INTRODUCTION

Antimicrobial resistance has become a global issue that limits the options available for the treatment of infections (Cassini et al., 2019). Carbapenem-resistant Enterobacteriaceae (CRE) cause infections that cannot be treated by standard antibiotics (Martin et al., 2018; Nabarro et al., 2017). The CRE colonization and transmission rates are high in low- and middle-income countries, and are associated with difficulties in treating hospital-acquired infections (HAI) and cause high mortality. In our previous study, a point prevalence survey of...
CRE colonization at 12 hospitals in Vietnam, 52% were CRE colonized (1165/2233 patients tested), most commonly Klebsiella pneumoniae, Escherichia coli (E. coli), and Enterobacter spp. (Tran et al., 2019) There was a strong correlation between colonization with CRE and HAI (Dickstein et al., 2016; Tischendorf et al., 2016), and it has been shown that CRE colonization and subsequent infection are associated with increased mortality due to treatment failure (Falagas et al., 2014; McConville et al., 2017).

CRE colonization in the human gut is considered as a reservoir for cross-transmission in healthcare settings. Active surveillance in a high-risk patient (Cassini et al., 2019) has resulted in the efficient control of this epidemic in acute-care facilities (Calfee & Jenkins, 2008; Schwaber et al., 2011). Therefore, the implementation of a reliable and sensitive method for the detection of CRE is crucial to the success of infection control measures. Although PCR-based methods have been proven to be highly sensitive and reliable as gold standard methods (Hindiyyeh et al., 2008; Schechner et al., 2009), they require expertise that is not readily available in many centers. Moreover, as the emergence and spread of other types of CRE are increasingly reported (Goren et al., 2011; Poirel et al., 2010), culture-based methods remain essential for the initial detection of these strains. Currently, there are several commercially available ready-to-use culture-based CRE plates or reagents for preparation, including CHROMagar KPC (chromagar@chromagar.com, Paris, France), HardyCHROM™ CRE (https://hardydiagnostics.com, Hardy Diagnostics), Brilliance CRE AGAR (http://www.oxoid.com/UK, Oxoid/Fisher Scientific), Chromogenic Media (https://www.sigmaaldrich.com, Sigma-Aldrich, Merck KGaA), and chromID Carba (http://www.biomerieux-culturemedia.com/product/1-chromidcarba, Biomerieux, France). However, there are no open access formulas for CRE plates with detailed preparation instructions and associated quality control procedures. Therefore, this study aimed to develop an in-house selective medium formula and a quality control procedure to actively screen CRE as a more cost-effective alternative to commercial plates.

2 | MATERIALS AND METHODS

Quality control and/or bacterial culture experiments were performed according to the protocol and laboratory regulations and norms developed for the CHROMagar Orientation medium. Good preparation of the medium can be tested by American Type Culture Collection (ATCC) strains as in Table 1.

2.1 | Development of an in-house CRE medium formula

2.1.1 | Principle of CRE medium formula

CHROMagar™ Orientation supplemented with various antibiotics is useful for detecting increasingly important nosocomial and multidrug-resistant microorganisms (CHROMagar, 2017). The intermediate breakpoint of carbapenem (meropenem or imipenem) is 2 µg/ml, as described in the CLSI 2018 guidelines (Testing, 2018). Bile salts (0.15%) inhibit the growth of the majority of, but not all, Gram-positive organisms. Therefore, crystal violet was added to further inhibit the growth of Gram-positive organisms, as in the Mac-Conkey formula (Macconkey, 1905, 1908; Macconkey & Laboratories, 1900).

The procedure of CRE medium preparation: (see Table 2 for a formula in details).

- **Step 1:** Prepare crystal violet (1 mg/ml)

  Weigh 0.1 g crystal violet (Merck) and dissolve in 100 ml of distilled water.

  Then autoclave for 15 min at 121°C and 15 lbs.

  Store in the dark at room temperature for 2 months.

- **Step 2:** Prepare bile salt 15%

  Weigh 15 g bile salt (Merck) and dissolve in 100 ml of distilled water.

  Then autoclave for 15 min at 121°C and 15 lbs.

  Store at −30°C for 3 months.

- **Step 3:** Prepare meropenem working stock (2000 µg/ml)

  Dissolve 0.5 g of Meropenem (Sigma-Aldrich, M2574-50MG) in 10 ml of distilled water (stock).

  Then take 400 µl of this stock to 10 ml of distilled water to make the working stock.

  Sterilize the working stock by passing through a 0.22 micron filter.

  Store at −80°C for 1 week.

**TABLE 1** List of microorganisms used for experimentation and the quality control process, as suggested by CHROMagar and the present study.

| Microorganism (Gram-negative/ positive) | Typical colony appearance |
|-----------------------------------------|---------------------------|
| E. faecalis ATCC® 29212                  | Turquoise blue            |
| E. coli ATCC® 25922                     | Reddish                   |
| S. aureus ATCC® 12600 (G+)              | Golden yellow             |
| S. epidermidis ATCC® 12228 (G+)         | Colorless                 |
| S. saprophyticus ATCC® 15305 (G+)       | Pink                      |
| K. pneumoniae ATCC® 13883               | Metallic blue             |
| K. pneumoniae ATCC® BAA−1705a           | Metallic blue             |
| E.coli ATCC® BAA−2340a                   | Reddish                   |

Clinical isolated strains (E. coli/K. pneumoniae) confirmed KPC and/or NDM−1 mutations by PCR.

aOur suggestion with CRE ATCC strains.
- **Step 4: Prepare CRE medium**

  Use 1000 ml of distilled water and take out and discard 12 ml of distilled water, then add 33 g of CHROMagar powder.

  Heat and swirl gently until the reagents are completely dissolved.

  Check pH in the range 6.9 - 7.2 at 25°C, if not, adjust pH with NaOH or 0.1 N HCl.

  Sterilize by autoclaving for 15 min at 121°C and 15 lbs.

  Let the mixture cool to 45°C–50°C, then add 1 ml of crystal violet (10 mg/ml), 10 ml of bile salt (15%), and 1 ml of meropenem (2000 µg/ml).

  Mix well the medium then pour it into sterile Petri plates in sterilized working space.

  The plates are stored in the dark at 4°C. The plates should be used within 4 weeks; however, they can be stored for up to 8 weeks if properly prepared and protected from light and dehydration. The surface of the medium should be dry when inoculating.

### 2.2 Quality control procedure

The following American Type Culture Collection (ATCC) strains were used for the quality control procedure for the medium: *E. coli* ATCC 25922, *K. pneumoniae* ATCC BAA 1705, *K. pneumoniae* ATCC BAA 1706, *E. faecalis* ATCC 29212, and *S. aureus* ATCC 25923. These strains were available in our laboratory. Clinically isolated mutant strains (KPC/NDM-1 or both, confirmed by real-time PCR according to CDC protocol (Centers for Disease Control & Prevention, 2011) were used as additional quality control strains.

A brief technical procedure on how to prepare the bacterial suspension: Bacterial colonies were isolated from the agar plate and a suspension calibrated to 0.5 McF (1.5 × 10^8 CFU/mL) with densitometer equipment was prepared. The suspension was diluted in sterile saline solution 0.9% to obtain an inoculum, which was subsequently incubated in aerobic conditions at 37°C for 18 – 24 h.

Bacterial culture result interpretation was based on the colony appearance as described in the CHROMagar™ package insert, and growth was based on resistance or susceptibility.

