Public health impact of nirsevimab on lower respiratory infections associated with respiratory syncytial virus among Chinese infants

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INTRODUCTION

- Respiratory syncytial virus (RSV) is the most common viral cause of lower respiratory tract infections (LRTI) in young children, resulting in substantial morbidity, mortality and health-care utilization, particularly among infants in their first RSV season [1].
- Globally, RSV is the leading cause of hospitalizations among infants <2 years old and is responsible for up to 70.8% of all hospitalizations for bronchiolitis [2].
- As a seasonal virus, the onset and duration of RSV circulation vary across the globe, and the monthly probability of developing RSV-LRTI depends strongly on RSV circulation across the country and the different regions [3-4].
- There is no specific treatment and prevention for RSV cases in China as of today. A new monoclonal antibody with extended half-life, nirsevimab, displayed significant efficacy against RSV, which is anticipated to become accessible in the near future in China [5-6].
- This study aims to assess the potential impact of nirsevimab on RSV-LRTI events and associated costs for all infants in their first RSV season in China compared to no intervention.

METHODS

- Model overview: A static decision-analytic model was developed to track a Chinese national birth cohort in 2020 during their first RSV season (Figure 1) [4]. All infants in the model were considered susceptible to RSV-LRTIs, with risk changing during the year, depending on age, level of RSV circulation over the season, and infant subpopulation (Table 1).
- Model populations: Infants in the birth cohort were stratified into subgroups, including higher-risk infants (i.e., those with <35 weeks' gestational age [wGA], or those with comorbid conditions) and healthy term infants (i.e., those with ≥35 wGA and without comorbid conditions) [7].
- Model strategies: (A) no prophylaxis provided for any infants; (B) administration of nirsevimab for infants applying lower and higher coverage rates.

