

Risk of incident SARS-CoV-2 infection among healthcare workers residing in Egyptian quarantine hospitals

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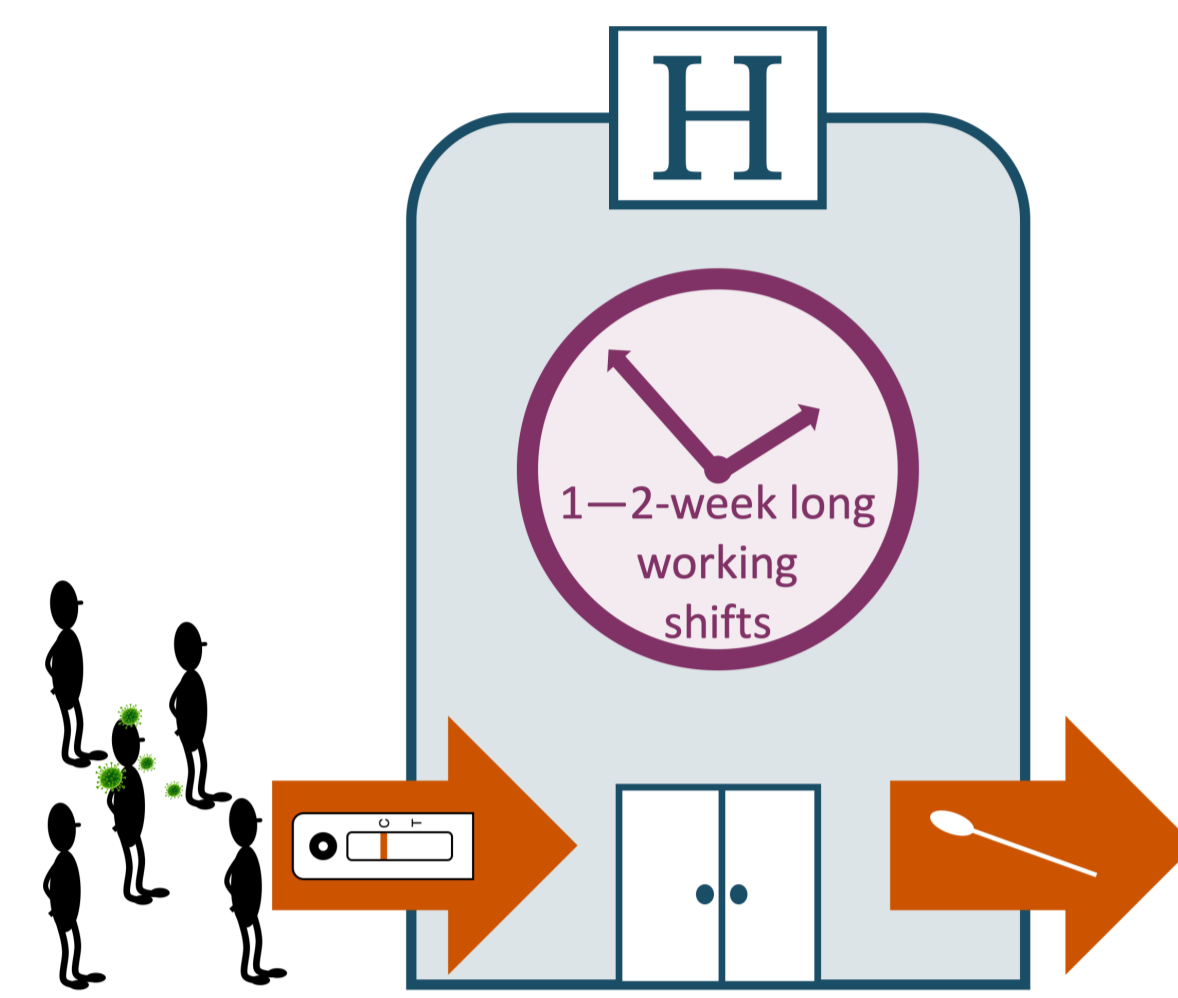
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INTRODUCTION