### 2.3 Sensitivity and specificity

A total of 200 clinically isolated strains, including 114 carbapenem-resistant and 86 carbapenem-susceptible strains, were used for determining the sensitivity and specificity of the medium. The phenotype of these strains was confirmed using PCR described in a CDC protocol (Centers for Disease Control & Prevention, 2011).

### 3 CRE surveillance

CRE in-house plates were used for cross-sectional CRE point prevalence survey (PPS) November 6, 2019, among patients admitted to the Viet-Tiep Hospital ICU following the WHO protocol (World Health Organisation, 2018). All 18 ICU inpatients were sampled with rectal swabs at the same time. The samples were transferred to a microbiology laboratory within 5 minutes at room temperature in sterilized tubes with 0.5 ml saline 0.9%, for bacterial culture.

### 4 RESULTS

#### 4.1 CRE in-house formula assessment with the quality control procedure

The in-house formula was prepared with or without antibiotics (meropenem/imipenem) and tested for its ability to select carbapenem-resistant bacteria and inhibit Gram-positive bacteria. All the tests were repeated 3 times (Table 3).

CHROMagar medium favors the growth of Gram-negative and Gram-positive bacteria with/without carbapenem-resistance mutations. The addition of bile salts and crystal violet inhibits the growth of Gram-positive bacteria; however, Gram-negative carbapenem-susceptible bacteria are unaffected. The addition of 2 µg/ml meropenem or imipenem improved the growth of Gram-negative carbapenem-resistant bacteria that can survive from good to excellent growth. Bacterial colony identification was not affected by the addition of the supplements, and the bacterial colony colors were the same as those for CHROMagar. (see Figure 1(a) (b) (c) (d))

#### 4.2 CRE in-house formula sensitivity and specificity

A total of 200 clinically isolated (susceptible/resistant by phenotype, and confirmed by genotyping for KPC/NDM-1 or both mutations) strains (*E. coli* and *K. pneumoniae*) were used, including 114 resistant and 86 susceptible strains. PCR confirmation was used as the gold standard. The results have been presented in Table 4.

Of the 114 true positive CRE strains as determined by PCR, 111 strains were detected as positive by the CRE in-house plate, resulting in a sensitivity of 97.4%. Of the 86 true negative CRE strains
identified by PCR, 85 strains were detected as negative by the in-house plate, resulting in a specificity of 98.8%. Therefore, the high values obtained suggested that the CRE in-house plate was a reliable method of detecting CRE.

### 4.3 CRE in-house plate application

All 18 patients were screened for CRE colonization with rectal swabs at the ICU of the Viet-Tiep Hospital, and clinical data were collected.

### Table 3: Assessment of the CRE in-house formula using ATCC and clinically isolated bacteria.

| Microorganism (Susceptible/resistant to carbapenem) | CHROMagar only/colony color | CRE in-house formula without antibiotics | CRE in-house formula with antibiotics |
|-----------------------------------------------------|-----------------------------|-----------------------------------------|-------------------------------------|
| E. coli ATCC 25922 (S)                              | Excellent/pink to reddish   | Excellent                               | Inhibited                           |
| E. coli with KPC/NDM-1 or both (R)                  |                             | Good to excellent                       |                                     |
| K. pneumoniae ATCC BAA 1705 (R)                     | Excellent/metalic blue      | Excellent                               |                                     |
| K. pneumoniae ATCC BAA 1706 (S)                     |                             | Excellent                               |                                     |
| K. pneumoniae with KPC/NDM-1 or both (R)            |                             | Good to luxuriant                       |                                     |
| E. faecalis ATCC 29212                              | Excellent/turquoise blue    | Inhibited                               |                                     |
| S. aureus ATCC 295923                               | Excellent/golden, opaque, small | Inhibited                               |                                     |

**FIGURE 1** The bacterial colony colors were the same as in (a, c) CHROMagar without any supplement and (b,d) CRE in-house plate

Klebsiella pneumoniae - KP1705 (resistant clinical strain), a, b
E.coli - KN920 (resistant clinical strain) c, d
TABLE 4 Sensitivity and specificity of the CRE in-house formula for the detection of E. coli and/or K. pneumoniae with/without carbapenem-resistant mutations (KPC/NDM-1 or both, confirmed by real-time PCR as CDC protocol [20]).

| Characteristics | CRE (+) | PCR (+) | Total PCR |
|-----------------|--------|---------|-----------|
| CRE (+)         | 111    | 1       | 112       |
| CRE (-)         | 3      | 85      | 88        |
| Total CRE       | 114    | 86      | 200       |

Sensitivity = 97.4%; Specificity = 98.8%.

for further analysis (Table 5). The prevalence of CRE colonization was 44.4%. Eight patients were CRE-positive, including 7 patients with KESC only and 1 patient with KESC and E. coli.

5 | DISCUSSION AND CONCLUSIONS

MacConkey agar, 0.15% bile salts, and a selective medium support the growth of Gram-negative enteric bacteria and inhibit the growth of most Gram-positive bacteria. This selective advantage for Gram-negative bacteria has been hypothesized to be largely due to components of their outer membrane, which decrease the permeability of bile salts and hence improve survival (Cremers et al., 2014). Intestinal bacteria can adapt to bile-induced injuries and subsequently become resistant to bile salts (Urdaneta & Casadesus, 2017). Furthermore, most Gram-positive bacteria are sensitive to crystal violet, while the majority of Gram-negative bacteria are not sensitive. Therefore, crystal violet is bacteriostatic rather than bactericidal (Churchman, 1912; Churchman & Michael, 1912). CHROMagar favors both Gram-negative and Gram-positive bacteria. However, the addition of 0.15% bile salts, 1 mg/L crystal violet, and 2 µg/ml meropenem (the breakpoint as described in the CLSI) resulted in a “CRE in-house formula” that could select CRE bacteria (from intermediate to high resistance) and inhibit Gram-positive bacteria as shown in Table 6. Drigalski Lactose Agar is a selective differential medium similar to MacConkey Agar and Desoxycholate based media that uses crystal violet in low concentration 0.5 mg/L. [BD package insert, (BD Diagnostic Systems, 2003)] The Supercarba medium was developed to detect carbapenemase producers with low-level resistance to carbapenems by adding ertapenem 0.25 g/ml, ZnSO4 (70 g/ml), and Cloxacillin (250 g/ml) enabling detection of strains with many mutants (OXA-48, NDM, VIM or IMP, and KPC) (Nordmann et al., 2012).

TABLE 5 CRE colonization and patient clinicopathological characteristics.

| Characteristic | CRE (+) n = 10 (%) | CRE (-) n = 8 (%) |
|----------------|--------------------|-------------------|
| Mean age (years) | 62.4               | 52.1              |
| Sex            |                    |                   |
| Male           | 53.9               | 46.1              |
| Female         | 60.0               | 40.0              |
| HAI            |                    |                   |
| Yes            | 37.5               | 62.5              |
| No             | 70                 | 30                |
| Underwent surgery |                 |                   |
| Yes            | 64.3               | 35.7              |
| No             | 25.0               | 75.0              |
| Current carbapenem treatment |       |                   |
| Yes            | 50.0               | 50.0              |
| No             | 56.3               | 43.7              |

Current infectious diseases and/or pneumoniae as found in Vietnam, which is also the case in earlier studies (4). The result obtained by pilot CRE screening was only based on a visual reading of the plates as we did not have a chance to do further confirmatory tests due to limited resources in the provincial hospital.

