**Supplementary Materials**

# In-hospital mortality from healthcare-associated infection by multidrug-resistant *Pseudomonas aeruginosa*: a competing risks analysis of a 4-year propensity-matched cohort study in southern China

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Attachment 1 to*: Zhou M, Kritsotakis EI, Xu B, Guo Z, Zeng Y, Zhou B, Brinks R, Wang J. In-hospital mortality from healthcare-associated infection by multidrug-resistant Pseudomonas aeruginosa: a competing risks analysis of a 4-year propensity-matched cohort study in southern China. GMS Hyg Infect Control. 2025;20:Doc68. DOI: 10.3205/ddgkh000597*

## R code for main analyses

```
library("MatchIt")

# Matching based on the estimated propensity scores
formula <- mdr ~ age + sex + admission_department + infection_site + diabetes + immunocompromised + COVID_period
matchit_model <- matchit(formula,
                         data=df,
                         distance='logit',
                         method='nearest',
                         replace=FALSE,
                         caliper=0.2,
                         discard=,
                         ratio=1)

# Check the balance after matching
summary(matchit_model, standardize = TRUE)
```

**Competing risks 14-day survival analysis after matching**

```
library(survival)

# survival analysis variables

# define time and event variables (from infection onset to death/dicharge)

df2$dthtm= as.numeric(round(df2$discharge_date - df2$infection_date))

df2$dth <- ifelse(df2$alive_mortality == 1, 1, 0) # alive_mortality == 1 = died [dth==1 = died]

# admin right censoring at 14 days after infection

df2$dthtm14 <- df2$dthtm

df2$dthtm14[df2$dthtm14 > 14]  <- 14

df2$dth14 <- ifelse(df2$dthtm<=14 & df2$dth ==1, 2, 1)

df2$dth14[df2$dthtm>14] <- 0

#14d in-hospital death

# bivariable analysis

fgmodel_mtch_univr1_d14 <- FGR(Hist(dthtm14, dth14) ~ mdr , data = df2, cause = 2)        # dth14=2 when inpatient death

print(fgmodel_mtch_univr1_d14)
```

```
# multivariable analysis
fgmodel_mtch_multivar1_d14 <- FGR(Hist(dthtm14, dth14) ~ mdr + infection_site + empiric_therapy
                        + age65 + sex + admission_department + admission_diagnosis + diabetes + immunocompromised
                        + COVID_period , data = df2, cause = 2,maxiter=15)  # dth14=2 when inpatient death
print(fgmodel_mtch_multivar1_d14)
```

**#14d discharge alive**

```
# bivariable analysis
fgmodel_mtch_univr2_d14 <- FGR(Hist(dthtm14, dth14) ~ mdr , data = df2, cause = 1)        # dth14=1 is discharge alive
print(fgmodel_mtch_univr2_d14)
# multivariable analysis
fgmodel_mtch_multivar2_d14 <- FGR(Hist(dthtm14, dth14) ~ mdr + infection_site + empiric_therapy
                        + age65 + sex + admission_department + admission_diagnosis + diabetes + immunocompromised
                        + COVID_period , data = df2, cause = 1)                                  # dth14=1 is discharge alive
print(fgmodel_mtch_multivar2_d14)
```

## Table S1. Multicollinearity analysis

| Variable | Generalised Variance Inflation Factor | Degrees of Freedom | Adjusted Generalized Variance Inflation Factor |
|---|---|---|---|
| Age ≥65 years | 1.160 | 1 | 1.077 |
| Sex = Male | 1.045 | 1 | 1.022 |
| Admission Department | 1.950 | 3 | 1.118 |
| Admission Diagnosis | 2.123 | 5 | 1.078 |
| Infection Site | 1.220 | 3 | 1.034 |
| Receipt of empiric therapy | 1.287 | 1 | 1.134 |
| Diabetes = Yes | 1.056 | 1 | 1.028 |
| Immunocompromised = Yes | 1.150 | 1 | 1.073 |
| COVID Period | 1.228 | 2 | 1.053 |

Note: Generalised Variance Inflation Factor (GVIF) analysis for the included variables showed no evidence of multicollinearity. The adjusted GVIF values for all variables were close to 1, indicating low correlation between predictors and suggesting that multicollinearity is not an issue for this set of covariates.

