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

Martin Grünewald[1], Hans Eberhardt[1], Jade Xiao[2], Anika Jöcker[3], Oya Hoban[2], Mert Edali[2,4], Jagpreet Chhatwal[2,5,6], Ruth Pulikottil-Jacob[7]

[1] Kliniken Landkreis Heidenheim, Heidenheim, Germany; [2] Value Analytics Labs, Boston, MA, USA; [3] Cepheid GmbH, Krefeld, Germany; [4] Yildiz Technical University, Istanbul, Turkey; [5] Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA; [6] Center for Health Decision Science, Harvard University, Boston, MA, USA; [7] Cepheid UK, High Wycombe, UK

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 Klinken Heidenheim (KH) 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.
- **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**). In the antigen scenario, patients with a negative test result receive confirmatory PCR testing, assumed to have 100% sensitivity. Upon receiving the confirmatory test result, the patient can end isolation, i.e., cohorting is now permitted in their room.
- **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).

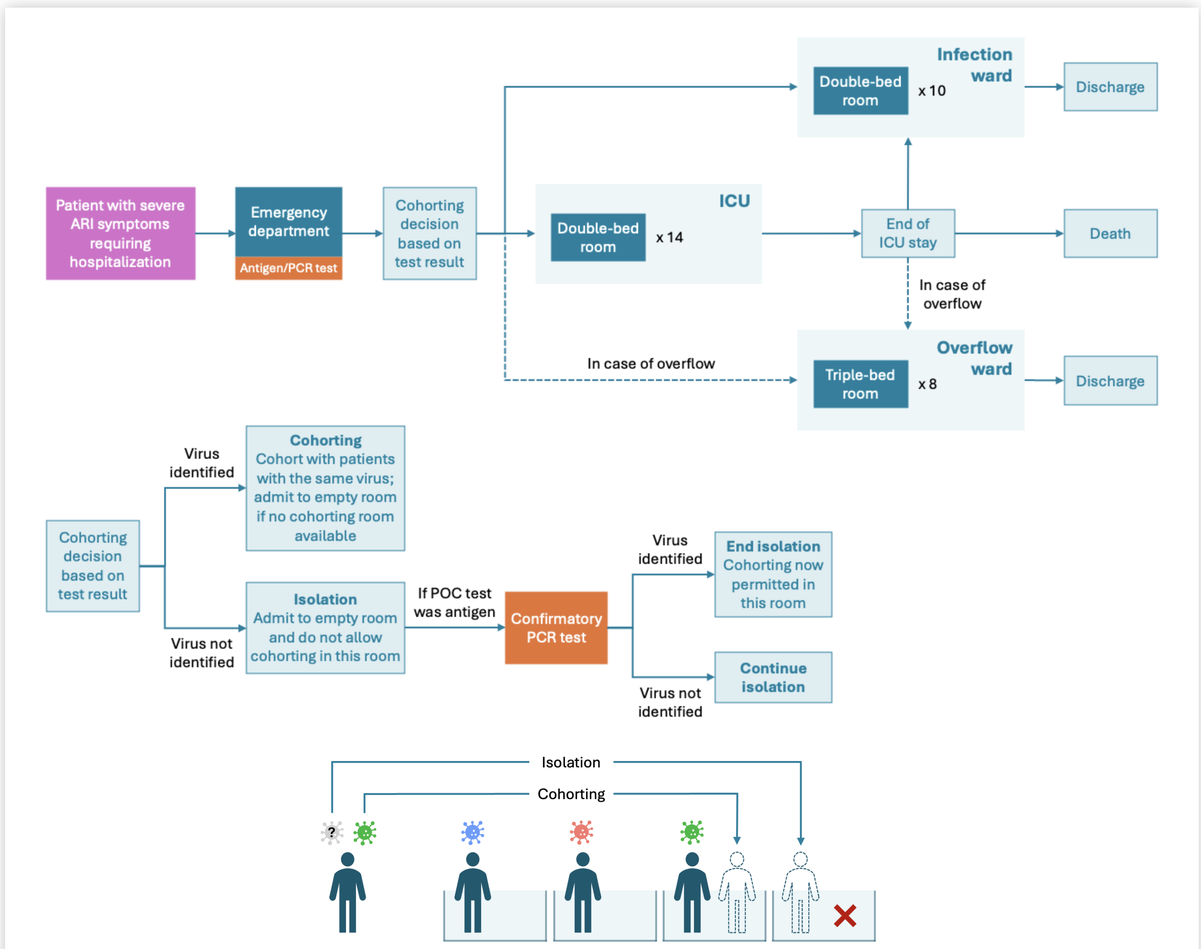

Figure 1. Model schematic of the ARI patient pathway at a German hospital.