The efficacy of the CRE in-house formula was tested in a cross-sectional survey at a provincial level hospital in Vietnam. A total of 18 patients were recruited for CRE PPS. The CRE colonization rate was relatively high 44.4% in an international perspective (8/18), but still lower than most of the other 18 Vietnamese ICU’s (N = 1030) where PPS has been performed, where the CRE colonization rate ranged from 35% to 83% with an average of 64% (Tran et al., 2019). The most common CRE bacteria isolated belonged to the KESC group (7/8), potentially K. pneumoniae as found in Vietnam, which is also the case in earlier studies (4). The result obtained by pilot CRE screening was only based on a visual reading of the plates as we did not have a chance to do further confirmatory tests due to limited resources in the provincial hospital.

The CRE colonization and transmission rates are high in low- and middle-income countries, and are associated with difficulties in treating hospital-acquired infections (HAI) and high mortality.
Enterobacteriaceae were most commonly colonizing. The present study described the development and application of an affordable and innovative plate ready for the emerging need of high CRE colonization and transmission rate in South East Asia, which can be produced in local settings and modified to accommodate the types of CRE subtypes that are prominent in South East Asia (Tran et al., 2019). However, the present study has certain limitations, including a lack of ATCC carbapenem-resistant strains (E. coli) and a limited number of patients tested with the CRE in-house medium.

In conclusion, the CRE in-house medium formula developed in the present study was able to screen CRE prevalence with high sensitivity and specificity, particularly E. coli and the KESC group. The formula can be widely used and complies with quality control procedures required for ATCC and/or clinically isolated strains. This in-house medium may serve as an alternative low-cost option with similar performance to commercially available ones.

ACKNOWLEDGEMENTS
This study was funded by the Training and Research Academic Collaboration Sweden—Vietnam in the Seed Funding program in 2019, financed by the Swedish Foundation for International Cooperation in Research and Higher Education (STINT) (SG 2015-5972), and Karolinska Institutet by research time from involved KI researchers and the different departments’ administration. This study was also funded and supported by Nam Khoa Biotech. Co., Ltd. Vietnam, who provided materials, bacterial strains, and laboratory facilities to produce the CRE in-house plates.

CONFLICT OF INTEREST
None declared.

AUTHOR CONTRIBUTION
Thanh Chi Tran: Conceptualization (equal); Data curation (lead); Investigation (equal); Validation (lead); Writing-original draft (equal); Writing-review & editing (equal). Binh thai Pham: Conceptualization (supporting); Data curation (supporting); Methodology (supporting); Resources (equal); Writing-review & editing (equal). Van H Pham: Funding acquisition (equal); Investigation (supporting); Resources (lead); Software (equal); Writing-review & editing (equal). Ngo Anh The: Data curation (supporting); Investigation (equal); Methodology (equal); Resources (equal); Visualization (supporting); Writing-review & editing (equal). Hakan Hanberger: Conceptualization (equal); Funding acquisition (equal); Methodology (equal); Project administration (equal); Supervision (supporting); Writing-review & editing (equal). Mattias Larsson: Conceptualization (equal); Funding acquisition (equal); Methodology (equal); Project administration (equal); Resources (supporting); Supervision (equal); Writing-original draft (supporting); Writing-review & editing (equal). Linus Olson: Conceptualization (equal); Funding acquisition (equal); Project administration (equal); Resources (supporting); Supervision (supporting); Visualization (equal); Writing-original draft (supporting); Writing-review & editing (lead).

ETHICS STATEMENT
This study followed the procedures in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 1983. The study was approved by the Ethical Review Board of Viet Tiep hospital, Hai Phong city, Vietnam. Verbal consent was taken at the local hospital by referring doctors regarding samples for medical studies. Caretakers could withdraw their children at any time from the study without justification.

DATA AVAILABILITY STATEMENT
Most of the data generated or analyzed during this study are included in this published article. For other datasets generated and/or analyzed during the current study are not publicly available due to request from involved researchers until a commercial of plates can be made, and to protect involved patients samples, but they are available from the corresponding author on reasonable request.

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| Microorganism | Growth after 18 h–24 h of incubation | Typical colony appearance |
|---------------|-------------------------------------|--------------------------|
| E. coli ATCC 25922 | Inhibited | — |
| K. pneumoniae ATCC BAA 1705 | Good to luxuriant | Metallic blue |
| K. pneumoniae ATCC BAA 1706 | Inhibited | — |
| E. faecalis ATCC 29212 | Inhibited | — |
| S. aureus ATCC 295923 | Inhibited | — |
| E. coli (KPC/NDM−1 or both) | Good to luxuriant | Dark pink to reddish |
| K. pneumoniae (KPC/NDM−1 or both) | Good to luxuriant | Metallic blue |

