

## Supplementary online only material

**Table A ICD-10 codes used for identification of viral pneumonia/severe lung involvement**

Any one of the following codes:

- J10.0 Influenza with pneumonia, virus identified
- J11.0 Influenza with pneumonia, virus not identified
- J12.0 Adenoviral pneumonia
- J12.1 Respiratory-Syncytial-Virus pneumonia
- J12.2 Parainfluenza virus pneumonia
- J12.3 Human Metapneumovirus pneumonia
- J12.8 Pneumonia caused by other viruses
- J12.9 Viral pneumonia causative agent not coded
- Combination of (J13-J18 or J44.0 or J44.1 or J80 or J81 or J96) **and** concomitant coding of (J09 or J10 or J11 or U69.20! or U69.21)
  - Details of the codes:
    - J13-J18: Pneumonia (bacterial or unclassified)
    - J44.0/J44.1 Chronic obstructive pulmonary disease with acute respiratory infection/exacerbation
    - J80 Adult respiratory distress syndrome
    - J81 Pulmonary oedema
    - J96 Respiratory failure, unclassified
    - J09 Influenza due to identified zoonotic or pandemic influenza virus
    - J10 Influenza due to identified seasonal influenza
    - J11 Influenza, virus not identified
    - U69.20! Influenza A/H1N1 pandemic 2009
    - U69.21! Influenza A/H5N1 epidemic

### ICD-10 codes used for endpoint definitions

- (1) All-cause mortality (inpatient or within 30 days post discharge)
- (2) Death / survived resuscitation/cardiac transplantation or mechanical cardiac support
  - Mechanical cardiac support: OPS 5-375, 5-376, 5-37b, 8-851, 8-852, 8-83a, 8-839.4, 8.839.a, 8.839.b
  - Resuscitation: OPS 8-77 or ICD-10 I49.0 or R09.2 or I46
- (3) Mechanical ventilation/extracorporeal lung support (ECLS)/death or resuscitation
  - Ventilation: OPS 8-70, 8-71, 5-311
  - ECLS: 8-852.0, 8-852.2

**Table B ICD-10 Codes used for identification and grouping of patients with congenital heart disease (CHD).****Simple CHD**

Isolated ventricular septal defect	Q21.0
Persistent arterial duct	Q25.0
Isolated congenital valve disease	Q23.0, Q23.1, Q22.4, Q22.8, Q22.9, Q23.2, Q23.3, Q22.1, Q22.2, Q22.3
Other congenital malformation of the great arteries	Q25.8, Q25.9

**Moderate complexity CHD**

Tetralogy of Fallot	Q21.3, Q21.80, (Q22.0 and Q21.0)
Ebstein's anomaly	Q22.5
Aortic isthmus stenosis, interrupted aortic arch	Q25.1, Q25.2
Atrioventricular septal defect	Q21.2
Partial anomalous pulmonary venous connection	Q26.3, Q26.4

**Complex CHD**

Univentricular heart	Q20.1, Q20.2, Q20.4, Q22.6, Q23.4, (Q22.0 without Q21.0)
Eisenmenger's syndrome	I27.8 and at least one further Q-Code with the exception of Q21.1 or Q21.88 and at least one further Q-Code with the exception of Q21.1
Transposition of the great arteries (TGA)	Q20.3, Q20.5
Other complex heart malformation, e.g. total anomalous pulmonary venous connection, common arterial trunk	Q20.0, Q26.2

**Table C. Co-Variables and comorbidities considered:**

Chromosomal anomalies	Q90, Q91-Q94, Q95-Q99
Cerebral infarction	I63, I64, G45
Myocardial infarction	I21, I22
Heart failure	I50.0 or I50.1
History of cancer	any C-code
Diabetes	E10-E14
Obesity	E66
Smoking history	F17
Alcohol abuse	F10
Severe renal dysfunction	N18.4, N18.5
Severe hepatic dysfunction	K72.1, K72.7
Cardiac arrhythmias	I47-I49
Arterial hypertension	I10, I11, I12, I13, I15
Chronic lung disease	J40-J47

**Drug therapy (Anatomical Therapeutic Chemical code):**Cardiac medication:

ACE-Inhibitors/ARBs	C09
Diuretics	C03
Betablockers	C07
Cardiac glycosides	C01AA
Class III antiarrhythmics	C01BD
Antiarrhythmics	C01BA, C01BB, C01BC, C01BD, C01BG, C01AA
Calcium channel blockers	C08

Antidepressants und antipsychotics N06A, N05AAnticonvulsives N03NSAIDs: C01EB16, M01AE01, C01EB16, M01AAntidiabetics: A10A, A10B, A10XAPulmonary hypertension drugs B01AC27, B01AC19, B01AC21, B01AC11, G04BE08, G04BE03, C02KXAnticoagulants (Vitamin K antagon.) B01AA04, B01AA03Novel oral anticoagulants B01AF, B01AE07Antiplatelet drugs B01AC06, B01AC04, B01AC34, B01AC36, B01AC56, B01AC86Immunosuppressants L04A, H02AB, H02B

**Table D.** Data on the distribution of virus diagnosis between the age groups and specific information about the virus types. In addition, selected information relevant to the SARS CoV-2 virus is provided from the literature.