Quarantine hospitals

- Implemented only in Egypt
- Externally-referred COVID-19 patients only
- Healthcare workers (HCWs) screened for SARS-CoV-2 infection (IgM/IgG antibody tests) before starting working shifts
- HCWs resided continuously within hospital
- Infected HCWs were isolated or admitted



Within-shift testing strategy

HCWs tested using RT-PCR tests:

- At the end of working shifts
- Upon symptoms
- In case of outbreak suspicion (>2 positive tests among HCWs)

OBJECTIVES

- To estimate the risk of SARS-CoV-2 infection among HCWs in quarantine-hospital settings
- To assess the relative contribution of HCW-to-HCW (HtoH) and patient-to-HCW (PtoH) transmissions.

DATA

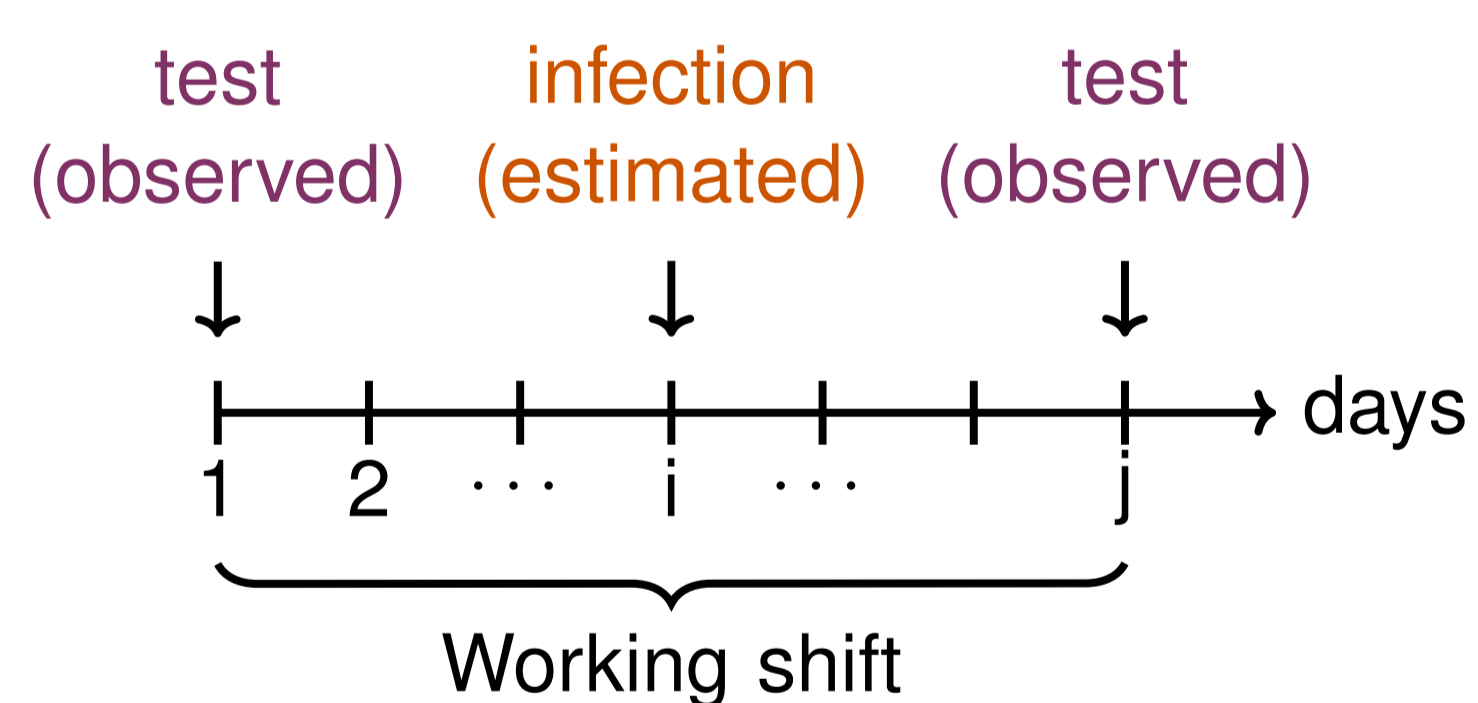
Detailed longitudinal data was collected in two healthcare facilities (denoted by **Hosp1** and **Hosp2**), during the 2020 first wave of the epidemic.