## Table S2. STROBE Statement—Checklist of items that should be included in reports of cohort studies

| | No | Recommendation | Page(s) |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 3 |
| Introduction | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4-5 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| Methods | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up | 5-6 |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed | 7 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5 |
| Data sources/ measurement | 8 | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | N/A |
| Study size | 10 | Explain how the study size was arrived at | N/A |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 5-6 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 6-8 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | Subgroup modelling of incidence trends for major types of HAIs-MDRPa, Figure 1 and Figure S3 |
| | | (*c*) Explain how missing data were addressed | 8 |
| | | (*d*) If applicable, explain how loss to follow-up was addressed | N/A |
| | | (*e*) Describe any sensitivity analyses | Table 2 |
| Results | | | |

| | | | |
|---|---|---|---|
| Participants | 13 | (a) Report numbers of individuals at each stage of study—e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 8, Table 1 |
| | | (b) Give reasons for non-participation at each stage | Supplementary Figure S1 |
| | | (c) Consider use of a flow diagram | Supplementary Figure S1 |
| Descriptive data | 14 | (a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders | 8 |
| | | (b) Indicate number of participants with missing data for each variable of interest | N/A |
| | | (c) Summarise follow-up time (e.g., average and total amount) | N/A |
| Outcome data | 15 | Report numbers of outcome events or summary measures over time | 8-9 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Table 2 and Supplementary Tables S3 and S4. |
| | | (*b*) Report category boundaries when continuous variables were categorized | N/A |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | We reported subdistribution hazard ratio |
| Other analyses | 17 | Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses | We did subgroup analysis for incidence rate (Figure 1 and Figure S3). |
| Discussion | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10-11 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 10-11 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | N/A |
| Other information | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 13 |