Distribution in current study							
Virus Type	% overall	% children	% adults	Family	Characteristics	Vaccine	Antiviral therapy
Influenza	47.1%	14.2%	76.8%	Orthomyxoviridae (RNA virus)	Seasonal and epi-/pandemics	+	+
Adenovirus	2.7%	4.5%	1.1 %	Adenoviridae (dsDNA virus)	Respiratory infections / conjunctivitis / gastrointestinal infections no seasonality	(+) military personnel	(+)
RSV	28.7 %	55.5 %	4.5 %	Pneumoviridae (RNA virus)	Seasonal respiratory disease	+ monoclonal antibody	(+)
Human Metapneumovirus	1.3%	1.8%	0.8%	Pneumoviridae (RNA virus)	Respiratory infections	-	-
Parainfluenza	1.8%	1.3%	2.2%	Paramyxovirus (RNA virus)	Respiratory infections	-	-
Published data (Lu et al 2020)							
SARS CoV-2		≈1 %	≈99%	Coronaviridae (RNA virus)	Respiratory infections - Pandemic	-	-

RSV=respiratory-syncytial virus; DNA=deoxyribonucleic acid; RNA=ribonucleic acid; SARS CoV-2: severe acute respiratory syndrome coronavirus 2  
+ = available, - = absent, (+) = experimental, or approved for other indications

**Reference:** Lu X, Zhang L, Du H, Zhang J, Li YY, Qu J, Zhang W, Wang Y, Bao S, Li Y, Wu C, Liu H, Liu D, Shao J, Peng X, Yang Y, Liu Z, Xiang Y, Zhang F, Silva RM, Pinkerton KE, Shen K, Xiao H, Xu S, Wong GWK and Chinese Pediatric Novel Coronavirus Study T. SARS-CoV-2 Infection in Children. *The New Engl. J. Med.* 2020.