TABLE 6 Interpretation of quality control results for the CRE in-house formula.
| STT | SID    | ID     | ID patient | Age | Sex | Specimen | Hospital (department) | Bacteria          | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR               |
|-----|--------|--------|------------|-----|-----|----------|-----------------------|-------------------|--------------|--------------|---------------|--------------|-----------------------------|
| 1   | KN.065 | I01.1344 | 036/0515  | Y51 | M   | Urine    | BV. NTP (HSCD)        | *Escherichia coli* | 32           | R            | 32            | R            | KPC (-)/NDM1 (+)                |
| 2   | KN.091 | I01.1346 | 085/0515  | Y51 | M   | Urine    | BV. NTP (HSCD)        | *Escherichia coli* | 4            | R            | 128           | R            | KPC (-)/NDM1 (+)                |
| 3   | KN.091 | I01.1346 | 085/0515  | Y51 | M   | Urine    | BV. NTP (HSCD)        | *Escherichia coli* | 4            | 1            | S             |               | KPC (-)/NDM1 (-)                |
| 4   | KN.094 | I01.1607 | 952/0715  | Y84 | M   | Sputum   | BV. NTP (Nơi hô hấp) | *Escherichia coli* | 16           | R            | 16            | R            | KPC (-)/NDM1 (+)                |
| 5   | KN.096 | I01.1618 | 1144/0715 | Y69 | M   | Pus      | BV. NTP (Ngoại thần kinh) | *Escherichia coli* | 32           | R            | 32            | R            | KPC (-)/NDM1 (+)                |
| 6   | KN.207 | I01.2935 | 1275/1016 | Y78 | M   | Phân     | BV. NTP (Nơi tiết)    | *Escherichia coli* | 16           | R            | 4             | R            | KPC (-)/NDM1 (+)                |
| 7   | KN.215 | I01.2968 | 383/1116  | Y79 | F   | LRI      | BV. NTP (Nơi hô hấp) | *Escherichia coli* | 2            | I            | 0.25          | S            | KPC (-)/NDM1 (+)                |
| 8   | KN.230 | I01.3055 | 2222 DV/1216 | Y60 | M   | Pus      | BV. NTP (Nơi tiết)    | *Escherichia coli* | 32           | R            | 8             | R            | KPC (-)/NDM1 (+)                |
| 9   | KN.223 | I01.3081 | 2251/1216 | Y60 | M   | Pus      | BV. NTP (Nơi tiết)    | *Escherichia coli* | 32           | R            | 16            | R            | KPC (-)/NDM1 (+)                |
| 10  | KN.287 | I01.3015 | 1776/0417 | Y55 | M   | Phân     | BV. NTP (HSCD)        | *Escherichia coli* | 32           | R            | 16            | R            | KPC (-)/NDM1 (+)                |
| 11  | KN.304 | I01.3414 | 510/0617  | Y43 | F   | Pus      | BV. NTP (GMHS)        | *Escherichia coli* | 32           | R            | 16            | R            | KPC (-)/NDM1 (+)                |
| 12  | KN.308 | I01.3425 | 356DV/17  | Y76 | F   | LRI      | BV. Nguyễn Trãi       | *Escherichia coli* | 64           | R            | 32            | R            | KPC (-)/NDM1 (+)                |
| 13  | KN.321 | I01.3458 | 379DV/17  | Y90 | M   | LRI      | BV. Nguyễn Trãi       | *Escherichia coli* | 32           | R            | 32            | R            | KPC (-)/NDM1 (+)                |
| 14  | KN.330 | I01.3481 | 070/0717  | Y83 | F   | Urine    | BV. NTP (Ngoại thần kinh) | *Escherichia coli* | 32           | R            | 16            | R            | KPC (-)/NDM1 (+)                |
| 15  | KN.034 | I01.3580 | 1273/1213 | Y69 | M   | LRI      | BV. NTP (HSCD)        | *Escherichia coli* | 2            | I            | 0.25          | S            | KPC (-)/NDM1 (+)                |
| 16  | I01.5081 | 073/1018 | Y28 | M   | Urine    | BV. NTP (Nơi cấp cứu xương khớp) | *Escherichia coli* | < 0.25        | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                |
| 17  | I01.5082 | 084/1018 | Y45 | F   | Urine    | BV. NTP (Nơi thần)    | *Escherichia coli* | < 0.25        | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                |
| 18  | I01.5083 | 013/1018 | Y66 | F   | Urine    | BV. NTP (Nơi tim mạch) | *Escherichia coli* | < 0.25        | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                |
| 19  | I01.5085 | 190/1018 | Y43 | M   | Pus      | BV. NTP (Nơi tiết)    | *Escherichia coli* | < 0.25        | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                |
| 20  | I01.5086 | 202/1018 | Y21 | F   | Blood    | BV. NTP (Cấp cứu)     | *Escherichia coli* | < 0.25        | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                |
| 21  | I01.5087 | 251/1018 | Y26 | M   | Urine    | BV. NTP (Đa khoa)     | *Escherichia coli* | < 0.25        | S            | 0.25          | S            | KPC (-)/NDM1 (-)                |
| 22  | I01.5088 | 176/1018 | Y82 | F   | Urine    | BV. NTP (Đa khoa)     | *Escherichia coli* | < 0.25        | S            | 0.25          | S            | KPC (-)/NDM1 (-)                |
| 23  | I01.5089 | 203/1018 | Y21 | F   | Urine    | BV. NTP (Cấp cứu)     | *Escherichia coli* | < 0.25        | S            | 1             | S            | KPC (-)/NDM1 (-)                |
| 24  | I01.5090 | 143/1018 | Y76 | F   | Urine    | BV. NTP (Cấp cứu)     | *Escherichia coli* | < 0.25        | S            | 1             | S            | KPC (-)/NDM1 (-)                |
| 25  | I01.5091 | 179/1018 | Y88 | F   | Pus      | BV. NTP (TMCT)        | *Escherichia coli* | < 0.25        | S            | 0.5           | S            | KPC (-)/NDM1 (-)                |
| 26  | I01.5092 | 151/1018 | Y32 | M   | Urine    | BV. NTP (Nơi thần)    | *Escherichia coli* | 0.25          | S            | 0.5           | S            | KPC (-)/NDM1 (-)                |
| 27  | I01.5093 | 508/1018 | Y70 | F   | Urine    | BV. NTP (GMHS)        | *Escherichia coli* | 1            | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                |
| 28  | I01.5094 | 461/1018 | Y25 | F   | Pus      | BV. NTP (Nơi cơ xương khớp) | *Escherichia coli* | 1            | S            | < 0.25        | S            | KPC (-)/NDM1 (-)                | (Continues)
| STT | SID | ID-Patient | Hospital (department) | Specimen | Age | Sex | Bacteria | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|-----|------------|----------------------|----------|-----|-----|----------|-------------|-------------|--------------|--------------|--------------|
| 29  | 101.5097 | 580/1018 | BV NTP (Nghiêngтом hop) | Urine | 17 | F | Escherichia coli | 0.25 | S | 0.25 | 1 | S KPC (−)/NDM1 (−) |
| 30  | 101.5098 | 704/1018 | BV NTP (Nghiêngtom hop) | Urine | 60 | F | Escherichia coli | 0.25 | 1 | 0.25 | S | S KPC (−)/NDM1 (−) |
| 31  | 101.5101 | 707/1018 | BV NTP (Nghiêngtom hop) | Urine | 58 | F | Escherichia coli | 0.5 | 1 | 0.5 | S | S KPC (−)/NDM1 (−) |
| 32  | 101.5102 | 679/1018 | BV NTP (Nghiêngtom hop) | Urine | 62 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 33  | 101.5103 | 673/1018 | BV NTP (Nghiêngtom hop) | Urine | 31 | M | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 34  | 101.5104 | 673/1018 | BV NTP (Nghiêngtom hop) | Urine | 37 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 35  | 101.5105 | 673/1018 | BV NTP (Nghiêngtom hop) | Urine | 43 | M | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 36  | 101.5106 | 673/1018 | BV NTP (Nghiêngtom hop) | Urine | 46 | M | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 37  | 101.5107 | 673/1018 | BV NTP (Nghiêngtom hop) | Urine | 49 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 38  | 101.5108 | 673/1018 | BV NTP (Nghiêngtom hop) | Urine | 51 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 39  | 101.5111 | 704/1018 | BV NTP (Nghiêngtom hop) | Urine | 60 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 40  | 101.5112 | 704/1018 | BV NTP (Nghiêngtom hop) | Urine | 62 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 41  | 101.5113 | 704/1018 | BV NTP (Nghiêngtom hop) | Urine | 62 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 42  | 101.5114 | 704/1018 | BV NTP (Nghiêngtom hop) | Urine | 62 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 43  | 101.5115 | 704/1018 | BV NTP (Nghiêngtom hop) | Urine | 62 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 44  | 101.5116 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 65 | M | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 45  | 101.5117 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 46  | 101.5118 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 47  | 101.5119 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 48  | 101.5120 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 49  | 101.5121 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 50  | 101.5122 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |
| 51  | 101.5123 | 847/1018 | BV NTP (Nghiêngtom hop) | Urine | 68 | F | Escherichia coli | 0.5 | 0.25 | <0.25 | S | S KPC (−)/NDM1 (−) |