**Figure S1.** Flow chart of data collection and patient selection

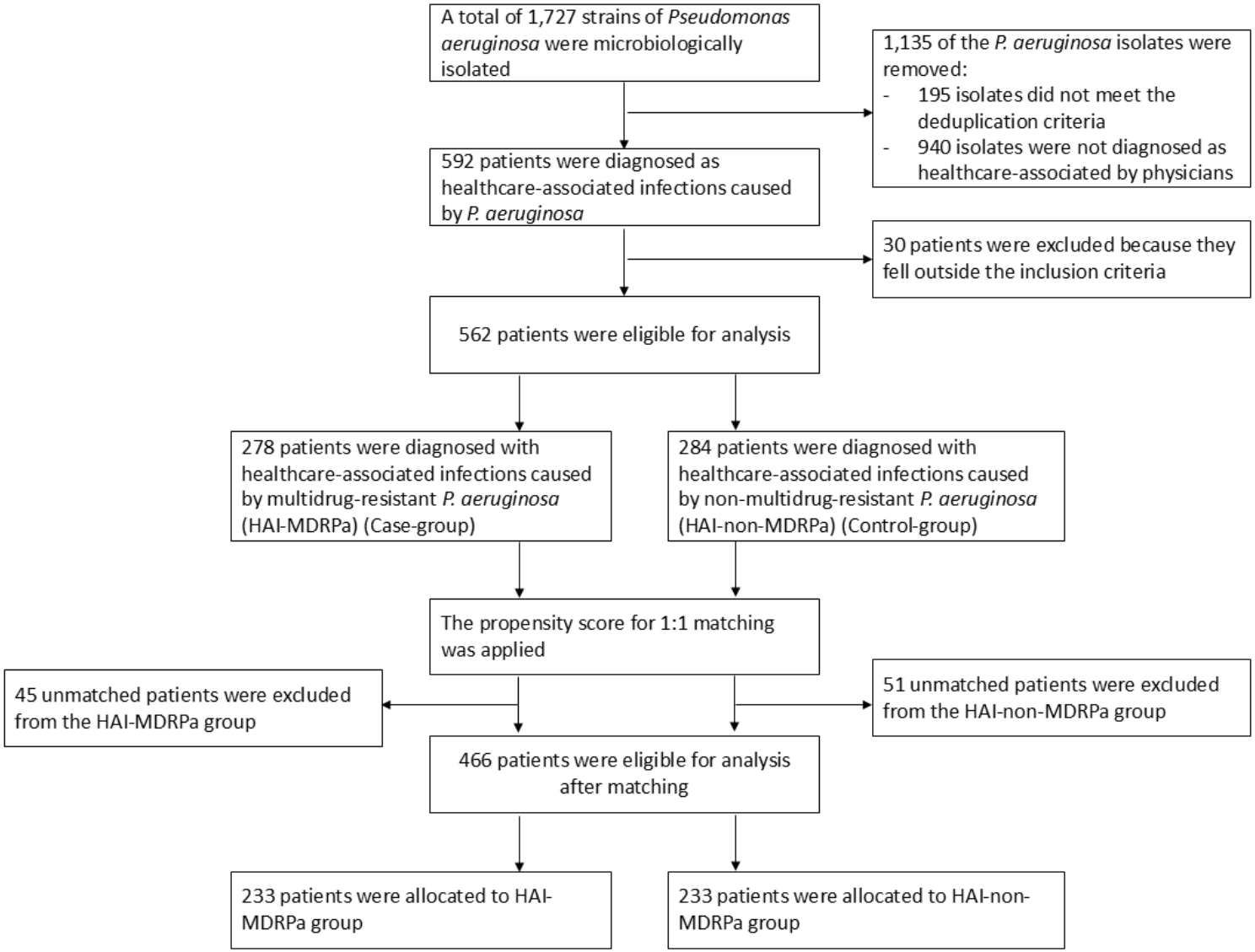


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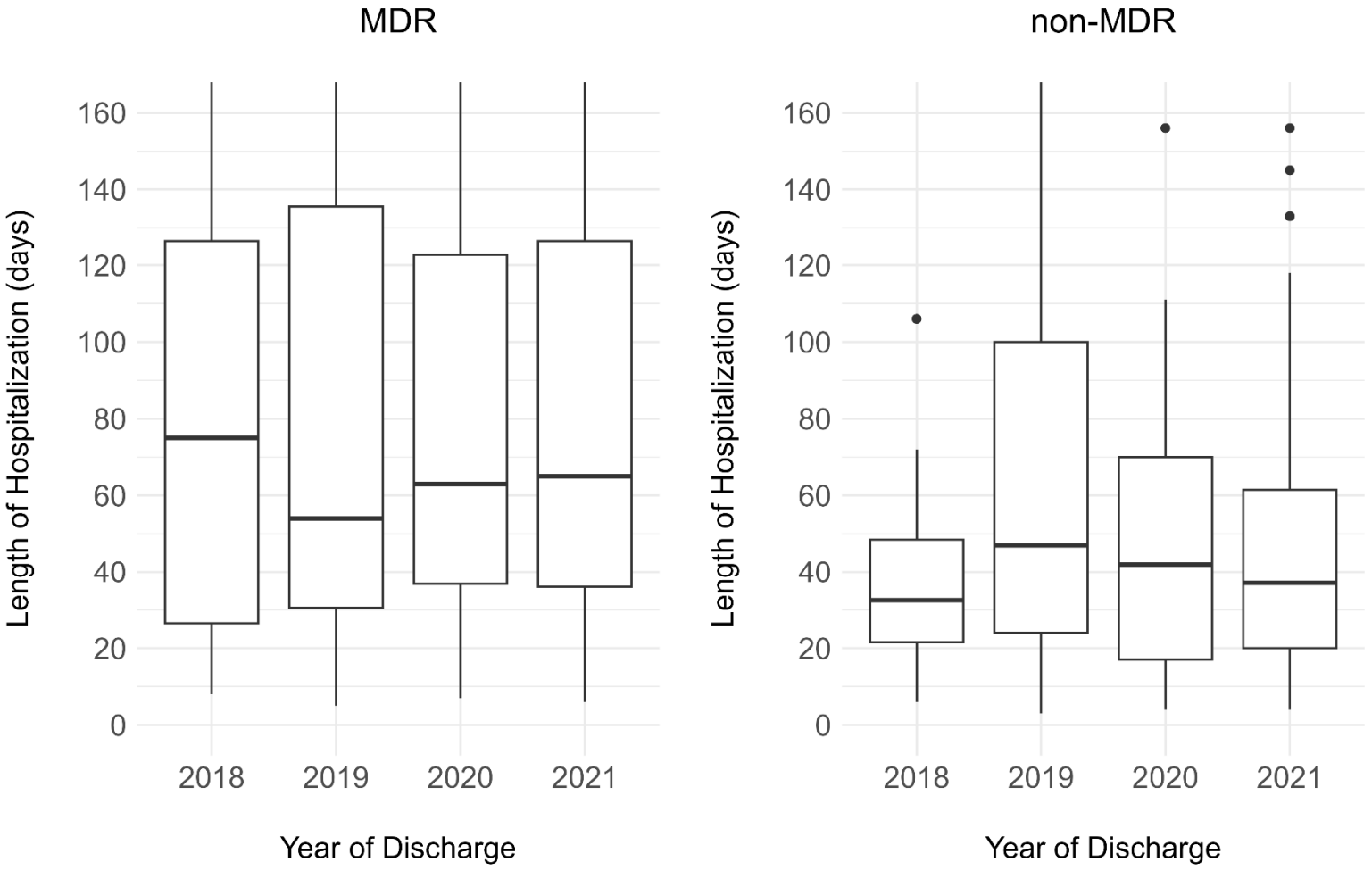
