Point-of-Care Polymerase Chain Reaction Testing Versus Antigen Testing for Influenza, SARS-CoV-2, and RSV is Cost-Saving in a German Hospital

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1. BACKGROUND

- Acute respiratory infection (ARI) poses a significant public health challenge in Germany. During the 2023/2024 season, the combined burden of influenza, severe acute respiratory coronavirus 2 (SARS-CoV-2), and respiratory syncytial virus (RSV) was approximately 700,000 laboratory-confirmed cases, 200,000 hospitalizations, and 9,000 deaths [1].
- The practice of cohorting, whereby patients with the same test-confirmed virus are placed in the same multi-bed hospital room, is one strategy for increasing the efficiency of resource utilization. Effective cohorting relies on the correct identification of viruses to determine which patients can be placed together without the possibility of nosocomial transmission.

2. OBJECTIVE

Our objective was to evaluate the clinico-economic impact of point-of-care (POC) testing with a polymerase chain reaction (PCR) test versus an antigen test. The PCR test was modeled after the Xpert® Xpress CoV-2/Flu/RSV plus test.
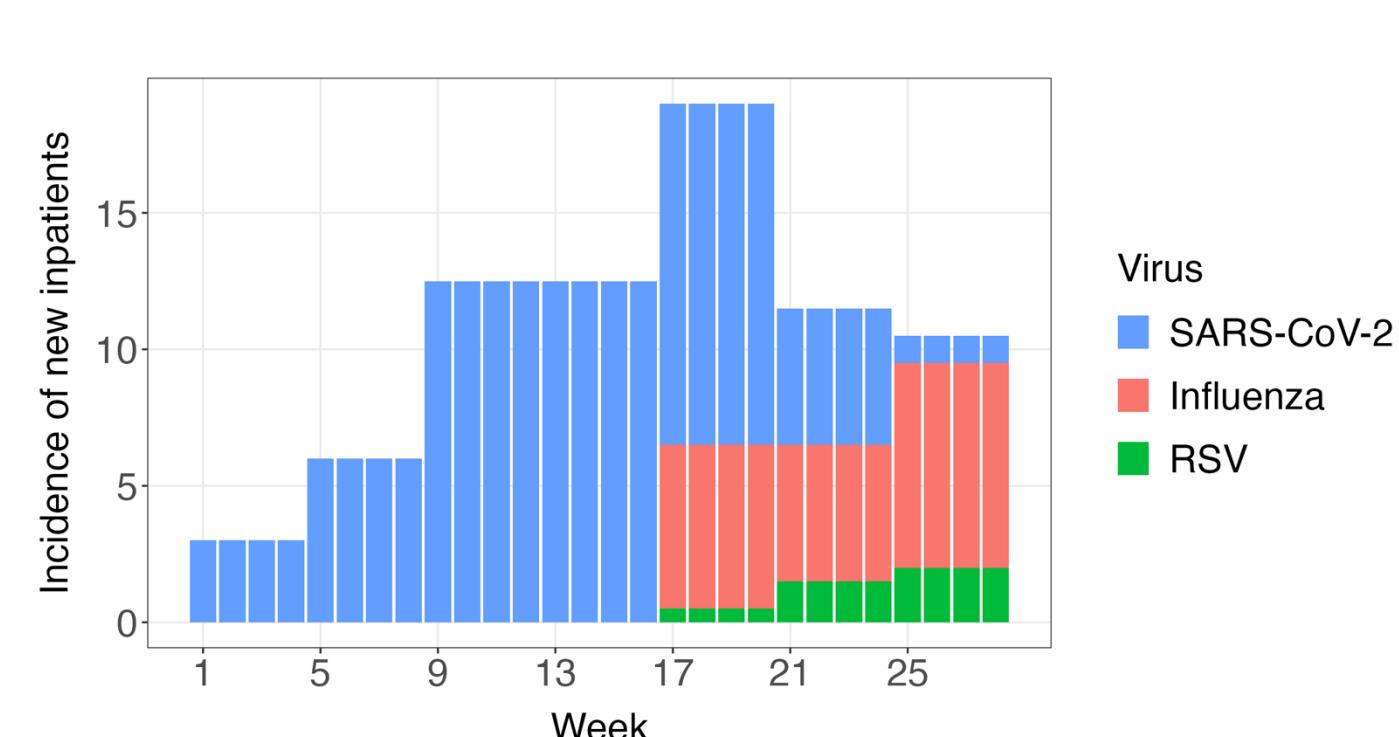
3. METHODS