Figure 1. Markov decision tree

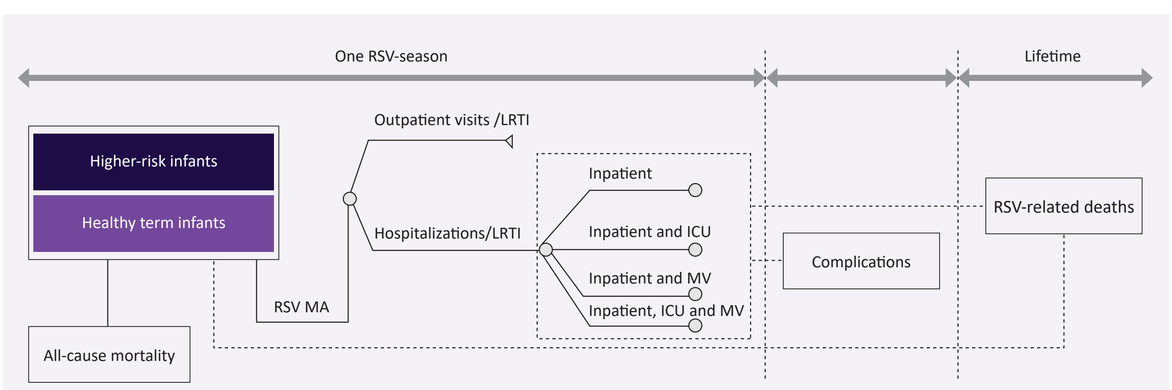


Table 1. Age-specific model parameters

Inputs	Higher-risk infants	Healthy term infants
Population size, n	627 372	11 377 320
Proportion of annual births by month, %	Month-specific estimates	
Monthly probability of RSV infections, %	Month-specific estimates	
Per-patient risk of RSV, %, outpatient, inpatient	Month-specific estimates	
Per-inpatient risk of severe cases, %, ICU, MV	Month-specific estimates	
Per-inpatient risk of recurrent wheezing, %, Year 1, 2, 3	31, 27, 17	31, 27, 17
Mortality rates, %, All-cause mortality, RSV-related hospitalization CFR		
0–5 mo	0.0055, 0.0187	0.0055, 0.0074
6–11 mo	0.0055, 0.0094	0.0055, 0.0037
QALY loss of health events and complications		
Inpatient episode/ICU/MV	0.0102	0.0102
Outpatient episode	0.0063	0.0063
Caregiver QALY loss	0.0008	0.0008
Recurrent wheezing (Year 1)	0.0392	0.0392
Premature death	27.7822	27.7822
Cost by event, 2020 USD		
Inpatient cases, $, direct medical (hospitalizations alone), direct medical (ICU/MV), direct non-medical, indirect	612, 984, 300, 331	612, 984, 300, 331
Outpatient cases, $, direct medical, direct non-medical, indirect	72, 27, 54	72, 27, 54
Recurrent wheezing (Year 1), $, direct medical, direct non-medical	398, 148	398, 148
Lifetime lost earnings due to infant RSV death, $	128 595	128 595
Nirsevimab product profile		
Efficacy, %, outpatient, inpatient	79.5, 83.21	79.5, 83.21
Uptake rate, %, lower, higher	20, 60	10, 30
Duration of protection by dose, mo	5	5