(Continued)
| STT | SID   | ID     | ID patient (department) | Specimen  | Bacteria                | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|-------|--------|------------------------|------------|-------------------------|--------------|--------------|---------------|---------------|---------------|
| 52  | KN.086| I02.0291| 2267DV/1015 | Y 36 F Pus | Enterobacter aerogenes  | 8            | R            | 1 S           |               |               |
| 53  | KN.112| I02.0485| 1246DV Y56 M Pus   | BV 7A      | Enterobacter aerogenes  | 4            | R 0.5        | S             |               |               |
| 54  | KN.161| I02.532 | 1798/0816 Y49 M LRI (Sputum) | BV NTP (Nơi tiêu hóa) | Enterobacter aerogenes  | 8            | R 1 S        |               |               |               |
| 55  | KN.088| I03.0609| 205/0215 Y80 M Urine | BV NTP (Nội cơ xương khớp) | Klebsiella pneumoniae | > 128        | R > 128      | R             |               |               |
| 56  | KN.057| I03.0656| 639/0315 Y65 M Pus | BV NTP (HSCD) | Klebsiella pneumoniae  | 8            | R 16 S       | R             |               |               |
| 57  | KN.062| I03.0693| 093/0415 Y62 M LRI (Sputum) | BV NTP (Nơi hô hấp) | Klebsiella pneumoniae | 4            | R 8 S        | R             |               |               |
| 58  | KN.061| I03.0694| 091B/0415 Y49 M LRI (Sputum) | BV NTP (Nơi hô hấp) | Klebsiella pneumoniae | 4            | R 8 S        | R             |               |               |
| 59  | KN.064| I03.0709| 678/0415 Y63 F LRI (Sputum) | BV NTP (HSCD) | Klebsiella pneumoniae | 8            | R 4 S        | R             |               |               |
| 60  | KN.064| I03.0709| 678/0415 Y63 F LRI (Sputum) | BV NTP (HSCD) | Klebsiella pneumoniae | 8            | R 1 S        | R             |               |               |
| 61  | KN.089| I03.0710| 729/0415 Y63 F LRI (Sputum) | BV NTP (HSCD) | Klebsiella pneumoniae | 4            | R 1 S        | R             |               |               |
| 62  | KN.090| I03.0711| 733/0415 Y63 F Pus | BV NTP (HSCD) | Klebsiella pneumoniae | 4            | R 1 S        | S             |               |               |
| 63  | KN.070| I03.0740| 338/0515 Y51 M Pus | BV NTP (GMHS) | Klebsiella pneumoniae | 4            | R 4 S        | R             |               |               |
| 64  | KN.070| I03.0740| 338/0515 Y51 M Pus | BV NTP (GMHS) | Klebsiella pneumoniae | 2            | I 1 S        |               |               |               |
| 65  | KN.066| I03.0742| 354/0515 Y64 M LRI (Sputum) | BV NTP (Nơi hô hấp) | Klebsiella pneumoniae | 4            | R 1 S        | R             |               |               |
| 66  | KN.073| I03.0779| 1561/0515 Y78 F Blood (CVC) | BV NTP (ĐVLM) | Klebsiella pneumoniae | 128          | R 128 S      | R             |               |               |
| 67  | KN.074| I03.0815| 1338/0615 Y92 F Urine | BV NTP (Nơi cơ xương khớp) | Klebsiella pneumoniae | 128          | R 128 S      | R             |               |               |
| 68  | KN.092| I03.0844| 543/0715 Y92 F Urine | BV NTP (Nơi cơ xương khớp) | Klebsiella pneumoniae | 128          | R 64 S       | R             |               |               |
| 69  | KN.097| I03.0856| 1145/0715 Y82 F LRI (Sputum) | BV NTP (Ngoại thần kinh) | Klebsiella pneumoniae | 8            | R 16 S       | R             |               |               |
| 70  | KN.095| I03.0857| 1110/0715 Y96 F Urine | BV NTP (HSCD) | Klebsiella pneumoniae | 2            | I 1 S        | S             |               |               |

(Continued)
| STT | SID  | ID    | ID patient | Age | Sex | Specimen       | Hospital (department) | Bacteria                  | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|------|-------|------------|-----|-----|----------------|----------------------|-------------------------|--------------|--------------|---------------|---------------|---------------|
| 71  | KN.080 | I03.0903 | 1261/0815  | Y22 | F   | LRI (Sputum)  | BV. NTP (HSCĐ)       | Klebsiella pneumoniae   | 8            | R            | 16            | R             | KPC (-)/NDM1 (-) |
| 72  | KN.081 | I03.0907 | 1340/0815  | Y71 | M   | LRI (Sputum)  | BV. NTP (Nơi tổng hôp) | Klebsiella pneumoniae   | 8            | R            | 32            | R             | KPC (-)/NDM1 (+) |
| 73  | KN.082 | I03.0913 | 1510/0815  | Y63 | F   | Pus           | BV. NTP (HSCĐ)       | Klebsiella pneumoniae   | 128           | R            | 64            | R             | KPC (-)/NDM1 (+) |
| 74  | KN.098 | I03.0959 | 2078DV/0915| Y77 | M   | LRI (Sputum)  | BV. Nguyễn Trãi       | Klebsiella pneumoniae   | 8            | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 75  | KN.083 | I03.1004 | 1306/1015  | Y80 | F   | Urine         | BV. NTP (Nơi tim mạch) | Klebsiella pneumoniae   | 16           | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 76  | KN.085 | I03.1010 | 2311DV/1015| Y34 | F   | Pus           | BV 7A                 | Klebsiella pneumoniae   | 8            | R            | 1             | S             | KPC (-)/NDM1 (+) |
| 77  | KN.085 | I03.1010 | 2311DV/1015| Y34 | F   | Pus           | BV 7A                 | Klebsiella pneumoniae   | 8            | R            | 1             | S             | KPC (-)/NDM1 (-)  |
| 78  | KN.111 | I03.1133 | 023DV/0116 | Y88 | M   | LRI (Sputum)  | BV. Nguyễn Trãi       | Klebsiella pneumoniae   | 32           | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 79  | KN.201 | I03.1169 | 1551/0116  | Y85 | M   | LRI (Sputum)  | BV. NTP (Đa khoa)     | Klebsiella pneumoniae   | 32           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 80  | KN.140 | I03.1180 | 1930/0116  | Y58 | M   | LRI (Sputum)  | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae   | 8            | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 81  | KN.145 | I03.1217 | 252Q2/0316 | Y58 | F   | Urine         | BV. Quận 2           | Klebsiella pneumoniae   | 8            | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 82  | KN.147 | I03.1223 | 402DV/0316 | Y66 | M   | Pus           | BV 7A                 | Klebsiella pneumoniae   | 8            | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 83  | KN.151 | I03.1249 | 558DV/0316 | Y66 | M   | Pus           | BV 7A                 | Klebsiella pneumoniae   | 16           | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 84  | KN.151 | I03.1249 | 558DV/0316 | Y66 | M   | Pus           | BV 7A                 | Klebsiella pneumoniae   | 16           | R            | 1             | S             | KPC (-)/NDM1 (-) |
| 85  | KN.139 | I03.1255 | 2108/0316  | Y74 | M   | LRI (Sputum)  | BV. NTP (Đa khoa)     | Klebsiella pneumoniae   | 16           | R            | 32            | R             | KPC (+)/NDM1 (-) |
| 86  | KN.153 | I03.1278 | 772/0416   | Y63 | M   | Pus           | BV. NTP (Nơi tiết)    | Klebsiella pneumoniae   | 128          | R            | 64            | R             | KPC (-)/NDM1 (+) |
| 87  | KN.158 | I03.1284 | 1099HM/0416| Y48 | M   | Pus           | BV. Hoàn Mỹ           | Klebsiella pneumoniae   | 2            | I            | 4             | R             | KPC (-)/NDM1 (+) |
| 88  | KN.155 | I03.1290 | 1279/0416  | Y84 | F   | LRI (Sputum)  | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae   | 16           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| STT | SID   | ID     | ID patient | Age | Sex | Specimen | Hospital (department) | Bacteria | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|--------|--------|------------|-----|-----|----------|----------------------|----------|--------------|--------------|--------------|--------------|---------------|
| 89  | KN.160 | I03.1307 | 319/0516   | Y89 | F   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae | 8            | R             | 4             | R             | KPC (−)/NDM1 (+) |
| 90  | KN.159 | I03.1324 | 639-Q2     | Y65 | F   | LRI (Sputum) | BV. Quân 2           | Klebsiella pneumoniae | 128          | R             | 64            | R             | KPC (−)/NDM1 (+) |
| 91  | KN.162 | I03.1333 | 1582/0516  | Y58 | F   | Pus      | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 4           | R             | 1             | S             | KPC (−)/NDM1 (−) |
| 92  | KN.116 | I03.1346 | 1948/0516  | Y84 | F   | Pus      | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 2           | I             | 1             | S             | KPC (−)/NDM1 (−) |
| 93  | KN.115 | I03.1347 | 1947/0516  | Y84 | F   | LRI (Sputum) | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 2           | I             | 1             | S             | KPC (−)/NDM1 (−) |
| 94  | KN.119 | I03.1353 | 366/0616   | Y83 | F   | Pus      | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 8           | R             | 16            | R             | KPC (−)/NDM1 (+) |
| 95  | KN.120 | I03.1358 | 439/0616   | Y87 | F   | LRI (Sputum) | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 8           | R             | 8             | R             | KPC (−)/NDM1 (+) |
| 96  | KN.164 | I03.1367 | 791/0616   | Y47 | M   | Urine    | BV. NTP (Nơi cc xương khớp) | Klebsiella pneumoniae | 4           | R             | 1             | S             | KPC (−)/NDM1 (−) |
| 97  | KN.156 | I03.1369 | 727/0616   | Y84 | F   | Pus      | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 128          | R             | 128           | R             | KPC (−)/NDM1 (+) |
| 98  | KN.124 | I03.1373 | 949/0616   | Y83 | M   | Pus      | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 8           | R             | 16            | R             | KPC (−)/NDM1 (+) |
| 99  | KN.165 | I03.1381 | 1099/0616  | Y84 | F   | Pus      | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 4           | R             | 1             | S             | KPC (−)/NDM1 (−) |
| 100 | KN.194 | I03.1382 | 1171/0616  | Y86 | M   | LRI (Sputum) | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 1           | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 101 | KN.194 | I03.1382 | 1171/0616  | Y86 | M   | LRI (Sputum) | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 1           | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 102 | KN.193 | I03.1390 | 631/0916   | Y21 | F   | LRI (Sputum) | BV. NTP (Nơi thận) | Klebsiella pneumoniae | > 128        | R             | 64            | R             | KPC (−)/NDM1 (+) |
| 103 | KN.175 | I03.1394 | 1794/0616  | Y57 | F   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae | 2           | I             | 1             | S             | KPC (−)/NDM1 (−) |
| 104 | KN.125 | I03.1404 | 934-Q2     |     |     | Urine    | BV. Quân 2          | Klebsiella pneumoniae | 32          | R             | 8             | R             | KPC (−)/NDM1 (+) |
| 105 | KN.166 | I03.1424 | 1023/0716  | Y82 | F   | LRI (Sputum) | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 2           | I             | 1             | S             | KPC (−)/NDM1 (−) |
| 106 | KN.195 | I03.1433 | 1137/0716  | Y66 | F   | LRI (Sputum) | BV. NTP (HSCĐ)     | Klebsiella pneumoniae | 32          | R             | 8             | R             | KPC (−)/NDM1 (+) |