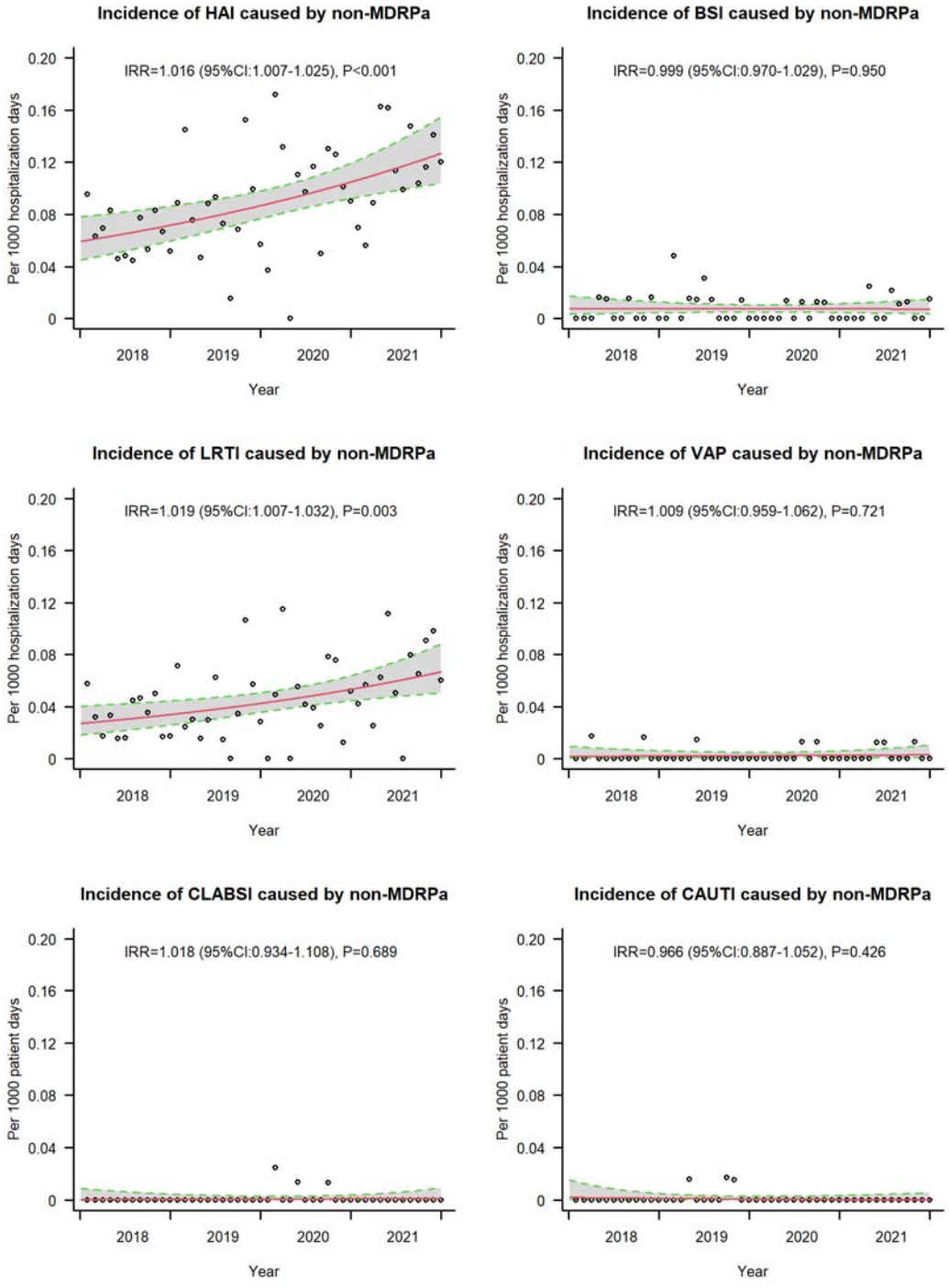
**Figure S2.** Length of hospitalisation of patients with healthcare-associated infections by *P. aeruginosa*