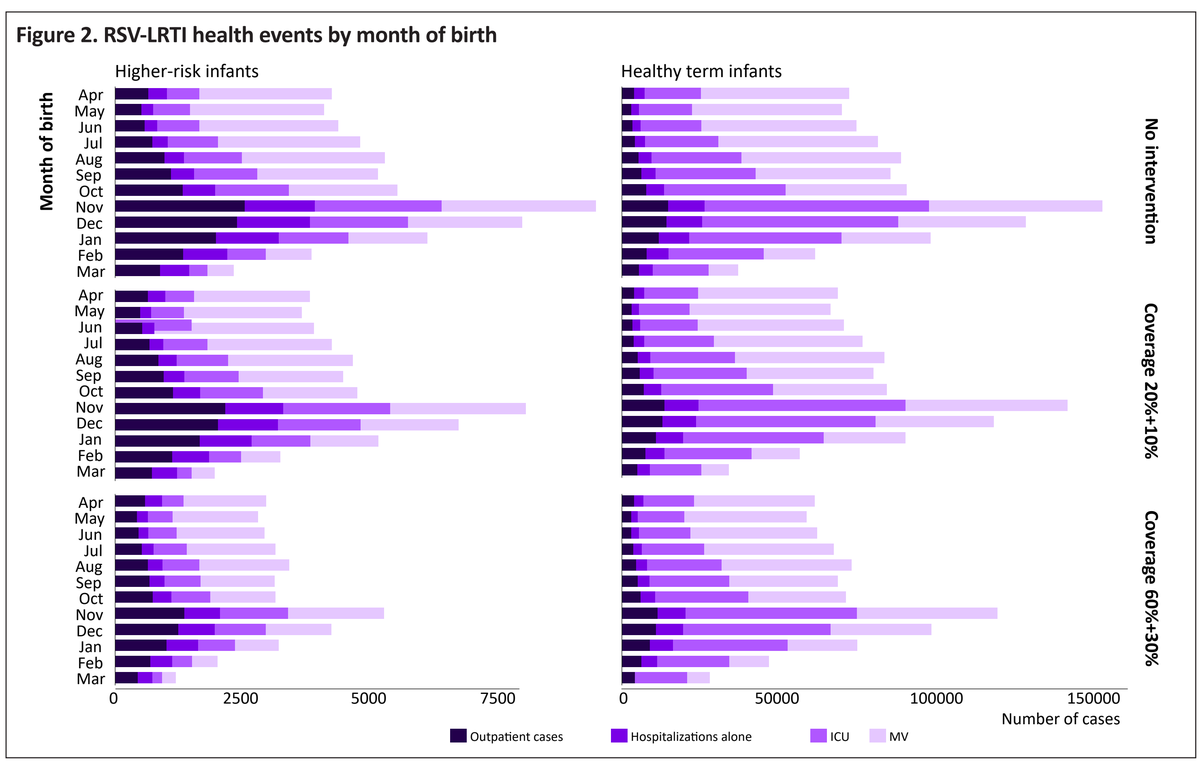
RESULTS

- Disease burden in the scenario of no intervention (A) vs Disease burden with nirsevimab administration applying lower (B1) and higher (B2) coverage rates (Table 2 and Figure 2).
- Under the scenario of no intervention in 2020, a total of 1,094,442 RSV-LRTI cases (including 594,454 hospital admissions), 4,564 in-hospital deaths, 153,903 QALY loss and $1,706 million (in 2020 USD) associated costs were observed. Higher-risk infants (5.23% of the birth cohort) accounted for 11.65% of inpatient severe cases, and 7.45% of costs.
- The administration of nirsevimab with 20% coverage for higher-risk infants and 10% for healthy term infants was predicted to avert 78,597 RSV-LRTI cases (44,497 hospital admissions) and 12,260 QALY loss, saving $131 million.
- Improved coverage to 60% for higher-risk infants and 30% for healthy term infants would result in larger decreases in RSV-LRTI health and economic burden, averting 235,791 RSV-LRTI cases (133,493 hospital admissions), 36,780 QALY loss, and saving $393 million in costs.

Table 2. RSV-LRTI health events and related costs

Inputs	Disease burden in different scenarios			Differences in burden	
	A	B1	B2	B1 vs. A	B2 vs. A
Health outcomes					
Total cases (incl. outpatient and inpatient)	10,94,442	10,15,845	8,58,651	-78,597	-2,35,791
Outpatient cases	4,99,988	4,65,888	3,97,690	-34,100	-1,02,298
Inpatient cases (incl. ICU and MV)	5,94,454	5,49,957	4,60,961	-44,497	-1,33,493
Hospitalizations Alone	4,17,444	3,86,926	3,25,886	-30,518	-91,558
ICU	77,610	71,635	59,686	-5,975	-17,924
MV	99,400	91,396	75,389	-8,004	-24,011
Inpatient deaths	4,564	4,195	3,457	-369	-1,107
Total QALY loss	1,53,903	1,41,643	1,17,124	-12,260	-36,780
Outpatient cases	3,151	2,936	2,506	-215	-645
Inpatient cases (incl. ICU and MV)	1,32,865	1,22,156	1,00,739	-10,708	-32,125
Hospitalizations Alone	4,258	3,947	3,324	-311	-934
ICU	792	731	609	-61	-183
MV	1,014	932	769	-82	-245
Premature deaths	1,26,801	1,16,547	96,037	-10,255	-30,764
Recurrent wheezing	17,066	15,789	13,234	-1,277	-3,832
Year 1	7,224	6,683	5,602	-541	-1,622
Year 2	6,108	5,651	4,737	-457	-1,372
Year 3	3,734	3,455	2,896	-280	-839
QALY loss of caregivers	822	763	645	-59	-177
Cost outcomes (2020 USD)					
Total cost	1,70,55,87,226	1,57,46,23,280	1,31,26,95,385	-13,09,63,946	-39,28,91,841
Direct cost of outpatient cases	4,96,74,103	4,62,86,311	3,95,10,727	-33,87,792	-1,01,63,376
Direct cost of inpatient cases (incl. ICU and MV)	60,75,19,432	56,17,72,783	47,02,79,483	-4,57,46,649	-13,72,39,949
Hospitalizations Alone	38,03,46,064	35,25,38,992	29,69,24,848	-2,78,07,072	-8,34,21,216
ICU	9,96,03,343	9,19,36,007	7,66,01,334	-76,67,336	-2,30,02,009
MV	12,75,70,025	11,72,97,784	9,67,53,301	-1,02,72,241	-3,08,16,724
Direct cost of recurrent wheezing	23,78,95,775	22,00,88,213	18,44,73,088	-1,78,07,562	-5,34,22,687
Indirect cost	81,04,97,916	74,64,75,973	61,84,32,087	-6,40,21,943	-19,20,65,829
Labor loss of caregivers	22,35,76,298	20,70,19,497	17,39,05,894	-1,65,56,801	-4,96,70,404
Premature deaths	58,69,21,618	53,94,56,476	44,45,26,193	-4,74,65,142	-14,23,95,425