(Continues)
| Patient ID | ID | Age | Sex | Specimen | Hospital (department) | Bacteria | MIC | AST | Result of PCR |
|------------|----|-----|-----|----------|----------------------|----------|-----|-----|--------------|
| 107        | KN.167 | 26/16 | Y66 | F | Urine | Klebsiella pneumoniae | MIC: 8 | AST: R | KPC(−)/NDM1(+) |
| 108        | KN.132 | 28/16 | Y59 | F | Urine | Klebsiella pneumoniae | MIC: 32 | AST: R | KPC(−)/NDM1(+) |
| 109        | KN.170 | 27/16 | Y52 | F | Urine | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 110        | KN.168 | 27/16 | Y66 | F | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 111        | KN.134 | 28/16 | Y63 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 112        | KN.134 | 28/16 | Y63 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 2 | AST: S | KPC(−)/NDM1(+) |
| 113        | KN.169 | 28/16 | Y67 | F | Blood (CVC) | Klebsiella pneumoniae | MIC: 8 | AST: R | KPC(−)/NDM1(+) |
| 114        | KN.171 | 28/16 | Y24 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 32 | AST: R | KPC(−)/NDM1(+) |
| 115        | KN.173 | 28/16 | Y21 | F | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 116        | KN.172 | 28/16 | Y25 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 32 | AST: R | KPC(−)/NDM1(+) |
| 117        | KN.198 | 29/16 | Y9 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 118        | KN.176 | 29/16 | Y9 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 119        | KN.183 | 29/16 | Y69 | F | LRI (Sputum) | Klebsiella pneumoniae | MIC: 64 | AST: R | KPC(−)/NDM1(+) |
| 120        | KN.180 | 29/16 | Y55 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 64 | AST: R | KPC(−)/NDM1(+) |
| 121        | KN.184 | 29/16 | Y64 | F | LRI (Sputum) | Klebsiella pneumoniae | MIC: 2 | AST: S | KPC(−)/NDM1(+) |
| 122        | KN.185 | 29/16 | Y81 | F | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 123        | KN.191 | 30/16 | Y9 | M | LRI (Sputum) | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| 124        | KN.204 | 30/16 | Y85 | M | Pus | Klebsiella pneumoniae | MIC: 16 | AST: R | KPC(−)/NDM1(+) |
| STT | SID     | ID      | ID patient | Age | Sex | Specimen (department) | Bacteria                           | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|---------|---------|------------|-----|-----|------------------------|------------------------------------|--------------|--------------|---------------|---------------|--------------|
| 125 | KN.203  | I03.1559| 736/1016    | Y84 | M   | LRI (Sputum) BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae              | 32           | R            | 8             | R             | KPC (+)/NDM1 (+) |
| 126 | KN.205  | I03.1562| 914/1016    | Y66 | F   | LRI (Sputum) BV. NTP (Nội hô hấp) | Klebsiella pneumoniae              | 16           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 127 | KN.200  | I03.1566| 1399A/1016  | Y58 | M   | Pus BV. NTP (HSCĐ) | Klebsiella pneumoniae              | 4            | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 128 | KN.209  | I03.1571| 1603/1016   | Y75 | M   | LRI (Sputum) BV. NTP (HSCĐ) | Klebsiella pneumoniae              | 128          | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 129 | KN.210  | I03.1599| 699/1116    | Y64 | F   | LRI (Sputum) BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae              | 16           | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 130 | KN.220  | I03.1622| 104/1216    | Y55 | M   | LRI (Sputum) BV. NTP (Nội hô hấp) | Klebsiella pneumoniae              | 64           | R            | 32            | R             | KPC (-)/NDM1 (+) |
| 131 | KN.219  | I03.1624| 2151DV/1216 | Y20 | M   | Pus BV 7A | Klebsiella pneumoniae              | 8            | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 132 | KN.231  | I03.1626| 2173 DV/1216 | Y28 | M   | Pus BV 7A | Klebsiella pneumoniae              | 4            | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 133 | KN.221  | I03.1627| 424/1216    | Y81 | F   | LRI (Sputum) BV. NTP (Nội hô hấp) | Klebsiella pneumoniae              | 16           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 134 | KN.236  | I03.1630| 2142-Q2/16  | Y72 | F   | Pus BV. Quân 2 | Klebsiella pneumoniae              | 8            | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 135 | KN.264  | I03.1633| 680/1216    | Y80 | F   | LRI (Sputum) BV. NTP (Nội hô hấp) | Klebsiella pneumoniae              | 32           | R            | 8             | R             | KPC (+)/NDM1 (+) |
| 136 | KN.229  | I03.1637| 828/1216    | Y81 | F   | LRI (Sputum) BV. NTP (Nội hô hấp) | Klebsiella pneumoniae              | 32           | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 137 | KN.222  | I03.1655| 1492/1216   | Y73 | M   | LRI (Sputum) BV. NTP (Nội tiết) | Klebsiella pneumoniae              | 16           | R            | 16            | R             | KPC (-)/NDM1 (+) |
| 138 | KN.265  | I03.1668| 2294DV/1216 | Y76 | F   | LRI (Sputum) BV. Nguyễn Trãi | Klebsiella pneumoniae              | 8            | R            | 4             | R             | KPC (-)/NDM1 (+) |
| 139 | KN.250  | I03.1673| 344/0117    | Y91 | F   | Pus BV. Đa khoa | Klebsiella pneumoniae              | 64           | R            | 32            | R             | KPC (-)/NDM1 (+) |
| 140 | KN.249  | I03.1678| 023DV      | Y96 | M   | LRI (Sputum) BV. Đa khoa | Klebsiella pneumoniae              | 32           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 141 | KN.239  | I03.1683| 700/0117    | Y80 | F   | LRI (Sputum) BV. NTP (Nội hô hấp) | Klebsiella pneumoniae              | 32           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| 142 | KN.241  | I03.1685| 840/0117    | Y71 | M   | LRI (Sputum) BV. NTP (HSCĐ) | Klebsiella pneumoniae              | 16           | R            | 8             | R             | KPC (-)/NDM1 (+) |
| STT | SID   | ID      | ID patient | Age | Sex | Specimen          | Hospital (department)   | Bacteria                     | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR     |
|-----|-------|---------|------------|-----|-----|--------------------|-------------------------|----------------------------|--------------|--------------|---------------|---------------|------------------|
| 143 | KN.245| I03.1693| 1177/0117  | Y91 | F   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 16           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 144 | KN.246| I03.1694| 1240/1216  | Y79 | F   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 64           | R            | 32            | R             | KPC(-)/NDM1(+)   |