- We developed an agent-based model based on the ARI patient pathway at a large (500+ beds) German hospital.
- **Figure 1** shows a model schematic. **Table 1** lists the model parameters.
- **Patient population.** The simulated population consists of adult patients arriving at the emergency department with severe ARI symptoms requiring hospitalization. **Figure 2** shows the time series of weekly patient incidence stratified by virus type.
- **Hospital layout.** *ICU* represents the intensive care unit. *Infection* represents the ward dedicated to respiratory illness. *Overflow* is an abstract representation of non-respiratory illness wards where ARI patients may be redirected in case of overflow in the *Infection* ward.
- **Testing and cohorting.** Patients enter the hospital via the emergency department, where POC testing with either an antigen or PCR test is performed. A cohorting decision is made based on the POC test result (**Figure 1**, bottom left).
- **Room disinfection.** In a multi-bed room, once a bed is vacated, it cannot be occupied again until every patient in the room has been discharged and the room has been disinfected. This assumption is relaxed in the *ICU* and *Infection* ward due to the high bed demand. These rooms are disinfected only once they are completely vacated.
- **Healthcare workers.** Healthcare workers (HCWs) must enter occupied rooms to treat patients. Room entries are assumed to be spread uniformly over 24 hours. Every room entry requires donning a fresh set of personal protective equipment (PPE).
- **Nosocomial infection.** Nosocomial infection can occur in the *Overflow* ward only due to lower patient and visitor adherence to infection prevention measures.
- **Opportunity cost of blocked beds.** When a patient is isolated due to an unidentified virus, the other beds in that room are "blocked," i.e., prevented from accommodating other patients for the duration of the isolated patient's length-of-stay (LOS).

Figure 1. Model schematic of the ARI patient pathway at a German hospital.

4. RESULTS

- Despite a tenfold increase in testing costs, the higher diagnostic accuracy of the PCR test enabled greater opportunities for cohorting, leading to substantial cost savings over one respiratory illness season (**Table 2**).
- The overall virus detection rate was 61% using antigen testing and 98% using PCR testing.
- In the antigen testing scenario, the total cost was EUR 744,000, with the opportunity cost of 988 unused bed days accounting for 97% of the total cost.
- In the PCR testing scenario, the total cost was EUR 62,741, with the opportunity cost of 48 unused bed days accounting for 56% of the total cost.
- Total cost savings amounted to EUR 681,259 (EUR 2,302 per patient) when PCR testing was used in place of antigen testing.
- One-way sensitivity analysis indicated that the model parameters with the greatest influence on total cost savings per patient were (1) non-*ICU* LOS for SARS-CoV-2, (2) opportunity cost of blocked bed days, and (3) non-*ICU* LOS for influenza (**Figure 3**).

Table 1. List of model parameters.

Parameter	Base	Low	High	Reference
PCR test: Sensitivity (probability of detection)				
Influenza	0.97	0.95	0.98	[2]
SARS-CoV-2	0.98	0.95	0.99	[3]
RSV	0.96	0.94	0.98	[2]
Antigen test: Sensitivity (probability of detection)				
Influenza	0.544	0.489	0.598	[4]
SARS-CoV-2	0.706	0.672	0.738	[3]
ICU admission rate				
Influenza	0.17	-25%	+25%	
SARS-CoV-2	0.17	-25%	+25%	[5]
RSV	0.29	-25%	+25%	
ICU mortality rate				
Influenza	0.50	-25%	+25%	
SARS-CoV-2	0.52	-25%	+25%	[5]
RSV	0.70	-25%	+25%	
ICU LOS (days)				
Influenza	5.2	2.3	7.8	
SARS-CoV-2	4.0	2.0	7.9	[5]
RSV	5.6	2.6	10.5	
Non-_ICU_ LOS (days)				
Influenza	7.3	4.2	11.4	
SARS-CoV-2	7.2	3.8	13.7	[5]
RSV	6.0	3.7	12.9	
Number of room entries per day by HCWs				
ICU	12	5	15	Kliniken Heidenheim
Non-*ICU*	8	4	10	
Duration of room disinfection (hours)	0.75	-25%	+25%	Kliniken Heidenheim
Ratio of hospital-acquired ARI to community-acquired ARI in the _Overflow_ ward	15:100	10:100	20:100	[6], [7]
Cost of testing				
PCR test	50	-25%	+25%	Cepheid
Antigen test	5	-25%	+25%	
Opportunity cost of blocked bed per day (EUR)	734.53	-25%	+25%	[8]
Cost of PPE donned to enter a patient room (EUR)	1.82	-25%	+25%	Kliniken Heidenheim
ICU	1.82	-25%	+25%	
Non-*ICU*	0.66	-25%	+25%	
Cost per hour of room disinfection (EUR)	32.50	-25%	+25%	Kliniken Heidenheim

Existing antigen tests for RSV are targeted at the paediatric population and known to be unreliable when used in adults (sensitivity: 0.22 [0.11–0.33]) [9]. Therefore, antigen testing for RSV was excluded.

Table 2. Base case model outcomes.

