1598–>10000)	HRI (423–855)	In vitro; RG	(80, 83, 84)
	E117V	119	HRI (300)	NI (2)	HRI (531)	?	RG	(83)
	H134N	136	NI (3–4)	HRI (121–212)	HRI (100–131)	RI/HRI (49–240)	Sur; Clin/No; RG	(3, 85, 86)
	H134Q	136	NI (3)	RI (6)	?	?	Sur	(1)
	H134Y	136	NI (4)	NI (1)	HRI (76)	NI (2)	Sur	(3)
	Q138R	140	NI (1)	RI (15)	RI (41)	RI (7)	Sur; in vitro	(87)

	P139S	141	RI/HRI (10–68)	NI/RI/HRI (2–160)	RI/HRI (12–>9091)	NI/RI/HRI (3–142)	Sur; in vitro; RG	(80, 87)
	G140R	142	RI/HRI (9–184)	NI/RI/HRI (1–1037)	RI/HRI (12–>9091)	NI/RI/HRI (2–1197)	Sur; in vitro; RG	(80, 87)
	Y142H	144	NI (2)	NI (1)	RI (6)	NI (1)	Sur	(12)
	G145E	147	NI (1)	NI (1)	RI (14)	NI (1)	Sur	(59)
Not found in clinical specimen	T146I	148	NI (2)	NI (1)	HRI (145)	NI (1)	Sur	(59)
Not found in clinical specimen	T146K	148	NI/RI (1–34)	NI/RI/HRI (3–192)	HRI (187–21893)	NI/RI (1–6)	Sur; RG	(78)
Not found in clinical specimen	T146P	148	NI/RI (2–8)	NI/RI (4–11)	HRI (128–3338)	NI (3)	Sur; RG	(78)
	R150K	152	HRI (60–252)	RI/HRI (5–1000)	HRI (214–2869)	HRI (473)	Clin; Clin/Zan; RG; Sur	(2, 41, 61, 83, 86, 88–90)
	N151S	153	NI (1)	RI (7)	?	?	Sur	(13)
	K152M	154	RI (5)	NI (1)	NI (1)	NI (1)	Sur	(59)
	K152N	154	RI (6)	NI (2)	NI (1)	NI (2)	Sur	(3)
	N169S	170	NI (2)	NI (1)	NI (1)	NI (1)	RG	(78)
	D197E	198	RI (12–26)	NI (3–7)	RI (16–18)	?	Clin/No; Sur; RG	(38, 82, 91)
Not found in clinical specimen	D197G	198	NI (3)	RI (5)	?	?	Sur	(59)
	D197N	198	NI/RI (4–10)	NI/RI (3–17)	NI/RI (5–24)	NI (2–3)	Clin/No; Clin/Ose; Sur	(3, 40, 41, 56, 92)
	D197Y	198	RI/HRI (15/57)	RI (14)	HRI (168)	?	Sur; RG	(82, 93)
	A200T	201	RI (5–48)	RI (5–23)	RI (67–85)	NI/RI (4–27)	Sur; RG	(14, 30, 78)
	I221L	222	HRI (70–121)	RI (7–41)	RI (39–56)	?	Clin/Ose	(94, 95)
	I221N	222	RI/HRI (36–219)	RI (6–14)	HRI (136–956)	?	RG	(95)
	I221T	222	NI/RI (5–8)	NI (2–4)	RI (15–43)	NI (<3)	Clin/No; Sur; RG	(26, 38, 82, 92, 96)
	I221V	222	NI (2)	NI (2)	RI (6)	NI (3)	Sur	(3)
	A245T	246	RI (9–24)	RI/HRI (39–205)	RI (5–10)	NI/RI (3–5)	Sur	(14, 26)
	S246P	247	NI (2)	RI (40)	?	?	Sur	(2)
	G247D	248	NI (4)	NI (4)	NI (2)	NI (2)	RG	(78)
	H273Y	274	NI/RI (2–12)	NI (1)	RI/HRI (15–13434)	NI (1)	Sur; RG	(3, 28, 40, 82)
	R292K	292	HRI (>300)	RI (29)	HRI (502)	?	RG	(83)
	N294S	294	RI (8–61)	NI/RI (1–18)	RI (17–58)	?	Clin/No; RG	(82, 86, 95, 97)
	K360E	358–359[i]	NI (2)	NI (2)	HRI (165)	NI (<3)	Sur	(26)
	I361V	358	NI (2)	NI (1)	NI (1)	NI (1)	RG	(78)
	R374K	371	HRI (101–407)	RI/HRI (29–145)	HRI (352)	?	Sur; RG	(40, 82)
	A395E	392	RI (5)	NI (1)	RI (5)	NI (<3)	Sur	(26)
	L396H	393	NI (3)	RI (11)	?	?	Sur	(14)
	G407S	404	NI (4)	RI (7)	?	?	Clin/Ose; Sur	(92)