MDR, multidrug resistance

**Figure S3.** Incidence rate trends for healthcare-associated infections by non-multidrug-resistant *P. aeruginosa* (non-MDRPA), 2018-2021




BSI, Bloodstream infection; CAUTI, catheter-associated urinary tract infection; CI, confidence Interval; CLABSI, central line-associated bloodstream infection; HAI, healthcare-associated

infection; IRR, mean monthly incidence rate ratio; LRTI, lower respiratory tract infection; MDRPa, multidrug-resistant *Pseudomonas aeruginosa*; VAP, ventilator-associated pneumonia.

**Table S3.** Results of multivariable competing risks survival analysis in the matched samples

| | 14 Days | | | | 30 Days | | | | Overall | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In-hospital death | | Discharge alive | | In-hospital death | | Discharge alive | | In-hospital death | | Discharge alive | |
| **Variable** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** |
| Multidrug-resistant | 1.07 (0.52 - 2.19) | 0.850 | 0.44 (0.31 - 0.63) | <0.001 | 0.95 (0.51 - 1.77) | 0.860 | 0.56 (0.43 - 0.74) | <0.001 | 1.37 (0.78 - 2.39) | 0.280 | 0.66 (0.54 - 0.82) | <0.001 |
| Age > 65 years | 1.34 (0.67 - 2.72) | 0.410 | 0.55 (0.38 - 0.82) | 0.003 | 1.39 (0.74 - 2.60) | 0.300 | 0.68 (0.51 - 0.91) | 0.010 | 1.64 (0.94 - 2.88) | 0.082 | 0.70 (0.55 - 0.89) | 0.004 |
| Male Sex | 1.21 (0.49 - 3.00) | 0.680 | 0.87 (0.58 - 1.31) | 0.510 | 1.35 (0.60 - 3.00) | 0.470 | 0.90 (0.66 - 1.22) | 0.480 | 1.19 (0.63 - 2.22) | 0.600 | 0.89 (0.69 - 1.14) | 0.350 |
| Admission Department | | | | | | | | | | | | |
| Internal Medicine | 0.04 (0.00 - 0.35) | 0.004 | 1.01 (0.58 - 1.75) | 0.980 | 0.05 (0.01 - 0.20) | <0.001 | 1.21 (0.81 - 1.82) | 0.350 | 0.11 (0.04 - 0.30) | <0.001 | 1.93 (1.30 - 2.87) | 0.001 |
| Surgery | 0.09 (0.03 - 0.31) | <0.001 | 0.75 (0.45 - 1.26) | 0.270 | 0.08 (0.03 - 0.23) | <0.001 | 0.76 (0.50 - 1.16) | 0.210 | 0.11 (0.05 - 0.25) | <0.001 | 1.51 (1.04 - 2.19) | 0.030 |
| Other | 0.00 (0.00 - 0.00) | <0.001 | 0.61 (0.34 - 1.11) | 0.110 | 0.00 (0.00 - 0.00) | <0.001 | 0.69 (0.44 - 1.07) | 0.098 | 0.06 (0.01 - 0.28) | <0.001 | 1.47 (1.02 - 2.10) | 0.036 |
| Admission Diagnosis | | | | | | | | | | | | |
| Neurological disorder | 1.65 (0.32 - 8.41) | 0.550 | 0.63 (0.28 - 1.42) | 0.270 | 1.18 (0.34 - 4.08) | 0.790 | 0.64 (0.35 - 1.17) | 0.150 | 1.07 (0.36 - 3.16) | 0.910 | 0.76 (0.44 - 1.31) | 0.320 |