| 145 | KN.247| I03.1699| 1517/0117  | Y59 | M   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 64           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 146 | KN.256| I03.1700| 003/0217   | Y55 | M   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 128          | R            | 32            | R             | KPC(-)/NDM1(+)   |
| 147 | KN.255| I03.1703| 089/0217   | Y22 | F   | LRI (Sputum)       | BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae   | 64           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 148 | KN.254| I03.1704| 127/0217   | Y79 | F   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 128          | R            | 16            | R             | KPC(-)/NDM1(+)   |
| 149 | KN.252| I03.1706| 214/0217   | Y36 | M   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 128          | R            | 32            | R             | KPC(-)/NDM1(+)   |
| 150 | KN.261| I03.1733| 072/0317   | Y57 | M   | LRI (BAL)          | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 64           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 151 | KN.262| I03.1735| 059/0317   | Y83 | M   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 32           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 152 | KN.263| I03.1748| 473/0317   | Y92 | M   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 8            | R            | 0.5           | S             | KPC(+)/NDM1(-)   |
| 153 | KN.269| I03.1755| 626A/0317  | Y01 | F   | LRI (Sputum)       | BV. NTP (HSCĐ)          | Klebsiella pneumoniae   | 128          | R            | 16            | R             | KPC(-)/NDM1(+)   |
| 154 | KN.270| I03.1760| 787/0317   | Y83 | M   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | > 128         | R            | 128           | R             | KPC(+)/NDM1(+)   |
| 155 | KN.279| I03.1791| 073/0417   | Y87 | M   | Blood              | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 16           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 156 | KN.284| I03.1796| 547/0417   | Y72 | M   | Pus                | BV. NTP (HSCĐ)          | Klebsiella pneumoniae   | 32           | R            | 16            | R             | KPC(-)/NDM1(+)   |
| 157 | KN.282| I03.1805| 1221/0417  | Y81 | F   | LRI (BAL)          | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 8            | R            | 4             | R             | KPC(-)/NDM1(+)   |
| 158 | KN.283| I03.1806| 1270/0417  | Y72 | F   | LRI (Sputum)       | BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae   | 32           | R            | 8             | R             | KPC(-)/NDM1(+)   |
| 159 | KN.289| I03.1821| 299DV/17   | Y90 | F   | LRI (Sputum)       | BV. Nguyễn Trãi         | Klebsiella pneumoniae   | 8            | R            | 4             | R             | KPC(+)/NDM1(-)   |
| 160 | KN.291| I03.1827| 1167/0517  | Y72 | F   | LRI (Sputum)       | BV. NTP (Nơi hô hấp)   | Klebsiella pneumoniae   | 16           | R            | 16            | R             | KPC(-)/NDM1(+)   |
| STT | SID   | ID    | ID patient | Age | Sex | Specimen (department) | Bacteria                        | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|-------|-------|------------|------|-----|-----------------------|--------------------------------|--------------|-------------|--------------|---------------|---------------|
| 161 | KN.292| I03.1831 | 1235/0517  | Y72  | F   | LRI (Sputum)          | **Klebsiella pneumoniae**      | 32           | R           | 8            | R             | KPC (-)/NDM1 (+) |
| 162 | KN.302| I03.1845 | 1849/0517  | Y47  | M   | LRI (Sputum)          | **Klebsiella pneumoniae**      | 32           | R           | 8            | R             | KPC (-)/NDM1 (+) |
| 163 | KN.298| I03.1855 | 162/0617   | Y84  | M   | Urine                 | **Klebsiella pneumoniae**      | > 128        | R           | 128          | R             | KPC (-)/NDM1 (+) |
| 164 | KN.301| I03.1862 | 300/0617   | Y79  | F   | LRI (Sputum)          | **Klebsiella pneumoniae**      | 16           | R           | 8            | R             | KPC (-)/NDM1 (+) |
| 165 | KN.309| I03.1879 | 1010/0617  | Y84  | M   | Pus                   | **Klebsiella pneumoniae**      | > 128        | R           | > 128        | R             | KPC (-)/NDM1 (+) |
| 166 | KN.310| I03.1880 | 1043/0617  | Y71  | M   | Pus                   | **Klebsiella pneumoniae**      | > 128        | R           | > 128        | R             | KPC (-)/NDM1 (+) |
| 167 | KN.311| I03.1881 | 1044/0617  | Y75  | M   | Pus                   | **Klebsiella pneumoniae**      | > 128        | R           | > 128        | R             | KPC (-)/NDM1 (+) |
| 168 | KN.327| I03.1898 | 1918B/0617 | Y81  | F   | LRI (Sputum)          | **Klebsiella pneumoniae**      | 8            | R           | 8            | R             | KPC (+)/NDM1 (+) |
| 169 | KN.328| I03.1900 | 380DV/17   | Y90  | F   | LRI (Sputum)          | **Klebsiella pneumoniae**      | 16           | R           | 4            | R             | KPC (+)/NDM1 (-)  |
| 170 | KN.325| I03.1922 | 178BV7A    | Y58  | M   | Pus                   | **Klebsiella pneumoniae**      | 32           | R           | 16           | R             | KPC (-)/NDM1 (+) |
| 171 | KN.332| I03.1924 | 518A/0717  | Y46  | M   | Blood (CVC)           | **Klebsiella pneumoniae**      | 64           | R           | 16           | R             | KPC (-)/NDM1 (+) |
| 172 | KN.334| I03.1933 | 916/0717   | Y49  | F   | Pus                   | **Klebsiella pneumoniae**      | 16           | R           | 8            | R             | KPC (-)/NDM1 (+) |
| 173 | KN.335| I03.1935 | 1146/0717  | Y80  | F   | Urine                 | **Klebsiella pneumoniae**      | 16           | R           | 16           | R             | KPC (-)/NDM1 (+) |
| 174 | KN.337| I03.1941 | 196BV7A    | Y58  | M   | Pus                   | **Klebsiella pneumoniae**      | 32           | R           | 16           | R             | KPC (-)/NDM1 (+) |
| 175 | I03.2783 | 116/1018 | Y48  | M   | Pus                   | **Klebsiella pneumoniae**      | 0.25         | S           | 0.25         | S             | KPC (-)/NDM1 (-) |
| 176 | I03.2785 | 179/1018 | Y88  | F   | Pus                   | **Klebsiella pneumoniae**      | 1            | S           | 0.25         | S             | KPC (-)/NDM1 (-) |
| 177 | I03.2786 | 376/1018 | Y73  | F   | Pus                   | **Klebsiella pneumoniae**      | 1            | S           | 0.25         | S             | KPC (-)/NDM1 (-) |
| 178 | I03.2787 | 379/1018 | Y62  | M   | Pus                   | **Klebsiella pneumoniae**      | 1            | S           | 0.25         | S             | KPC (-)/NDM1 (-) |