Table 1. List of model parameters.

Parameter	Base	Low	High	Reference
PCR test: Sensitivity				
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				
Influenza	0.544	0.489	0.598	[4]
SARS-CoV-2	0.706	0.672	0.738	[3]
Time to receive confirmatory PCR test result (hours)	16	8	24	KH
***ICU* admission rate**				
Influenza	0.17	-25%	+25%	[6]
SARS-CoV-2	0.17	-25%	+25%	
RSV	0.29	-25%	+25%	
***ICU* mortality rate**				
Influenza	0.50	-25%	+25%	[6]
SARS-CoV-2	0.52	-25%	+25%	
RSV	0.70	-25%	+25%	
***ICU* LOS (days)**				
Influenza	5.2	2.3	7.8	[6]
SARS-CoV-2	4.0	2.0	7.9	
RSV	5.6	2.6	10.5	
Non-*ICU* LOS (days)				
Influenza	7.3	4.2	11.4	[6]
SARS-CoV-2	7.2	3.8	13.7	
RSV	6.0	3.7	12.9	
Number of room entries per day by HCWs				
ICU	12	5	15	KH
Non-*ICU*	8	4	10	
Duration of room disinfection (hours)	0.75	-25%	+25%	KH
Ratio of hospital-acquired ARI to community-acquired ARI in the *Overflow* ward	15:100	10:100	20:100	[7], [8]
Cost of testing				
PCR test	50	-25%	+25%	Cepheid
Antigen test	5	-25%	+25%	Cepheid
Confirmatory PCR test		-25%	+25%	
Opportunity cost of blocked bed per day (EUR)	734.53	-25%	+25%	[9]
Cost of PPE donned to enter a patient room (EUR)				
ICU	1.82	-25%	+25%	KH
Non-*ICU*	0.66	-25%	+25%	
Cost per hour of room disinfection (EUR)	32.50	-25%	+25%	KH

Figure 2. One-way sensitivity analysis tornado plot.

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 66% using antigen testing and 98% using PCR testing.
- Total cost savings amounted to EUR 605,440 (EUR 2,045 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 2. Base case model outcomes.

Model outcome	Antigen testing	PCR testing	Difference
Number of unused bed days	884	48	-836
Number of room entries	14,140	11,555	-2,585
Number of room disinfections	187	103	-84
Number of nosocomial infections	4	1	-3
Cost of testing (EUR)	1,480	14,800	+13,320
Opportunity cost of blocked beds (EUR)	649,802	35,127	-614,675
Cost of PPE (EUR)	12,355	10,310	-2,045
Cost of room disinfections (EUR)	4,544	2,504	-2,040
Total cost (EUR)	**668,181**	**62,741**	**-605,440**
Total cost per ARI patient (EUR)	**2,257**	**212**	**-2,045**

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. CONCLUSION

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

References

1. Buda S et al. (2024). ARE-Wochenbericht KW 40.
2. Liu Y-L et al. (2022). Diagnostic Accuracy of Xpert Xpress Flu/RSV for the Detection of Influenza and Respiratory Syncytial Viruses. *Japanese Journal of Infectious Diseases*.
3. Fragkou PC et al. (2023). Performance of point-of care molecular and antigen-based tests for SARS-CoV-2: a living systematic review and meta-analysis. *Clinical Microbiology and Infection*.
4. Merckx J et al. (2017). Diagnostic Accuracy of Novel and Traditional Rapid Tests for Influenza Infection Compared With Reverse Transcriptase Polymerase Chain Reaction. *Ann Intern Med*.
5. Martin D et al. (2021). Dynamics of nosocomial parainfluenza virus type 3 and influenza virus infections at a large German University Hospital between 2012 and 2019. *Diagn Microbiol Infect Dis*.
6. Huzly D et al. (2015). Characterisation of nosocomial and community-acquired influenza in a large university hospital during two consecutive influenza seasons. *J Clin Virol*.
7. Diel R, Nienhaus A. (2023). Cost–Benefit of Real-Time Multiplex PCR Testing of SARS-CoV-2 in German Hospitals. *International Journal of Environmental Research and Public Health*.

Presented at ESCV 2025 | Corresponding author email: Martin.Gruenewald@Kliniken-Heidenheim.de | This study was funded by Cepheid, Sunnyvale, USA.