| Respiratory disease | 0.84 (0.18 - 4.01) | 0.830 | 1.72 (0.78 - 3.78) | 0.180 | 0.55 (0.16 - 1.85) | 0.330 | 1.33 (0.72 - 2.48) | 0.360 | 0.54 (0.19 - 1.58) | 0.260 | 1.29 (0.71 - 2.34) | 0.400 |
| Injury or orthopaedic condition | 0.39 (0.03 - 5.74) | 0.490 | 0.65 (0.28 - 1.53) | 0.320 | 0.48 (0.07 - 3.37) | 0.460 | 0.70 (0.36 - 1.35) | 0.290 | 0.26 (0.04 - 1.68) | 0.160 | 0.91 (0.52 - 1.60) | 0.750 |
| Cancer or related disorder | 2.44 (0.38 - 15.76) | 0.350 | 0.71 (0.29 - 1.73) | 0.450 | 1.59 (0.36 - 7.06) | 0.540 | 0.68 (0.34 - 1.37) | 0.280 | 1.43 (0.38 - 5.39) | 0.590 | 0.65 (0.34 - 1.23) | 0.190 |
| Other diagnosis | 1.71 (0.32 - 9.19) | 0.530 | 1.23 (0.58 - 2.60) | 0.590 | 0.97 (0.26 - 3.66) | 0.970 | 1.30 (0.74 - 2.29) | 0.360 | 1.14 (0.38 - 3.47) | 0.810 | 1.24 (0.73 - 2.12) | 0.420 |
| Infection Site | | | | | | | | | | | | |
| Lower Respiratory Tract | 1.09 (0.28 - 4.23) | 0.900 | 0.55 (0.35 - 0.86) | 0.008 | 0.99 (0.36 - 2.72) | 0.990 | 0.61 (0.43 - 0.88) | 0.008 | 1.08 (0.42 - 2.82) | 0.870 | 0.69 (0.51 - 0.95) | 0.021 |
| Urinary Tract | 1.80 (0.37 - 8.74) | 0.470 | 1.01 (0.55 - 1.85) | 0.990 | 1.00 (0.25 - 4.02) | 1.000 | 0.73 (0.43 - 1.26) | 0.260 | 1.59 (0.50 - 5.13) | 0.430 | 0.64 (0.41 - 0.99) | 0.043 |
| Other Site | 2.35 (0.55 - 10.07) | 0.250 | 0.97 (0.60 - 1.58) | 0.900 | 1.86 (0.58 - 5.95) | 0.300 | 0.90 (0.60 - 1.37) | 0.640 | 1.96 (0.67 - 5.77) | 0.220 | 0.79 (0.55 - 1.14) | 0.210 |
| Receipt of empiric therapy | 0.65 (0.23 - 1.84) | 0.420 | 1.29 (0.73 - 2.25) | 0.380 | 0.79 (0.33 - 1.90) | 0.600 | 1.11 (0.74 - 1.67) | 0.610 | 0.63 (0.31 - 1.28) | 0.200 | 1.22 (0.93 - 1.61) | 0.160 |
| Diabetes | 1.46 (0.34 - 6.26) | 0.610 | 0.81 (0.22 - 2.97) | 0.750 | 1.97 (0.67 - 5.79) | 0.220 | 1.06 (0.45 - 2.49) | 0.900 | 2.11 (0.66 - 6.73) | 0.210 | 0.93 (0.44 - 1.94) | 0.840 |
| Immunocompromised | 1.97 (0.45 - 8.67) | 0.370 | 1.23 (0.59 - 2.57) | 0.580 | 2.98 (0.76 - 11.76) | 0.120 | 1.14 (0.67 - 1.95) | 0.640 | 1.32 (0.34 - 5.09) | 0.690 | 1.16 (0.78 - 1.73) | 0.450 |
| Year | | | | | | | | | | | | |
| 2020 | 0.50 (0.20 - 1.22) | 0.130 | 0.89 (0.56 - 1.39) | 0.600 | 0.54 (0.24 - 1.22) | 0.140 | 0.95 (0.67 - 1.36) | 0.790 | 0.60 (0.29 - 1.25) | 0.170 | 1.24 (0.95 - 1.61) | 0.120 |
| 2021 | 0.46 (0.18 - 1.15) | 0.098 | 1.27 (0.85 - 1.89) | 0.250 | 0.44 (0.20 - 0.95) | 0.036 | 1.43 (1.04 - 1.97) | 0.030 | 0.46 (0.23 - 0.92) | 0.028 | 1.64 (1.25 - 2.15) | <0.001 |