**Table E. Univariable predictors of outcome for the entire population on logistic regression analysis**

Variable	Timeframe considered	All cause mortality			Death/CPR/assist device/transplantation			Mechanical ventilation/ECLS/CPR/death		
		OR	95%-CI	p-Value	OR	95%-CI	p-Value	OR	95%-CI	p-Value
Age (per year)	at admission	1.04	(1.04-1.04)	<b>&lt;0.001</b>	1.04	(1.03-1.04)	<b>&lt;0.001</b>	1.02	(1.02-1.02)	<b>&lt;0.001</b>
Number of previous viral pneumonias	at admission									
none										
1		1.32	(1.08-1.61)	<b>0.007</b>	1.61	(1.35-1.93)	<b>&lt;0.001</b>	1.75	(1.52-2.02)	<b>&lt;0.001</b>
2		0.70	(0.36-1.34)	0.28	1.09	(0.65-1.80)	0.75	1.88	(1.33-2.67)	<b>&lt;0.001</b>
Female gender		0.94	(0.86-1.03)	0.16	0.90	(0.83-0.98)	<b>0.01</b>	0.94	(0.88-1.00)	0.05
CHD Complexity										
no congenital heart disease										
simple defect		0.22	(0.13-0.35)	<b>&lt;0.001</b>	0.40	(0.28-0.56)	<b>&lt;0.001</b>	0.83	(0.68-1.01)	0.06
moderate complexity		0.33	(0.14-0.75)	<b>0.008</b>	0.53	(0.28-0.98)	<b>0.04</b>	1.31	(0.92-1.87)	0.14
complex CHD		0.50	(0.23-1.09)	0.08	0.97	(0.55-1.68)	0.90	2.48	(1.73-3.56)	<b>&lt;0.001</b>
Chromosomal anomalies	prior to admission	0.66	(0.42-1.05)	0.08	0.81	(0.54-1.21)	0.30	1.44	(1.11-1.88)	<b>0.007</b>
History of cerebral infarction	prior to admission	3.16	(2.75-3.62)	<b>&lt;0.001</b>	2.88	(2.52-3.28)	<b>&lt;0.001</b>	2.14	(1.90-2.41)	<b>&lt;0.001</b>
History of myocardial infarction	prior to admission	2.44	(1.98-3.00)	<b>&lt;0.001</b>	2.49	(2.05-3.03)	<b>&lt;0.001</b>	2.22	(1.87-2.63)	<b>&lt;0.001</b>
Diagnosis of heart failure	prior to admission	2.86	(2.40-3.40)	<b>&lt;0.001</b>	2.68	(2.27-3.17)	<b>&lt;0.001</b>	2.25	(1.94-2.61)	<b>&lt;0.001</b>
History of cancer	prior to admission	4.18	(3.80-4.59)	<b>&lt;0.001</b>	3.66	(3.35-4.00)	<b>&lt;0.001</b>	2.53	(2.34-2.73)	<b>&lt;0.001</b>
Immune disease	prior to admission	1.32	(1.08-1.62)	<b>0.007</b>	1.31	(1.08-1.59)	<b>0.006</b>	1.22	(1.04-1.43)	<b>0.01</b>
History of diabetes	prior to admission	3.00	(2.72-3.31)	<b>&lt;0.001</b>	2.97	(2.71-3.26)	<b>&lt;0.001</b>	2.54	(2.35-2.74)	<b>&lt;0.001</b>
Obesity	prior to admission	2.05	(1.83-2.29)	<b>&lt;0.001</b>	2.19	(1.98-2.43)	<b>&lt;0.001</b>	2.25	(2.06-2.45)	<b>&lt;0.001</b>
Smoking history	prior to admission	2.11	(1.83-2.44)	<b>&lt;0.001</b>	2.27	(1.99-2.59)	<b>&lt;0.001</b>	2.78	(2.49-3.10)	<b>&lt;0.001</b>
History of alcohol abuse	prior to admission	2.69	(2.23-3.26)	<b>&lt;0.001</b>	2.84	(2.38-3.39)	<b>&lt;0.001</b>	2.88	(2.47-3.37)	<b>&lt;0.001</b>