| | Hosp1 | Hosp2 |
|---|-------------------|----------------|
| Study period | March 14–August 1 | June 6–July 11 |
| Working shifts duration | 14 days | 7 days |
| Mean number of HCWs per shift (min–max) | 46.6 (34–63) | 19.2 (16–20) |
| Number of beds | 90–100 | 35 |

METHODS

Challenges

- Imperfect diagnosis (false negative test results)
- Right censoring (test at end of shift)



Model description

- SARS-CoV-2 infection model:** Stochastic compartmental model

$$I_H \sim \text{Binom}(S, \lambda)$$

where: I_H = infected HCWs
 S = susceptible HCWs
 λ = infection risk

- Observation model:** Time-since-exposure variation in false-negative rates of RT-PCR tests

- Model fitting:** Parameter estimation using Markov Chain Monte Carlo approaches

Modeling different routes of transmission

- Model λ considering PtoH and HtoH transmission (see Table 3)
- Use the Deviance Information Criterion (DIC) for model comparison

RESULTS

1. Observed relative risk of SARS-CoV-2 infection

Over both quarantine hospitals:

| HCWs | Events | PD | IRR | 95%CI | <i>p</i> |
|--------------------------|--------|-------|------|-----------|----------|
| Affectation ICU | 12 | 1 848 | 1 | ref | |
| Intermediate care | 10 | 1 549 | 0.95 | 0.43–2.11 | 0.897 |
| Standard care* | 21 | 3 528 | 2.27 | 0.95–5.39 | 0.064 |
| Occupation Doctor | 7 | 2 207 | 1 | ref | |
| Nurse | 34 | 4 736 | 2.17 | 0.98–4.82 | 0.057 |

Abbreviations: PD=person-days; IRR=Incidence rate ratio; CI=Confidence interval.

* No standard care unit in Hosp2.

2. Model-based estimation of the daily risk of infection

Assuming constant risk over the study period:

| | Hosp1 | Hosp2 |
|--|--------------------|---------------------|
| Incidence rate per 100 PD* (95% CrI) | 0.97 (0.56–1.53) | 8.98 (3.81–17.75) |
| Probability for a HCW to be infected at the end of a shift (95% CrI) | 12.8% (7.6%–19.5%) | 48.2% (23.8%–74.5%) |

Abbreviations: PD=person-days; CrI=Credibility interval.

3. Studying different routes of transmission

Considering different routes of transmission, by affectation, by hospital

| Model | Hypothesis | Definition of the risk (λ) | DIC | |
|---------|---|--|-------|-------|
| | | | Hosp1 | Hosp2 |
| Model 1 | PtoH transmission, dependent of the ratio patients/HCW by affectation (r^A) | $\lambda_P^A = \beta_P r^A I_P^A$ | 16.5 | 11.7 |
| Model 2 | Model 1 + HtoH transmission | $\lambda_{PH}^A = \beta_H I_H + \beta_P r^A I_P^A$ | 18 | 14.1 |

Notation: A = Affectation, with $A \in \{\text{ICU, Intermediate, Standard}\}$; P = Patients; H = HCWs; λ_X^A = Constant daily risk of SARS-CoV-2 infection in A , where $X \in \{H, P\}$; β_X = transmission rate from X ; I_X^A = Daily number of infected X in A .

CONCLUSIONS

- HCWs tended to face a higher risk of infection when working in the standard care unit
- Nurses tended to face a higher risk of infection as compared to doctors
- The large variation in the infection risk between the two hospitals suggests that HCWs may face a high risk of infection, but that **implementing infection control measures can decrease this risk to levels observed in standard healthcare settings.**
- Modeling PtoH transmission considering constant risk seems to fit better the observed data

PERSPECTIVES

- Include data from other Egyptian quarantine hospitals
- Account for time-varying risk of SARS-CoV-2 infection.



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