Note: The reference group is the intensive care unit for the admission department, cardiovascular disease for the admission diagnosis, bloodstream infection for the infection site, and 2018-2019 for the year

sHR: subdistribution hazard ratio from the Fine-Gray model; 95% CI: 95% confidence interval.

**Table S4.** Results of multivariable competing risks analysis in the unmatched samples

| | 14 Days | | | | 30 Days | | | | Overall | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In-hospital death | | Discharge alive | | In-hospital death | | Discharge alive | | In-hospital death | | Discharge alive | |
| **Variable** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** | **sHR (95%CI)** | **P** |
| Multidrug-resistant | 1.20 (0.62 - 2.35) | 0.590 | 0.48 (0.34 - 0.68) | <0.001 | 1.14 (0.65 - 2.01) | 0.640 | 0.61 (0.47 - 0.79) | <0.001 | 1.48 (0.89 - 2.49) | 0.130 | 0.68 (0.56 - 0.83) | <0.001 |
| Age > 65 years | 1.14 (0.60 - 2.19) | 0.690 | 0.68 (0.48 - 0.97) | 0.033 | 1.33 (0.75 - 2.35) | 0.330 | 0.80 (0.61 - 1.04) | 0.100 | 1.58 (0.94 - 2.66) | 0.087 | 0.75 (0.61 - 0.94) | 0.011 |
| Male Sex | 1.50 (0.64 - 3.53) | 0.350 | 0.80 (0.56 - 1.13) | 0.210 | 1.78 (0.84 - 3.78) | 0.140 | 0.80 (0.61 - 1.04) | 0.096 | 1.53 (0.85 - 2.76) | 0.160 | 0.83 (0.66 - 1.03) | 0.097 |
| Admission Department | | | | | | | | | | | | |
| Internal Medicine | 0.04 (0.01 - 0.24) | <0.001 | 0.95 (0.58 - 1.57) | 0.850 | 0.05 (0.01 - 0.18) | <0.001 | 1.03 (0.70 - 1.50) | 0.890 | 0.14 (0.06 - 0.34) | <0.001 | 1.75 (1.22 - 2.53) | 0.002 |
| Surgery | 0.07 (0.02 - 0.23) | <0.001 | 0.76 (0.47 - 1.23) | 0.260 | 0.07 (0.02 - 0.19) | <0.001 | 0.83 (0.57 - 1.21) | 0.330 | 0.10 (0.04 - 0.22) | <0.001 | 1.51 (1.08 - 2.12) | 0.017 |
| Other | 0.00 (0.00 - 0.00) | <0.001 | 0.69 (0.41 - 1.14) | 0.150 | 0.02 (0.00 - 0.20) | <0.001 | 0.78 (0.53 - 1.15) | 0.210 | 0.06 (0.02 - 0.21) | <0.001 | 1.58 (1.14 - 2.19) | 0.007 |
| Admission Diagnosis | | | | | | | | | | | | |
| Neurological disorder | 1.00 (0.25 - 3.95) | 1.000 | 0.66 (0.31 - 1.39) | 0.270 | 0.85 (0.28 - 2.58) | 0.780 | 0.70 (0.39 - 1.24) | 0.220 | 0.68 (0.27 - 1.74) | 0.420 | 0.86 (0.52 - 1.41) | 0.540 |
| Respiratory disease | 0.65 (0.18 - 2.34) | 0.510 | 1.78 (0.85 - 3.75) | 0.130 | 0.58 (0.20 - 1.69) | 0.320 | 1.39 (0.77 - 2.53) | 0.270 | 0.49 (0.20 - 1.21) | 0.120 | 1.30 (0.74 - 2.28) | 0.360 |