Model outcome	Antigen testing	PCR testing	Difference
Number of unused bed days	988	48	-940
Number of room entries	14,283	11,555	-2,728
Number of room disinfections	192	103	-89
Number of nosocomial infections	4	1	-3
Cost of testing (EUR)	1,480	14,800	+13,320
Opportunity cost of blocked beds (EUR)	725,359	35,127	-690,232
Cost of PPE (EUR)	12,481	10,310	-2,171
Cost of room disinfections (EUR)	4,680	2,504	-2,176
Total cost (EUR)	**744,000**	**62,741**	**-681,259**
Total cost per ARI patient (EUR)	**2,514**	**212**	**-2,302**

Figure 3. One-way sensitivity analysis tornado plot.

Figure 2. Time series of patient incidence.

Based on data for the period from August 2023 to February 2024 [5].
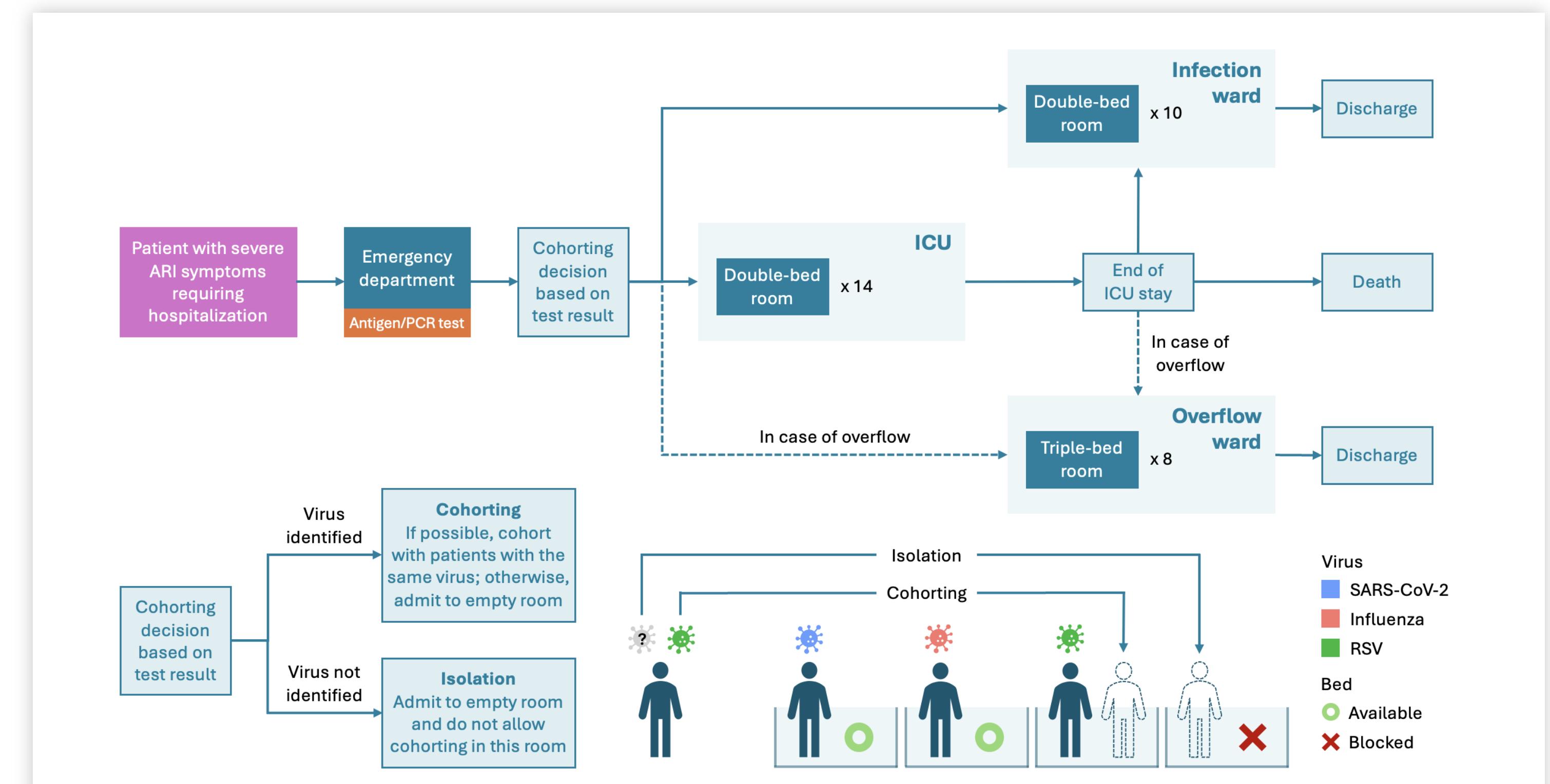
5. LIMITATIONS

The model does not allow for the possibility of recovery. A patient who is no longer infectious after their ICU stay may not require further cohorting or isolation, but the model does not capture retesting upon ICU discharge and the associated potential cost-savings.

6. CONCLUSIONS

PCR testing at the POC could greatly increase the virus detection rate among ARI patients, leading to more efficient cohorting, improved bed management, and reduced hospital expenditures associated with influenza, SARS-CoV-2, and RSV.

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