Figure 2. RSV-LRTI health events by month of birth



DISCUSSION

- To our knowledge, this study is the first study to provide a comprehensive view of season-specific burden of RSV-LRTI capturing outpatient and inpatient cases among Chinese infants of different months of age for both higher-risk and healthy term infants subgroups, and underscore the clinical importance of preventive strategies of RSV-LRTI.
- High RSV-LRTI burden in all infants, including higher risk infants and healthy term infants: While higher risk infants are at a higher risk of inpatient severe cases and in-hospital deaths, attention should also be directed towards the healthy term group which represents 94.77% of the overall RSV burden, highlighting the importance of prevention strategies such as nirsevimab for all infants to significantly reduce the RSV burden.
- Reducing disease burden with nirsevimab timely immunisation: The use of nirsevimab has the potential to reduce the disease burden and economic costs associated with RSV-LRTI, and a higher uptake is associated with greater benefits.
- Limitation of the study: Uncertainty around nirsevimab uptake and limited local data available in China. Since there lack reliable forecasts regarding the coverage rate once the product became available, different assumed coverage rates were evaluated after considering the coverage of self-paid non-National Immunization Program (NIP) vaccines as a proxy [8]. In addition, where age group specific data inputs were required for the model but Chinese data was unavailable, international RSV specific references were used as assumptions for health events and utility inputs.

CONCLUSIONS

- Considering the substantial RSV health and economic burden on Chinese infants in their first RSV season, nirsevimab introduction may serve as an effective prophylaxis in reducing this burden in all Chinese infants. The findings underscore the significance of introducing preventive measures and advocate for further high coverage, which would yield considerable benefits to public health.

REFERENCES

1. Li Y, Wang X, Blau DM, et al. Global, regional, and national disease burden estimates of acute lower respiratory infections due to respiratory syncytial virus in children younger than 5 years in 2019: a systematic analysis. *Lancet.* 2022;399(10340):2047-2064.; 2. Kenmoe S, Kengne-Nde C, Ebogo-Belobo JT, et al. Systematic review and meta-analysis of the prevalence of common respiratory viruses in children < 2 years with bronchiolitis in the pre-COVID-19 pandemic era. *PLoS One.* 2020;15(11):e0242302.; 3. Zhang Y, Yuan L, Zhang Y, et al. Burden of respiratory syncytial virus infections in China: systematic review and meta-analysis. *J Glob Health*. 2015;5(2):020417.; 4. Kieffer A, Beuvelet M, Sardesai A, et al. Expected impact of universal immunization with nirsevimab against RSV-related outcomes and costs among all US infants in their first RSV season: a static model. *J Infect Dis*. 2022;226(Suppl 2):S282-S292.; 5. Griffin MP, Yuan Y, Takas T, et al. Single-dose nirsevimab for prevention of RSV in preterm infants. *N Engl J Med.* 2020;383(5):415-425.; 6. Simões EAF, Madhi SA, Muller WJ, et al. Efficacy of nirsevimab against respiratory syncytial virus lower respiratory tract infections in preterm and term infants, and pharmacokinetic extrapolation to infants with congenital heart disease and chronic lung disease: a pooled analysis of randomised controlled trials. *Lancet Child Adolesc Health*. 2023;7(3):180-189.; 7. Chawanpaiboon S, Vogel JP, Moller AB, et al. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. *Lancet Glob Health*. 2019; 7: e37-e46.; 8. Zhang H, Lai X, Mak J, et al. Coverage and equity of childhood vaccines in China. *JAMA Netw Open*. 2022; 5: e2246005.

CONFLICTS OF INTEREST:

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