| Injury or orthopaedic condition | 0.25 (0.02 - 3.17) | 0.290 | 0.62 (0.27 - 1.44) | 0.270 | 0.34 (0.05 - 2.15) | 0.250 | 0.74 (0.39 - 1.39) | 0.350 | 0.17 (0.03 - 1.02) | 0.053 | 0.96 (0.57 - 1.63) | 0.890 |
| Cancer or related disorder | 1.78 (0.39 - 8.12) | 0.450 | 0.70 (0.31 - 1.61) | 0.410 | 1.34 (0.37 - 4.90) | 0.660 | 0.85 (0.45 - 1.60) | 0.610 | 0.91 (0.29 - 2.91) | 0.880 | 0.81 (0.47 - 1.42) | 0.470 |
| Other diagnosis | 1.06 (0.28 - 4.01) | 0.930 | 1.15 (0.57 - 2.35) | 0.690 | 0.79 (0.26 - 2.46) | 0.690 | 1.35 (0.79 - 2.32) | 0.280 | 0.79 (0.31 - 2.00) | 0.620 | 1.32 (0.81 - 2.17) | 0.270 |
| Infection Site | | | | | | | | | | | | |
| Lower Respiratory Tract | 0.81 (0.29 - 2.26) | 0.690 | 0.57 (0.37 - 0.87) | 0.010 | 0.79 (0.34 - 1.82) | 0.580 | 0.66 (0.46 - 0.94) | 0.020 | 0.89 (0.40 - 1.96) | 0.760 | 0.74 (0.54 - 1.00) | 0.053 |
| Urinary Tract | 1.06 (0.29 - 3.90) | 0.930 | 1.01 (0.58 - 1.77) | 0.970 | 0.80 (0.26 - 2.51) | 0.700 | 0.79 (0.48 - 1.29) | 0.350 | 1.25 (0.48 - 3.26) | 0.650 | 0.72 (0.48 - 1.07) | 0.110 |
| Other Site | 1.56 (0.49 - 4.98) | 0.460 | 0.80 (0.50 - 1.29) | 0.370 | 1.17 (0.43 - 3.19) | 0.760 | 0.85 (0.57 - 1.27) | 0.440 | 1.36 (0.55 - 3.40) | 0.510 | 0.84 (0.60 - 1.20) | 0.340 |
| Receipt of empiric therapy | 0.59 (0.24 - 1.45) | 0.250 | 1.35 (0.81 - 2.25) | 0.250 | 0.72 (0.33 - 1.55) | 0.400 | 1.27 (0.88 - 1.84) | 0.210 | 0.59 (0.30 - 1.14) | 0.120 | 1.32 (1.03 - 1.68) | 0.029 |
| Diabetes | 0.78 (0.18 - 3.35) | 0.740 | 0.45 (0.13 - 1.51) | 0.200 | 1.19 (0.40 - 3.51) | 0.760 | 0.72 (0.34 - 1.50) | 0.370 | 1.76 (0.61 - 5.02) | 0.290 | 0.72 (0.39 - 1.34) | 0.300 |
| Immunocompromised | 5.16 (1.74 - 15.27) | 0.003 | 1.06 (0.55 - 2.04) | 0.850 | 4.46 (1.59 - 12.5) | 0.004 | 0.96 (0.58 - 1.60) | 0.880 | 2.20 (0.78 - 6.22) | 0.140 | 1.00 (0.70 - 1.44) | 1.000 |
| Year | | | | | | | | | | | | |
| 2020 | 0.52 (0.24 - 1.12) | 0.094 | 0.94 (0.62 - 1.44) | 0.790 | 0.63 (0.33 - 1.21) | 0.170 | 0.97 (0.69 - 1.35) | 0.850 | 0.59 (0.33 - 1.08) | 0.086 | 1.25 (0.97 - 1.60) | 0.080 |
| 2021 | 0.36 (0.15 - 0.86) | 0.022 | 1.25 (0.86 - 1.81) | 0.240 | 0.40 (0.19 - 0.83) | 0.014 | 1.43 (1.07 - 1.92) | 0.015 | 0.38 (0.20 - 0.74) | 0.004 | 1.62 (1.27 - 2.07) | <0.001 |

Note: The reference group is the intensive care unit for the admission department, cardiovascular disease for the admission diagnosis, bloodstream infection for the infection site, and 2018-2019 for the year

sHR: subdistribution hazard ratio from the Fine-Gray model; 95% CI: 95% confidence interval.