Severe renal dysfunction	prior to admission	2.39	(1.83-3.11)	<b>&lt;0.001</b>	2.46	(1.92-3.15)	<b>&lt;0.001</b>	2.47	(1.99-3.06)	<b>&lt;0.001</b>
Severe hepatic disease	prior to admission	---	---	---	1.71	(0.35-8.40)	0.51	1.48	(0.37-5.87)	0.58
History of cardiac arrhythmias	prior to admission	2.84	(2.56-3.15)	<b>&lt;0.001</b>	2.65	(2.40-2.93)	<b>&lt;0.001</b>	2.13	(1.96-2.32)	<b>&lt;0.001</b>
Arterial hypertension	prior to admission	5.11	(4.64-5.62)	<b>&lt;0.001</b>	4.56	(4.18-4.98)	<b>&lt;0.001</b>	3.25	(3.03-3.47)	<b>&lt;0.001</b>
Chronic lung disease	prior to admission	1.28	(1.16-1.40)	<b>&lt;0.001</b>	1.31	(1.20-1.43)	<b>&lt;0.001</b>	1.28	(1.20-1.37)	<b>&lt;0.001</b>
Documented vaccination										
Influenza	1 year prior	2.34	(2.11-2.59)	<b>&lt;0.001</b>	2.22	(2.01-2.44)	<b>&lt;0.001</b>	1.98	(1.83-2.15)	<b>&lt;0.001</b>
Pneumococcal disease	5 years prior	1.85	(1.60-2.15)	<b>&lt;0.001</b>	1.91	(1.66-2.19)	<b>&lt;0.001</b>	1.81	(1.61-2.03)	<b>&lt;0.001</b>
Prescription medication										
Cardiac medication	prior to admission	6.54	(5.89-7.26)	<b>&lt;0.001</b>	5.65	(5.14-6.21)	<b>&lt;0.001</b>	3.65	(3.41-3.91)	<b>&lt;0.001</b>
Antidepressant or antipsychotic drugs	prior to admission	3.25	(2.94-3.59)	<b>&lt;0.001</b>	2.99	(2.72-3.29)	<b>&lt;0.001</b>	2.43	(2.24-2.63)	<b>&lt;0.001</b>
Anticonvulsives	prior to admission	2.26	(1.99-2.57)	<b>&lt;0.001</b>	2.31	(2.05-2.60)	<b>&lt;0.001</b>	2.25	(2.04-2.49)	<b>&lt;0.001</b>
NSAIDs	prior to admission	0.77	(0.70-0.85)	<b>&lt;0.001</b>	0.77	(0.70-0.84)	<b>&lt;0.001</b>	0.78	(0.73-0.84)	<b>&lt;0.001</b>
Antidiabetics	prior to admission	2.64	(2.35-2.95)	<b>&lt;0.001</b>	2.70	(2.42-3.00)	<b>&lt;0.001</b>	2.51	(2.29-2.75)	<b>&lt;0.001</b>
Pulmonary hypertension drugs	prior to admission	2.05	(1.04-4.03)	<b>0.04</b>	1.93	(1.01-3.70)	<b>0.05</b>	2.46	(1.45-4.16)	<b>0.01</b>
Anticoagulation Vitamin K antagonists	prior to admission	2.43	(2.09-2.82)	<b>&lt;0.001</b>	2.39	(2.07-2.76)	<b>&lt;0.001</b>	2.08	(1.84-2.35)	<b>&lt;0.001</b>
Novel oral anticoagulants	prior to admission	3.11	(2.67-3.61)	<b>&lt;0.001</b>	2.80	(2.41-3.24)	<b>&lt;0.001</b>	2.35	(2.06-2.67)	<b>&lt;0.001</b>
Antiplatelet drugs	prior to admission	3.02	(2.68-3.39)	<b>&lt;0.001</b>	2.84	(2.54-3.17)	<b>&lt;0.001</b>	2.22	(2.02-2.45)	<b>&lt;0.001</b>
Immunosuppressant medication	prior to admission	1.59	(1.45-1.76)	<b>&lt;0.001</b>	1.46	(1.33-1.60)	<b>&lt;0.001</b>	1.36	(1.27-1.47)	<b>&lt;0.001</b>