	D432G	429	NI (1)	NI (1-3)	RI/HRI (41-148)	NI (1−3)	Sur; RG	(26, 78)
	D432N	429	NI (1)	NI (1)	RI (8)	NI (1)	Sur	(14)
	H439P	439	NI/RI (1−6)	NI/RI (4−13)	HRI (56-120)	NI (2−4)	Sur; RG	(78)
	H439R	439	NI (1)	RI (5-10)	RI (20-23)	NI (2)	Sur; RG	(78)
	M464T	466	NI (1)	NI (1)	RI (8)	NI (1)	Sur	(14)
	T106I+P165L	108+166	NI (4)	RI (14)	?	?	Sur	(3)
	G140R+N144K	142+146	NI (6)	RI (10)	HRI (257)	?	Sur	(28)
	Y142H+G145R	144+147	RI (5)	NI (4)	HRI (487)	NI (<3)	Sur	(26)
	T146P+N169S	148+170	RI (31−44)	HRI (225−573)	HRI (7158−10074)	HRI (86−280)	Sur; RG	(78)
	K186R+I262T	187+263	NI (3)	RI (17)	?	?	Sur	(3)
	G247D+I361V	248+358	NI/RI (2−6)	NI/RI (3−6)	NI/RI (4−46)	NI (1−3)	Sur; RG	(78)

[a] Numbering is based on the neuraminidase subtype for type A viruses and the neuraminidase of type B viruses.
[b] Equivalent N2 numbering is based on an alignment of neuraminidases from A/Brisbane/59/2007 [H1N1], A/California/7/2009 [H1N1pdm09], A/turkey/Turkey/1/2005 [H5N1], A/Singapore/1/57 [H2N2], A/Aichi/2/68 [H3N2], A/Perth/16/2009 [H3N2], A/Hong Kong/1074/97 [H9N2], A/Anhui/1/2013 [H7N9], B/Brisbane/60/2008 [B/Vic lineage], B/Bangladesh/3333/2007 [B/Yam lineage].
[c] Assessed by NA inhibition (NI) assays: chemiluminescent (NA-Star), fluorescent (MUNANA) and/or colorimetric (fetuin). NAI phenotype is shown according to the referenced studies: NI, normal inhibition; RI, reduced inhibition; HRI, highly reduced inhibition as defined in (98). Fold-changes in IC_{50} (half maximal inhibitory concentration) relative to wild-type virus or type/subtype-specific median IC_{50}s, are shown in parentheses.
[d] Clin, clinical detection; No, no NAI used; Ose, oseltamivir used; Zan, zanamivir used; P-p, Plaque purification; RG, reverse genetics; recNA: Recombinant NA; Sur, surveillance studies; Lan, laninamivir used; Per, peramivir used. Highlighted rows signify the most common amino acid substitutions associated with HRI by oseltamivir and peramivir which have been associated with clinical resistance.
[e] ? signifies that the NAI(s) indicated were not studied.
[f] Del signifies deletion of the amino acids indicated.
[g] The positive charge on the amino acid sidechain causes higher neuraminidase K_ms for the MUNANA substrate resulting in higher IC_{50} values and therefore fold-changes relative to wild-type virus or type/subtype-specific median IC_{50}s.
[h] Some viruses lacked sufficient neuraminidase activity to allow IC_{50} determination.
[i] Precise N2 numbering cannot be given because the neuraminidase of influenza B carries an insertion in the alignment compared to the neuraminidase of H3N2.

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