(Continues)
| STT | SID    | ID     | ID patient | Age | Sex | Specimen | Hospital (department) | Bacteria                  | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR |
|-----|--------|--------|------------|-----|-----|----------|-----------------------|----------------------------|---------------|---------------|---------------|---------------|---------------|
| 179 | I03.2790 | 318/1018 | Y51       | M   | LRI (Sputum) | BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae | 1             | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 180 | I03.2791 | 345/1018 | Y57       | F   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae | 1             | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 181 | I03.2792 | 506/1018 | Y73       | F   | LRI (Sputum) | BV. NTP (GMHS) | Klebsiella pneumoniae | 1             | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 182 | I03.2793 | 507/1018 | Y73       | F   | LRI (Sputum) | BV. NTP (GMHS) | Klebsiella pneumoniae | 0.5           | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 183 | I03.2794 | 413/1018 | Y73       | F   | Blood       | BV. NTP (Nơi tiết) | Klebsiella pneumoniae | 0.5           | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 184 | I03.2795 | 414/1018 | Y73       | F   | Blood       | BV. NTP (Nơi tiết) | Klebsiella pneumoniae | 0.5           | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 185 | I03.2796 | 432/1018 | Y70       | F   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae | 0.5           | S             | 0.5           | S             | KPC (−)/NDM1 (−) |
| 186 | I03.2797 | 783/1018 | Y64       | F   | LRI (Sputum) | BV. NTP (Nơi cơ xương khớp) | Klebsiella pneumoniae | 0.5           | S             | 0.25          | S             | KPC (−)/NDM1 (−) |
| 187 | I03.2799 | 736/1018 | Y87       | M   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae | 1             | S             | 0.25          | S             | KPC (−)/NDM1 (−) |
| 188 | I03.2800 | 784/1018 | Y38       | F   | Urine       | BV. NTP (Nơi tim mạch) | Klebsiella pneumoniae | 1             | S             | 0.25          | S             | KPC (−)/NDM1 (−) |
| 189 | I03.2807 | 1091/1018 | Y77      | M   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Klebsiella pneumoniae | 1             | S             | < 0.25        | S             | KPC (−)/NDM1 (−) |
| 190 | I03.2809 | 1285/1018 | Y65      | F   | LRI (Sputum) | BV. NTP (Nơi tiết) | Klebsiella pneumoniae | 1             | S             | < 0.25        | S             | KPC (−)/NDM1 (−) |
| 191 | I03.2817 | 1487/1018 | Y44      | F   | Urine       | BV. NTP (GMHS) | Klebsiella pneumoniae | 1             | S             | 0.25          | S             | KPC (−)/NDM1 (−) |
| 192 | I03.2819 | 1567/1018 | Y84      | F   | LRI (Sputum) | BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae | 1             | S             | 0.25          | S             | KPC (−)/NDM1 (−) |
| 193 | I03.2820 | 1579/1018 | Y87      | M   | LRI (Sputum) | BV. NTP (Ngoại thần kinh) | Klebsiella pneumoniae | 1             | S             | 0.25          | S             | KPC (−)/NDM1 (−) |
| 194 | KN.072 | 1077/0515 | Y40      | M   | LRI (Sputum) | BV. NTP (Ngoại hô hấp) | Klebsiella pneumoniae | 4             | 1             | S             |               | KPC (−)/NDM1 (−) |
| 195 | KN.047 | 1922/0814 | Y81      | F   | LRI (Sputum) | BV. NTP (Nơi hô hấp) | Escherichia. coli | 2             | 1             | S             |               | KPC (−)/NDM1 (−) |
| 196 | KN.058 | 394DV/0315 | Y63      | M   | LRI (Sputum) | BV. Nguyễn Trãi | Klebsiella pneumoniae | 2             | 1             | S             |               | KPC (−)/NDM1 (−) |
**APPENDIX A1** (Continued)

| STT | SID   | ID     | ID patient | Age | Sex | Specimen | Hospital (department) | Bacteria             | MIC imipenem | AST imipenem | MIC meropenem | AST meropenem | Result of PCR  |
|-----|-------|--------|------------|-----|-----|----------|------------------------|----------------------|--------------|--------------|---------------|---------------|----------------|
| 197 | KN.022| 405DV/0514 | 23         | M   | Pus | BV 7A    | Enterobacter cloacae   | 4         | 1            | S             | KPC (−)/NDM1 (−) |                |
| 198 | KN.016| 499/0214  | 79         | M   | Urine | BV, NTP (HSCĐ) | Klebsiella pneumoniae | 8         | 1            | S             | KPC (−)/NDM1 (−) |                |
| 199 | KN.041| 831DV/0514 | 30         | F   | Pus | BV 7A    | Klebsiella pneumoniae | 2         | 1            | S             | KPC (−)/NDM1 (−) |                |
| 200 | KN.045| 927/0814  | 52         | M   | Pus | BV, NTP (HSCĐ) | Klebsiella pneumoniae | 4         | 1            | S             | KPC (−)/NDM1 (−) |                |