Results of the univariable logistic regression analysis for the entire study population, assessing associations between patient demographics, congenital diagnosis and complexity of cardiac defect, associated cardiac and extracardiac conditions as well as vaccination and medication use and death or adverse clinical outcome. Significant values are in bold. CHD=congenital heart disease, CPR=cardio-pulmonary resuscitation, ECLS=extracorporeal lung support, MCS=mechanical cardiac support, NSAIDs= Non-steroidal anti-inflammatory drugs.

**Table F. Univariable predictors of outcome for the congenital heart disease group on logistic regression analysis**

Variable	Timeframe considered	All cause mortality			Death/CPR/assist device/transplantation			Mechanical ventilation/ECLS/		
		OR	95%-CI	p-Value	OR	95%-CI	p-Value	OR	95%-CI	p-Value
Age (per year)	at admission	1.03	(1.02-1.05)	<b>&lt;0.001</b>	1.02	(1.01-1.03)	<b>&lt;0.001</b>	1.01	(1.00-1.02)	0.05
Number of previous viral pneumonias	at admission									
none		reference			reference			reference		
1		1.57	(0.52-4.68)	0.42	1.56	(0.71-3.46)	0.27	1.41	(0.86-2.30)	0.17
2		1.38	(0.17-10.95)	0.76	2.48	(0.78-7.83)	0.12	2.83	(1.31-6.14)	<b>0.008</b>
Female gender		0.95	(0.45-1.99)	0.88	0.68	(0.39-1.17)	0.16	0.86	(0.63-1.18)	0.36
CHD Complexity										
simple defect		reference			reference			reference		
moderate complexity		1.51	(0.58-3.96)	0.40	1.32	(0.64-2.69)	0.45	1.58	(1.05-2.39)	<b>0.03</b>
complex CHD		2.28	(0.90-5.77)	0.08	2.39	(1.23-4.65)	<b>0.01</b>	3.00	(1.97-4.56)	<b>&lt;0.001</b>
Chromosomal anomalies	prior to admission	1.77	(0.73-4.31)	0.21	1.62	(0.84-3.16)	0.15	1.63	(1.08-2.46)	<b>0.02</b>
History of cerebral infarction	prior to admission	6.75	(1.28-35.54)	<b>0.02</b>	3.14	(0.62-15.79)	0.17	1.79	(0.51-6.33)	0.37
History of myocardial infarction	prior to admission	-	-	-	-	-	-	2.19	(0.16-29.27)	0.56
Diagnosis of heart failure	prior to admission	4.45	(1.19-16.61)	<b>0.03</b>	2.87	(0.91-9.07)	<b>0.07</b>	1.25	(0.50-3.11)	0.63
History of cancer	prior to admission	7.59	(2.95-19.51)	<b>&lt;0.001</b>	3.75	(1.59-8.89)	<b>0.003</b>	2.09	(1.07-4.08)	<b>0.03</b>
Immune disease	prior to admission	1.41	(0.32-6.30)	0.65	0.65	(0.15-2.82)	0.57	0.88	(0.42-1.86)	0.74
History of diabetes	prior to admission	1.85	(0.23-14.96)	0.57	0.87	(0.11-6.88)	0.90	0.97	(0.31-3.06)	0.96
Obesity	prior to admission	2.64	(0.57-12.20)	0.21	3.58	(1.24-10.29)	<b>0.02</b>	2.03	(0.90-4.62)	0.09
Smoking history	prior to admission	3.93	(0.43-35.50)	0.22	7.38	(1.64-33.17)	<b>0.009</b>	2.61	(0.67-10.11)	0.17
History of alcohol abuse	prior to admission	22.04	(2.95-164.56)	<b>0.003</b>	10.16	(1.44-71.78)	<b>0.02</b>	10.43	(1.54-70.62)	<b>0.02</b>
Severe renal dysfunction	prior to admission	17.14	(2.53-116.30)	<b>0.004</b>	7.93	(1.23-51.14)	<b>0.03</b>	10.95	(1.83-65.40)	<b>0.009</b>
History of arrhythmia	prior to admission	3.63	(1.29-10.25)	<b>0.02</b>	1.58	(0.59-4.25)	0.36	1.11	(0.57-2.17)	0.75
Arterial hypertension	prior to admission	4.44	(1.68-11.75)	<b>0.003</b>	2.71	(1.18-6.24)	<b>0.02</b>	1.67	(0.91-3.05)	0.10
Chronic lung disease	prior to admission	0.95	(0.40-2.28)	0.91	0.81	(0.43-1.55)	0.53	0.64	(0.43-0.94)	<b>0.02</b>
Documented vaccination										
Influenza	1 year prior	3.05	(1.29-7.20)	<b>0.011</b>	1.24	(0.56-2.73)	0.60	1.30	(0.82-2.08)	0.27
Pneumococcal disease	5 years prior	3.73	(0.99-14.00)	0.05	2.44	(0.77-7.70)	0.13	1.56	(0.67-3.63)	0.30
Prescription medication										
Cardiac medication	prior to admission	6.68	(3.12-14.27)	<b>&lt;0.001</b>	3.51	(1.96-6.29)	<b>&lt;0.001</b>	2.37	(1.60-3.53)	<b>&lt;0.001</b>
Antidepressant or antipsychotic drugs	prior to admission	4.00	(0.83-19.37)	0.09	1.86	(0.40-8.67)	0.43	1.67	(0.60-4.64)	0.33
Anticonvulsives	prior to admission	2.34	(0.84-6.50)	0.10	1.45	(0.62-3.39)	0.40	2.49	(1.51-4.09)	<b>&lt;0.001</b>
NSAIDs	prior to admission	0.65	(0.29-1.45)	0.30	0.49	(0.27-0.89)	<b>0.02</b>	0.48	(0.34-0.68)	<b>&lt;0.001</b>
Antidiabetics	prior to admission	4.37	(0.47-40.41)	0.19	2.07	(0.23-18.38)	0.52	1.11	(0.21-5.81)	0.90
Pulmonary hypertension drugs	prior to admission	3.89	(0.44-34.73)	0.22	1.85	(0.21-15.93)	0.58	1.68	(0.40-7.00)	0.48
Anticoagulation Vitamin K antagonists	prior to admission	4.46	(0.91-21.90)	0.07	2.07	(0.44-9.80)	0.36	1.10	(0.34-3.56)	0.87
Novel oral anticoagulants	prior to admission	3.88	(0.43-34.61)	0.23	1.84	(0.21-15.82)	0.58	2.53	(0.66-9.64)	0.18
Antiplatelet drugs	prior to admission	8.29	(2.43-28.37)	<b>0.001</b>	4.99	(1.65-15.07)	<b>0.004</b>	2.10	(0.83-5.29)	0.12
Immunosuppressant medication	prior to admission	1.51	(0.69-3.31)	0.31	1.07	(0.58-1.95)	0.83	0.78	(0.53-1.13)	0.18

Results of the univariable logistic regression analysis for the congenital heart disease (CHD) population, assessing associations between patient demographics, congenital diagnosis and complexity of cardiac defect, associated cardiac and extracardiac conditions as well as vaccination and medication use and death or adverse clinical outcome. Significant values are in bold. CHD=congenital heart disease, CPR=cardio-pulmonary resuscitation, ECLS=extracorporeal lung support, MCS=mechanical cardiac support, NSAIDs=Non-steroidal anti-inflammatory drugs.